TRANSACTIONS

OF THE

NEW ZEALAND INSTITUTE

WILLIAM MILES MASKELL

See Volume XXXI., pp. 707 and 708.

TRANSACTIONS

AND

PROCEEDINGS

OF THE

NEW ZEALAND INSTITUTE

1900

VOL. XXXIII.

(Sixteenth 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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CORRIGENDA.

Page 303, line 13. *After* Miriam *insert* Tarawau.
" line 27. *For* true varieties *read* tree varieties.

CONTENTS.

TRANSACTIONS.

I.—Zoology.

II.—Botany.

NEW ZEALAND INSTITUTE.

PROCEEDINGS.

WELLINGTON PHILOSOPHICAL SOCIETY.

AUCKLAND INSTITUTE.

PHILOSOPHICAL INSTITUTE OF CANTERBURY.

OTAGO INSTITUTE.

HAWKE'S BAY PHILOSOPHICAL INSTITUTE.

WESTLAND INSTITUTE.

NELSON PHILOSOPHICAL SOCIETY.

APPENDIX.

LIST OF PLATES.

[NOTE.—These are placed at the end of the volume.]

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.)

W. T. L. Travers, F.L.S.; Sir James Hector, K.C.M.G., M.D., F.R.S.; Thomas Mason; E. Tregear, F.R.G.S.; John Young; J. W. Joynt, M.A.

(ELECTED.)

1899.—Martin Chapman; S. Percy Smith, F.R.G.S.; Hon. C. C. Bowen.

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.

ROLL 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 1901.—*President*—G. V. Hudson, F.E.S.; *Vice-presidents*—H. B. Kirk, M.A., Sir J. Hector, K.C.M.G., M.D., F.R.S.; *Council*—G. Hogben, M.A., R. C. Harding, H. N. McLeod, R. L. Mestayer, M.Inst.C.E., E. Tregear, F.R.G.S., Martin Chapman, and George Denton; *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 1901.—*President*—J. Stewart, Esq., C.E.; *Vice-presidents*—Professor H. W. Segar and J. Batger; *Council*—C. Cooper, H. Haines, A. Hunter, C.E., E. V. Miller, T. Peacock, J. A. Pond, Dr. H. Swale; Professor Talbot-Tubbs, Professor A. P. Thomas, J. H. Upton; *Secretary and Treasurer*—T. F. Cheeseman, *Auditor*—W. Gorrie.

Extracts from the Rules of the Auckland Institute.

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

6. The annual subscription shall be one guinea. Members may at any time become life-members by one payment of ten guineas in lieu of future annual subscriptions.

9. The annual subscription shall become due on the first day of April for the year then commencing. The first year's subscription of a new member shall become due on the day of his election.

30. An annual general meeting of the Institute, convened by advertisement or circular, shall be held in the month of February in each year.

32. Ordinary meetings for the reading of papers, and for transacting the general business of the Institute, shall be called at such times as the Council shall decide.

PHILOSOPHICAL INSTITUTE OF CANTERBURY.

Office-bearers for 1901.—*President*—Captain F. W. Hutton; *Vice-presidents*—Mr. J. B. Mayne, Dr. W. P. Evans; *Hon. Secretary*—Professor A. Dendy; *Hon. Treasurer*—Dr. Charles Chilton; *Council*—Dr. W. H. Symes, Mr. L. Cockayne, Mr. R. M. Laing, Mr. C. C. Farr, Professor Scott, Mr. A. E. Flower; *Hon. Auditor*—Mr. George Way, F.I.A., N.Z.

Extracts from the Rules of the Philosophical Institute of Canterbury.

8. Every member of the Institute other than honorary shall pay one guinea annually as a subscription to the funds of the Institute. The subscription shall be due on the 1st January in each year.

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

15. The ordinary meetings of the Institute shall be held monthly during the months from May to November, both inclusive, on such day as the Council may determine.

OTAGO INSTITUTE.

Office-bearers for 1901.—*President*—Mr. G. M. Thomson; *Vice-presidents*—Mr. E. Melland and Mr. F. R. Chapman; *Hon. Secretary*—Professor Benham; *Hon. Treasurer*—Mr. W. Fels; *Council*—Messrs. A. Bathgate, S. Barningham, C. W. Chamberlain, A. Hamilton, T. D. Pearce, Dr. Hocken, and Dr. Colquhoun; *Auditor*—Mr. 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 the 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 1901.—*President*—Mr. A. Mahan; *Vice-president* — Dr. Teichelmann; *Hon. Treasurer* — Mr. G. K. Sinclair; *Trustees*—Messrs. T. W. Beare, W. Heinz, J. J. Clarke, J. S. Dawes, J. B. Lewis, D. Macfarlane, R. McNaughton, J. Park, H. L. Michel, A. J. Morton, G. Perry, and Dr. Macandrew.

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 1901.—*President*—W. Dinwiddie; *Vice-president*—F. Hutchinson, jun.; *Council*—J. E. H. Jarvis, M.R.C.S., T. Hall, H. Hill, B.A., F.G.S., J. S. Large, T. Tanner, A. Ronald, M.B., Ch.B.; *Hon. Secretary*—James Hislop; *Hon. Treasurer*—J. W. Craig; *Hon. Auditor*—G. White.

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

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

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

(5.) The session of the Hawke's Bay Philosophical Institute shall be during the winter months from May to October, both inclusive; and ordinary meetings shall be held on the second Monday in each of those six months, at 7.30 p.m.

SOUTHLAND INSTITUTE.

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

NELSON PHILOSOPHICAL SOCIETY.

Office-bearers for 1901.—*President*—The Bishop of Nelson; *Vice-presidents*, A. S. Atkinson and Dr. Mackie; *Hon. Secretary*—R. I. Kingsley; *Hon. Treasurer*—Dr. Hudson; *Hon. Curator*—R. I. Kingsley; *Assistant Curator*—E. Lukins; *Council*—The President, Vice-presidents, Hon. Secretary, Hon. Treasurer, F. G. Gibbs, E. Lukins, J. S. Chatterton, and J. G. Bartell.

Extracts from the Rules of the Nelson Philosophical Society.

4. Members shall be elected by ballot.

6. The annual subscription shall be one guinea.

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

16. Meetings shall be held on the second Monday in every month.

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

TRANSACTIONS

TRANSACTIONS

OF THE

NEW ZEALAND INSTITUTE,

1900.

I.—ZOOLOGY.

Art. I.—*Synopsis of the* Diptera brachycera *of New Zealand.*

By Captain F. W. Hutton, F.R.S.

[*Read before the Philosophical Institute of Canterbury, 3rd October, 1900.*]

In 1874 I published in our Transactions a list of the New Zealand *Diptera* which had been described before 1870, and in the same year Mr. A. G. Butler, of the British Museum, edited the "Insects of the Voyage of H.M.S. 'Erebus' and 'Terror,'" in which two new descriptions were given.

In 1881 the Geological Survey of New Zealand published a catalogue of our *Diptera*—compiled by me—which gave the original descriptions of the species, but without making any attempt to point out mistakes. In 1884 Mr. W. Kirby, of the British Museum, supplemented this catalogue by describing, in the "Transactions of the Entomological Society of London," three of the species which had been named, but not described, by Adam White, and by adding the names of four others which were unknown to me.

In 1896 Mr. P. Marshall published, in vol. xxviii. of the "Transactions of the New Zealand Institute," two papers which added largely to our knowledge of the *Cecidomyidæ* and the *Mycetophilidæ*, and last year I undertook the *Tipulidæ*.

The time, I think, has now arrived when a revision of the whole of our *Brachycera* may be made with some prospect of success, and the present paper has for its objects—(1) The correction of the synonymy of the known species; (2) the omission of names which have been erroneously included in our fauna; and (3) the description of the new species which are in the collection of the Canterbury Museum.

The omission of species which have been placed erroneously on our list is a difficult task, for some insects are so local and so irregular in their appearance that they may escape a second capture for a long time. Nevertheless, it is necessary that the work should be attempted, and I have therefore omitted all those species which I do not believe were ever taken in New Zealand. Most of these omitted species were originally stated to have been found near Auckland during the short stay there of the Austrian frigate "Novara" in 1859, but have never been found since. Several of these are now known to occur in other countries. In these cases there can be no doubt but they have been put down to New Zealand in error, and this makes it probable that there may be other mistakes which have not yet been found out. Indeed, the localities of the insects given in the "Voyage of the 'Novara'" must always be looked upon with suspicion until confirmed by some other collector. I have seen no description of *Paramenia semiauriceps*, Brauer and Bergenstamm (Denk. Akad. Wissen. Wien, vol. 56 (1890), p. 171); but as it belongs to a family (*Dexidæ*) which, to the best of my knowledge, does not occur in New Zealand I have omitted it also.

I have to thank Captain T. Broun for sending me a collection from the Auckland District, Mr. G. V. Hudson for one from Wellington and Nelson, and Mr. W. W. Smith for a collection made at Ashburton, in Canterbury. By these means the Museum now contains most of the described species. Those that are still unknown to me are mentioned in the text. I have included the introduced species as well as the natives, partly because collectors might be puzzled by them if descriptions were not given, and partly as a record of what species have been introduced and when they were first recorded, if that is known.

This list includes 191 species, of which six are doubtful inhabitants,* but which I retain for the present. Of the remaining 185, ten or eleven have been introduced from Europe, and three probably from Australia or the islands, thus leaving 171 or 172 native species. Of course, many more remain to be discovered. The most remarkable species are *Exsul singularis* and *Cerosomyia usitata*. Unfortunately, I have only a single specimen of each, but I could not pass them over on that account.

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* These are *Odontomyia australiensis*, *Clitellaria aberrans*, *Milesia bilineata*, *Sciomyza nigricornis*, *Sapromyza sciomyzina*, and *S. decora*.

Series ORTHORRHAPHA.

KEY TO THE NEW ZEALAND FAMILIES.

Third joint of the antennæ annulated.
- Costa stopping at the tip of the wing .. .. *Stratiomyidæ.*
- Costa continued all round the wing .. .. *Tabanidæ.*

Third joint of the antennæ simple.
- Thorax and abdomen inflated .. .. .. *Cyrtidæ.*
- Thorax and abdomen not inflated.
  - Five posterior cells.
    - Empodia styliform; fourth posterior cell often closed .. .. .. *Asilidæ.*
    - Empodia absent; fourth posterior cell always open .. .. .. *Therevidæ.*
  - Four posterior cells .. .. .. *Bombylidæ.*
  - Three posterior cells.
    - Second basal cell separated from the discal *Empidæ.*
    - Second basal cell united to discal .. *Dolichopodidæ.*

Family STRATIOMYIDÆ.

"Three basal cells, much prolonged; veins of the main trunks very crowded anteriorly; both intercalary veins usually existing; costal vein reaching only to the middle of the wing. Third joint of the antennæ annulated, sometimes divided into several portions. Tibiæ without spurs; empodia much developed, pulvilliform" (Loew).

KEY TO THE NEW ZEALAND GENERA.

Scutellum with four spines.
- An intercalary vein from the discal cell .. .. *Exaireta.*
- No intercalary vein from the discal cell .. .. *Beris.*

Scutellum with two spines.
- Posterior veins of the wing weak .. .. .. *Odontomyia.*
- Posterior veins of the wing strong .. .. .. *Clitellaria.*

Scutellum without spines .. .. *Cyclogaster.*

Sub-family **Beridinæ.**

Abdomen showing seven segments.

Genus EXAIRETA, Schiner (1867).

Antennæ filiform, the flagellum with ten rings generally indistinct near the end; no style, but a few bristles on the point. Eyes not contiguous in either sex. Scutellum with four long spines. Abdomen flat, with seven segments. Third longitudinal vein of the wing forked; an intercalary vein from the discal cell which sometimes does not reach the margin.

KEY TO THE SPECIES.

Thorax black .. .. *E. spiniger.*

Thorax bright bluish-green.
- Length, 10 mm. .. .. *E. alpina.*
- Length, 4 mm. .. .. *E. opposita.*

Thorax dark reddish-brown or bronzy.
- Abdomen ferruginous, with a black tip .. .. *E. apicalis.*
- Abdomen purplish, without a black tip .. .. *E. straznitzkii.*

Exaireta spiniger.

Xylophagus spiniger, Weidemann, Ausser-Europ. Zweif. Ins., ii., p. 618 (1830); Hutton, Cat. Dipt. N.Z., p. 35; Hudson, Man. N.Z. Ent., p. 56, pl. vi., fig. 5. *Beris servillei*, Macquart, Dipt. Exot., i., p. 176, pl. 21, fig. 1 (1838).

General colour black, the abdomen with violet reflections. Bases of the femora white, the tarsi yellowish. Wings with the outer half blackish, except a clear spot near the base of the submarginal cell. Length, ♂ 9–10 mm., ♀ 13–15 mm.; of the wing, ♂ 7–8 mm., ♀ 11–12 mm.

Hab. Auckland (Colonel Bolton); Whangarei and Wellington (F. W. H.).

Weidemann gives Australia as the habitat of this species, while Macquart says that the habitat is unknown. In the "Voyage of the 'Novara'" both Sydney and Auckland are given. Schiner made it the type of his genus *Exaireta*.

Exaireta apicalis.

Beris apicalis, White, Voy. "Erebus" and "Terror," pl. 7, fig. 17; Cat. Dipt. in Brit. Mus., p. 126. *Diphysa apicalis*, Walker, Cat. Dipt. Brit. Mus., p. 1151 (1849); Hutton, Cat. Dipt. N.Z., p. 34. *Exaireta analis*, Nowicki, Mem. d. Krakauer k.-k. Akad. d. Wissen., band ii., p. 11 (1875); Hutton, Cat. Dipt. N.Z., p. 36.

Thorax dark reddish-brown, sometimes slightly æneous, and with short golden hairs; the humeral callus tawny or rufous; scutellum tawny, abdomen tawny, the tip purplish-black. Wings ochraceous, with a transverse brown band from the costa to the discal cell; branch of the third longitudinal vein margined with dusky. The intercalary vein from the discal cell does not reach the margin. Length, 7–8 mm.; wing, 6–7 mm.

Hab. Bay of Islands (Sir J. Hooker); Auckland (Captain Broun); Wellington (Hudson); Otago (F. W. H.).

There are five distinct joints in the flagellum of the antennæ, of which the first and fourth are much longer than the others. Probably the fourth is made up of several.

Exaireta straznitzkii.

E. straznitzkii, Nowicki, Mem. Krakauer Akad. Wissen., ii., p. 14 (1875); Hutton, Cat. Dipt. N.Z., p. 36.

Thorax dark-red, with black lines (not very distinct); the humeral callus tawny. Abdomen purplish, the tip not darker than the rest. Wings ochraceous, with an oblique brown mark from the submarginal cell to the discal; the intercalary vein from the discal cell very short. Length, 8–11 mm.; wing, 7–8 mm.

Hab. Auckland (Captain Broun).

Exaireta opposita.

Actina opposita, Walker, Cat. Dipt. Brit. Mus., part v., Supp., p. 13 (1854); Hutton, Cat. Dipt. N.Z., p. 35.

Thorax metallic bluish-green (œrugineous). Abdomen tawny, each segment margined behind with fuscous, the tip dark. Intercalary vein short, not reaching half-way to the margin; branch of the third longitudinal slightly sinuated. Length, 7 mm.; wing, 7 mm.

Hab. Auckland (Colonel Bolton and Captain Broun); Otago (F. W. H.).

Exaireta alpina, sp. nov.

Vertex black, the front silvery; antennæ piceous, the base of the flagellum pale; palpi and proboscis pale-yellow, except the last joint of the palpi, which is dark-brown. Thorax metallic greenish-blue, with a little golden down; base of the scutellum the same, its apex and spines brown. Abdomen tawny, the posterior margin of each segment with green metallic reflections. Sixth segment with a longitudinal dark band with green reflections; seventh and eighth segments almost entirely dark. Legs tawny, the middle and hind tarsi paler, the fore tarsi fuscous. Wings pale-brownish, darker near the fore border; no dark band; costa brown, veins tawny; intercalary vein reaching the margin. Halteres pale-tawny. Length, 10 mm.; wing, 9 mm.

Hab. Mount Arthur, 3,600 ft. (Hudson).

The flagellum apparently consists of eight distinct joints, but the last is longer than the others, and is probably formed by three closely united joints. The abdomen in the female is slightly oval and rather broader than the thorax. The male is unknown.

Genus BERIS, Linnæus (1809).

Third joint of the antennæ long-fusiform, with eight rings; the palpi long. Eyes contiguous in the male. Scutellum with spines. Abdomen rather broad. Wing with four posterior cells, there being no intercalary vein from the discal cell.

In the New Zealand species the third joint of the antennæ is linear, and the eyes are not always contiguous in the male.

KEY TO THE SPECIES.

Thorax dull blackish-brown	*B. violacea.*
Thorax shining greenish-blue	*B. micans.*
Thorax dull-green or bronzy-green	*B. substituta.*
Thorax shining bronzy	*B. cuprea.*

Beris violacea, sp. nov.

Head black, with a patch of silvery tomentum in front. First and second joints of the antennæ brown, the flagellum fuscous, apparently 6- or 7-jointed. Thorax dull blackish-brown, finely punctured all over; the scutellum slightly bronzy; humeral callus tawny (occasionally dark-brown). Abdomen dark-blue, shining. Legs brown, with variable pale markings; generally the bases of the femora and the first joint of the hind tarsi are pale. Wings smoky, the stigma and veins black; a darkish cloud below the stigma. Length, 4 mm.; wings, 4 mm.

Hab. Christchurch and Otago (F. W. H.).

The eyes are not contiguous in the male. In both sexes the abdomen is oval. The second posterior cell is sessile, with a broad base.

Beris micans, sp. nov.

Head black (the antennæ are broken off). Thorax brilliant greenish-blue, including the scutellum; the spines tawny. Abdomen black. Legs pale-tawny, the last joints of the tarsi fuscous. Wings tinged with pale-brown, the stigma rather darker. Length, 5 mm.; wing, 4 mm.

Hab. Auckland (Captain Broun).

This species is so distinct that I have given it a name, although I have seen only a single specimen without antennæ. The second posterior cell is sessile.

Beris substituta.

Beris substituta, Walker, Cat. Dipt. in Brit. Mus., part v., Supp., p. 12 (1854). *Actina substituta*, Hutton, Cat. Dipt N.Z., p. 34.

Thorax dull-green or bronzy. Abdomen purplish-cupreous. Legs tawny, with brown bands on the femora and tibiæ. Wings greyish, the stigma and veins black. Length, 4 mm.

Hab. Auckland (Colonel Bolton).

This species is unknown to me.

Beris cuprea, sp. nov.

Head black, first and second joints of the antennæ dark-red, the flagellum dark reddish-brown. Thorax and scutellum brilliant bronze, the spines tawny. Abdomen blackish-brown in the female, purplish-black in the male. Legs pale-tawny, the last joint of the tarsi black. Wings tinged with tawny, the stigma rather darker. Length, 4 mm.; wing, 4 mm.

Hab. Auckland and Maketu (Captain Broun).

In the male the eyes are contiguous, the abdomen is narrow and linear, and the second posterior cell is petiolate.

In the female the flagellum of the antennæ is formed by six quite distinct short joints; the last one, however, is longer, and may consist of two fused together. The second posterior cell is shortly petiolate.

Sub-family **Odontomyinæ.**

Abdomen broad, apparently with only five segments.

Genus ODONTOMYIA, Latreille (1809).

First joint of the antennæ longer than the second, but not elongated; the third fusiform, with five rings and a short style. Eyes contiguous in the male. Scutellum with two spines. Veins of the wing faint towards the posterior margin; generally with four posterior cells (three in the New Zealand species).

KEY TO THE SPECIES.

Abdomen bordered with green.	
Spines of the scutellum well developed.	
Antennæ black.	
Base of scutellum black.	
Length, 10–12 mm.	*O. atrovirens.*
Length, 8–10 mm.	
Hairs on sides of thorax grey, or none	*O. chloris.*
Hairs on sides of thorax tawny	*O. chathamensis.*
Length 6–8 mm.	*O. collina.*
Scutellum green or tawny	*O. fulviceps.*
Antennæ yellow	*O. australiensis.*
Spines of scutellum obsolete; length, 7 mm. ..	*O. dorsalis.*
Abdomen black	*O. angusta.*

The females can be distinguished by the outline of the black on the vertex, as follows:—

Black on the vertex, convex in front.	
Length, 10–12 mm.	*O. atrovirens.*
Length, 6–8 mm.	*O. collina.*
Black on the vertex, notched in front	*O. chloris.*
Black on the vertex, concave in front.	
Length, 9–11 mm.	*O. chathamensis.*
Length, 6–7 mm.	*O. dorsalis.*
Black on the vertex, confined to the ocellar triangle ..	*O. fulviceps.*

Odontomyia atrovirens.

Odontomyia atrovirens, Bigot, Ann. de la Soc. Ent. de France, 5th série, tome ix., page 214 (1879).

♂. "Antennis basi nigris (segmentum tertium?); facie testaceo fulvo, utrinque albido villosâ; haustello nigro; thorace nigro cinereo et parcè villoso, pleuris testaceis, albido villosis; scutello prasino, basi nigro, spinis testaceis; abdomine prasino, supernè nigro nitido late vittato, vittâ parum crenatâ; halteribus prasinis; pedibus testaceis, femoribus anterioribus pallide castaneis, retrorsum, apice fuscis, tibiis basi tarsique parum infuscatis; alis hyalinis, stigmate testaceo" (Bigot).

Hab. Auckland (Captain Broun); Christchurch and Otago (F. W. H.).

There is no difference in size between the sexes. Length, 10–12 mm.; wing, 8–10 mm. The female wants the grey hairs on the sides of the thorax, and the green margin of the abdomen is not so broad. The black of the vertex ends anteriorly in a line which is convex, or sometimes slightly emarginate in the middle.

Odontomyia chloris.

Stratiomys chloris, Walker, Cat. Dipt. in Brit. Mus., part v., Supp., p. 57 (1854). *O. chloris*, Hutton, Cat. Dipt. N.Z., p. 37. *O. hypochlora*, Nowicki, Mem. Krakauer Akad. Wissen., ii., p. 15 (1875); Hutton, Cat. Dipt. N.Z., p. 38.

In the female the black of the vertex has a deep central square-ended notch, which extends further back than the termination of the black at the eyes. The scutellum is green with a black base. The male has grey hairs on each side of the thorax. Length, 8–10 mm.; wing, 7–8 mm.

Hab. Auckland (Colonel Bolton); Christchurch (F. W. H.).

Odontomyia collina, sp. nov.

Antennæ piceous; spines of scutellum well developed, tawny. Halteres pale-green. Wings hyaline, the stigma and veins tawny; three posterior cells. Abdomen black above, margined with green or tawny, which is broad in the male, narrow in the female.

Male.—Thorax and scutellum black. Legs tawny, the femora fuscous. Length, 6 mm.

Female.—Face yellow, the black of the vertex convex in front. Thorax piceous, with yellow hairs. Scutellum green, with a black spot at the base in the centre and one at each side. Legs tawny. Length, 8 mm.

Hab. Lindis Pass, Otago (F. W. H.).

Odontomyia chathamensis, sp. nov.

Head pale-tawny (green?) on the face, the vertex black in the female. Antennæ and proboscis black. Thorax black, with scattered fulvous hairs in both sexes, while in the male those on the sides are abundant; scutellum black margined with tawny; the spines tawny, small but distinct. Abdomen above black margined on each side with pale-tawny, which is broader in the male than in the female; below very pale-tawny. Halteres nearly white. Legs tawny, the outer surfaces of the tibiæ sometimes brown. Wings hyaline, the stigma and the outer portion of the costal cell tawny; three posterior cells. Length, 9–11 mm.; wing, 7–10 mm.

Hab. Chatham Islands (Fougère).

This species has its nearest ally in *O. dorsalis.* In the female the black of the vertex ends anteriorly in a line which is concave to the front and passes down in front of the eyes to the level of the bases of the antennæ.

My specimens have been in alcohol, and therefore the colours have been changed.

Odontomyia fulviceps.

Stratiomys fulviceps, Walker, Cat. Dipt. in Brit. Mus., part v., Supp., p. 56 (1854); Hutton, Cat. Dipt. N.Z., p. 37.

In this species the thorax has more golden down than in any of the others, and in the male there are no long hairs on the sides. The scutellum is green, or tawny when faded. In the female the vertex is green, except the ocellar triangle, which is black. Length, 8–10 mm.; wing, 6–7 mm.

Hab. Wellington (Hudson); Christchurch (F. W. H.).

Specimens taken Home by the "Erebus" and "Terror" were probably collected at the Bay of Islands.

Odontomyia australiensis.

Odontomyia australiensis, Schiner, Reise der "Novara," Dipt., p. 59 (1868); Hutton, Cat. Dipt. N.Z., p. 38.

Antennæ yellow; thorax copper-red. Length, 9 mm.

I do not know this species.

Odontomyia dorsalis.

Stratiomys dorsalis, Walker, Cat. Dipt. in Brit. Mus., p. 536 (1849); White, Voy. "Erebus" and "Terror," Insects, pl. 7, fig. 18; Hutton, Cat. Dipt. N.Z., p. 37.

A small species, distinguished by the absence of spines on the scutellum. The black on the vertex of the female resembles that of *O. chathamensis.* The base of the scutellum is black. Length, 6½–7 mm.; wing, 6–7 mm.

Hab. Auckland (Colonel Bolton); Napier (F. W. H.).

Odontomyia angusta.

Stratiomys angusta, Walker, Cat. Dipt. in Brit. Mus., part v., Supp., p. 57 (1854); Hutton, Cat. Dipt. N.Z., p. 38.

Abdomen black. Vertex and disc of the face black. In a female specimen I have of this species, from Christchurch, there is a large round black spot between the antennæ and the mouth, and the black on the vertex is concave in front. The antennæ are black and the halteres bluish-green. It differs from Walker's description in having the legs tawny with brown markings, and in the veins of the wing being pale-tawny. It is also only 6 mm. in length, and the wing 5 mm., while the type is 7½ mm. in length.

Hab. Auckland (Colonel Bolton); Christchurch (F. W. H.). Rare.

Genus Clitellaria, Meigen (1822).

Antennæ long, the first and second joints equal; the flagellum slightly obclavate, indistinctly 7-ringed, with a style at the end. Eyes contiguous in the male. Scutellum with two spines. Longitudinal veins of the wing strong up to the margin.

Clitellaria aberrans.

Clitellaria aberrans, Schiner, Reise der "Novara," Dipt., p. 55 (1868); Hutton, Cat. Dipt. N.Z., p. 39.

Black with a white oblique band above the border of the mouth. No style. Front tarsi yellow at the base, the last pair yellow. Length, 5 mm.

Hab. Auckland ("Novara" expedition).

I do not know this species.

Genus Cyclogaster, Macquart (1834).

Flagellum of the antennæ long, cylindrical. Scutellum without spines. Abdomen suborbicular. Longitudinal veins of the wing strong up to the margin.

Cyclogaster peregrinus, sp. nov.

Bluish-black, finely punctate over the whole upper surface; the thorax with short brown hairs. First and second joints of the antennæ and the palpi testaceous, or red. Legs testaceous, the middle and hind femora brownish; the proximal half of the fore tibiæ black in front. Wings rather smoky, dark at the tip; the stigma fuscous. Halteres dark-brown. Length, 5½ mm.; wing, 5 mm.

Hab. Whangarei (F. W. H.); Auckland (Captain Broun).

The first joint of the antennæ is short and cyathiform, the second is oval and about twice the length of the first; the flagellum is very long and linear, indistinctly ringed, without a style; the third longitudinal vein is strongly arcuated, the anterior branch leaving it a little outside the chief cross-vein; root of the fourth absent; fifth longitudinal strong; the sixth weak; seventh absent. Discal cell hexagonal; two intercalary veins, the second of which does not reach the margin; anterior and posterior basal cells not completely separated. Abdomen subcircular.

Family TABANIDÆ.

"Three basal cells much prolonged; third longitudinal vein furcate; two intercalary veins always present; marginal vein running round the whole border of the wing; tegulæ rather large. Third joint of the antennæ annulate, rarely divided into distinct joints, always without style or bristle. Empodium much developed and pulvilliform " (Loew).

Key to the Genera.

Hind tibiæ without spurs; no ocelli.	
Third joint of the antennæ with a basal tooth ..	*Tabanus.*
Third joint of the antennæ without a basal tooth ..	*Sylvius.*
Hind tibiæ with spurs; ocelli present.	
Proboscis much longer than the palpi	*Pangonia.*
Proboscis hardly longer than the palpi	*Apatolestes.*

Genus Tabanus, L.

Proboscis inclined backwards in the male, perpendicular in the female. Third joint of the antennæ elongated, divided into five divisions, of which the four last are small, and the first division has a tooth at its base. Eyes in the male contiguous, slightly separated in the female. No ocelli. Middle tibiæ spurred, but not the hinder ones. The eyes have long hairs in the male, and generally short hairs in the female. The second longitudinal vein is simple.

Key to the Species.

Abdomen reddish.	
Smaller; length, 9–10 mm.	*T. transversus.*
Larger; length, 12–14 mm.	
Abdomen with a dark dorsal streak.	
Thorax without bands	*T. oplus.*
Thorax with three pale bands	*T. sordidus.*
Abdomen without a dark dorsal streak ..	*T. impar.*
Abdomen blackish, with reddish spots on the sides.	
Spots on the first three segments	*T. impar.*
Spots on the first and second segments	*T. bratranchii.*
Spots on the second segment only	*T. gravis.*
Abdomen pitch-brown, without tawny spots.	
Thorax with pale bands	*T. sarpa.*
Thorax without pale bands	*T. viridis.*

Tabanus impar.

Tabanus impar, Walker, Cat. Dipt. in Brit. Mus., part v., Supp., p. 258 (1854); Hutton, Cat. Dipt. N.Z., p. 19.

Palpi pale-tawny, the proboscis dark-brown; antennæ fuscous at the tip. Thorax dark-brown, with short pale hairs. Wings brownish, darker in the costal, marginal, and interior basal cells. The sexes differ.

Male.—First and second joints of the antennæ dark reddish-brown. Abdomen blackish-brown, with a triangular white spot in the centre of each segment; margins of the segments and a large spot on each side of the first three segments dull-red. Legs brown, the fore and middle tibiæ tawny in the basal half, but the colours are variable.

Female.—Head and first two joints of the antennæ pale-tawny. Abdomen dull-red, fuscous at the tip. Legs tawny, the tarsi fuscous.

Length, ♂ 12–14 mm., ♀ 12 mm.; wings, ♂ 11–13 mm., ♀ 12 mm.

Hab. Auckland (Colonel Bolton and Captain Broun); Great Barrier Island (Suter); Taranaki (Clark).

Tabanus oplus.

T. oplus, White, MSS.; Walker, Cat. Dipt. in Brit. Mus., part v., Supp., p. 255 (1854); Hutton, Cat. Dipt. N.Z., p. 20; Butler, Cistula Entomologica, vol. i., p. 356 (1876).

Head brown; antennæ with the first, second, and base of the third joints brown, the tip fuscous; palpi yellow, proboscis brown. Thorax black, with short pale hairs. Abdomen dull-red, with a dark ill-defined band down the centre, which is interrupted at the porterior margin of each segment; the last four segments darker than the first three. Wings as in *T. impar*, the veins brown.

Male.—Legs dull-red, the femora blackish near their bases. The abdominal dark band is broader than in the female.

Female.—Legs dull-red, the last joints of the tarsi fuscous. Thorax with reddish marks on the sides and above, behind the middle; the humeral callus is also reddish.

Length, ♂ 12 mm., ♀ 13 mm.; wing, ♂ 12 mm., ♀ 13 mm.

Hab. Auckland (Colonel Bolton and Captain Broun).

Tabanus sordidus.

T. sordidus, Walker, Cat. Dipt. in Brit. Mus., Supp., p. 256 (1854); Hutton, Cat. Dipt. N.Z., p. 20.

Black, the thorax with three hoary stripes. Abdomen tawny, with an interrupted black stripe, which is dilated at the base and at the tip. Posterior tibiæ tawny. Length, 14½ mm.

Hab. Auckland (Colonel Bolton).

I have not seen this species.

Tabanus bratranchii.

T. bratranchii, Nowicki, Mem. Krakauer Akad. Wissen., band 2, ged. Aufsatzes, p. 19 (1875); Hutton, Cat. Dipt. N.Z., p. 20.

Head dark-grey in front, nearly white below; antennæ black, the first two joints occasionally brown; palpi tawny, the proboscis brown. Thorax dark-brown, with four indistinct greyish bands, sometimes reddish on the sides. Abdomen dark-brown, with a triangular white spot on the centre of each segment; posterior margins of the segments and a large spot on each side of the first and second segments tawny. Wings nearly hyaline, the outer portion of the marginal cell darker; veins piceous.

Male.—Legs fuscous, the fore and middle tibiæ tawny.

Female.—Legs fuscous, all the tibiæ tawny, and sometimes the femora (Auckland specimens) also. The white triangles on the abdomen are larger than in the male.

Length, 13 mm.; wing, 12–13 mm.

Hab. Auckland (Captain Broun); Taranaki (Clark).

Tabanus gravis, sp. nov.

Female.—Head dark-brown, paler on the face; antennæ black, the basal tooth large. Palpi dark-grey; proboscis dark-brown, the lancets reddish. Facets of the eyes very small. Thorax black, with two indistinct greyish bands; the sides greyish. Abdomen black, with small pale triangles on the second to the fifth segments; a small reddish spot on each side of the second segment; the posterior lateral corners of the second to the sixth segments tawny and with white hairs; the lower surface brown. Legs brown, the femora and tarsi blackish. Wings nearly colourless, the stigma brown, the veins dark-brown. Length, 16 mm.; wing, 15 mm.

Hab. Auckland (Captain Broun).

Tabanus sarpa.

T. sarpa, White, MSS.; Walker, Cat. Dipt. in Brit. Mus., part v., p. 255 (1854). *T. truncatus*, Walker, *l.c.*, p. 255; Hutton, Cat. Dipt. N.Z., p. 20.

Vertex, in the female, brown; face and a band above the antennæ yellowish-white. First and second joints of the antennæ dark-brown, the third black. Proboscis dark-brown. Thorax reddish-brown, with four cinereous longitudinal bands. Abdomen pitch-brown, segments 1 to 5 with a pale triangular mark in the centre (in the female). Legs fulvous, the anterior tarsi fuscous; the femora more or less dusted with grey. Wings nearly colourless, the veins tawny. Length, 11–12 mm.; wings, 12 mm.

Hab. Auckland (Colonel Bolton and Captain Broun).

Tabanus viridis.

Comptosia virida, Hudson, Man. N.Z. Ent., p. 55, pl. vi., fig. 3.

Vertex and face greyish-white. First and second joints of the antennæ brownish-fulvous, the third joint piceous. Eyes green when alive, piceous when dry, hairless. Thorax pitch-brown, without any bands; a few scattered black hairs in the centre and grey hairs on the sides. Abdomen pitch-brown, with grey dust; the margins of the segments grey. Legs testaceous, the tarsi fuscous; the femora with grey dust. Wings slightly greyish, the veins tawny. Length, 14–15 mm.; wing, 12 mm.

In the female the femora are rather darker than in the male, and the grey margin of the abdominal segments is produced forwards into a central triangular mark.

Hab. Wellington (Hudson); Ashburton (W. W. Smith).

This is the only species of *Tabanus* that I have seen from the South Island, and here it is very rare.

Tabanus transversus.

T. transversus, Walker, Cat. Dipt. in Brit. Mus., part v., Supp., p. 256 (1854); Hutton, Cat. Dipt. N.Z., p. 21.

Reddish-brown, the legs and under-surface paler. Wings colourless, the stigma pale-brown; the veins brown. Antennæ with the first and second joint yellow, the third black. Palpi pale-tawny, the proboscis brown.

The male differs from the female in having four dusky stripes on the thorax, and the abdomen is brown, with a row of triangular tawny spots down the centre. The wings also are brownish, and have darker cloudy spots at the fork of the third longitudinal, on the chief and posterior cross-veins, and on the outer margin of the discal cell. Length, ♂ 9 mm., ♀ 10 mm.; wing, ♂ 10 mm., ♀ 11 mm.

Hab. Auckland (Colonel Bolton and Captain Broun).

The male of this species is remarkable for the very large facets of the eyes, a fact probably of sufficient importance to place it in a different genus from the rest. They are without hairs in both sexes.

Genus Silvius, Meigen (1820).

First and second joints of the antennæ short, the third not toothed, with five rings. Second joint of the palpi cylindrical in the male. Ocelli generally present. The face without callosities. Hind tibiæ without spurs. Neuration of the wing as in *Pangonia*; the first posterior cell open.

Sylvius maorium.

Mesomyia maorium, Bigot, Mem. Soc. Zool. de France, vol. v., p. 621 (1892).

"*Male.*—Proboscis, palpi, and antennæ black; the first and second joints of the last grey; face blackish, with some grey hairs; front grey. Thorax and scutellum opaque-black, abdomen black, the segments bordered with obscure grey. Calyptræ and halteres pale-yellow. Legs pale-yellow, the femora, distal portion of the tibiæ, and all the tarsi black. Wings nearly hyaline, the stigma brown. Length, 8½ mm." (Bigot).

A specimen from Wellington, which I believe to be the female of this species, has the first and second joints of the antennæ black, and the face greyish-white, except the naked portion between the eyes. The thorax and scutellum are covered with grey dust, the former with three black bands. The grey posterior margins of the abdominal segments are very apparent, and in the middle they run forwards in a point, forming a triangle, which is largest on the second segment. In other respects it agrees with the description of the type. Length, 9 mm.; wing, 9 mm.

Hab. Wellington (Hudson).

The antennæ are inserted rather below the middle line of the head. The first joint of the antennæ is thick, slightly oval, and hairy. The ocelli are absent. The outline of the abdomen is slightly oval.

Genus PANGONIA, Latreille (1806).

Proboscis long, extending much further than the palpi. Third joint of the antennæ with seven or eight divisions, the first joint short. Eyes hairy or naked. Ocelli present, sometimes indistinct. Posterior tibiæ with well-developed spurs. Wings with the fourth posterior cell open, the first either open or closed. Eyes contiguous in the male, separated in the female.

KEY TO THE SPECIES.

Abdomen bluish-black	*P. adrel.*
Abdomen brown, tawny at the sides.	
Antennæ tawny, blackish at the tip	*P. lerda.*
Antennæ blackish.	
Sides of the thorax with tawny hairs	*P. hirticeps.*
Sides of the thorax with white hairs	*P. ricardoi.*
Abdomen altogether brown	*P. montana.*

Sub-genus EREPHROSIS, Rondani.

First posterior cells closed; eyes hairy.

Pangonia adrel.

P. adrel, Walker, Insecta Saundersiana, Dipt., i., p. 16 (1850); Hutton, Cat. Dipt. N.Z., p. 22. *Erephrosis adrel*, Ricardo, Ann. Mag. Nat. Hist., ser. 7, vol. 5, p. 115 (1900).

Thorax black. Abdomen bluish-black, shining. The posterior angles of the thorax and the abdomen with tufts of pale brownish-yellow hairs. Legs black. Length, 13 mm.; wing, 15 mm.

Hab. Auckland (Captain Broun); Taranaki (Clark).

Of our four female specimens, the first posterior cell is closed in one and open in three. I have not seen the male; Miss Ricardo says that in it the sides of the two first segments of the abdomen are fulvous.

Sub-genus Diatomineura, Rondani.

First posterior cell open; eyes hairy.

Pangonia lerda.

P. lerda, Walker, Insecta Saundersiana, Dipt., i., p. 16 (1850); Hutton, Cat. Dipt. N.Z., p. 21; White (A. G. Butler), Cistula Entomologica, vol. i., p. 355 (1876). *Diatomineura lerda*, Ricardo, Ann. Mag. Nat. Hist., ser. 7, vol. 5, p. 119 (1900).

"Palpi and antennæ yellowish-brown, the latter blackish at the end. Face and front with greyish down; thorax above black; a line of deep-brown hairs on each side; a tuft of yellowish hairs on each side, near the base of the wings; scutellum black; abdomen above ferruginous-brown, black in the middle, the terminal segments with yellowish hairs on the margins; under-side of the thorax with longish yellow hairs in front and on the sides, in the middle greyish; abdomen beneath ferruginous, almost without hairs; legs ferruginous, without hairs; no tooth on the third joint of the antennæ" (A. White).

No length is given, but according to Mr. Walker it is $14\frac{1}{2}$ mm.

Hab. New Zealand.

I have seen no specimen which I can confidently refer to *P. lerda*, therefore I have reproduced White's original description, which was published by Mr. Butler.

Pangonia hirticeps.

P. hirticeps, Nowicki, Mem. Krakauer Akad. Wissen., 1875, p. 17; Hutton, Cat. Dipt. N.Z., p. 22.

The head is white above, with pale-tawny or yellowish hairs below, the ocellar region dark-ferruginous. Palpi and antennæ nearly black. Thorax blackish-brown, with tawny hairs; a band of black hairs on each side, below which and on the posterior angles are long pale-yellowish hairs. The abdomen is blackish-brown, the first and second segments broadly margined with dull-red, and each segment has a central spot of pale-yellow hairs; the hairs on the sides of the abdomen are black and pale-yellow in alternate tufts. Legs brown, the fore and middle tibiæ reddish; the last joints of the tarsi fuscous. Length, 14 mm.; wing, 16 mm.

Hab. Auckland (Captain Broun).

Pangonia ricardoi, sp. nov.

Comptosia bicolor, Hudson, Man. N.Z. Ent., p. 54, pl. iv., fig. 2, not of Macquart.

Male.—Face pale-yellowish; first joint of the antennæ grey with black hairs, the rest pitch-brown; palpi brown;

proboscis pitch-brown; the hairs on the lower surface of the head pale-yellow. Thorax brown, with grey lines in the sutures; a band of black hairs on each side, below which, and on the lower surface, the hairs are white; a tuft of long white hairs on the posterior angles of the thorax, behind the wings. Abdomen black or blackish-brown; the two first segments largely and the third slightly margined with tawny (sometimes obscure); the posterior margins of the segments tawny and with tawny hairs, a spot of white hairs in the centre of the posterior margin of the first five segments; hairs on the sides arranged in alternate tufts of black and white. Legs blackish, all the tibiæ ferruginous. Wings smoky, darker on the anterior portion; the veins fuscous.

The *female* has the vertex dark-grey, and differs from the male in having white hairs below on the head; the thorax is less hairy and has no tufts; the abdomen is paler and less hairy.

Length, ♂ 12–13 mm., ♀ 12 mm.; wing, ♂ 12–14 mm., ♀ 12–13 mm.

Hab. Christchurch (F. W. H.); Ashburton (Smith); Wellington (Hudson).

This species differs from the last in being smaller, in the white hairs on the thorax and abdomen, and in the thorax being paler. In all the specimens I have seen the first posterior cell is open. The males are not uncommon, but the female is rarely seen.

Sub-genus CORIZONEURA, Roth.

First posterior cell open; the eyes naked.

Pangonia montana, sp. nov.

Female.—Upper surface uniform blackish-brown, with thinly scattered short white hairs on the dorsum of the thorax, more abundant and longer on its sides. Head tawny, the vertex darker than the face; antennæ brown at the base, fuscous at the tip; palpi pale-tawny; proboscis dark-brown. Lower surface brown. Legs tawny, the tarsi brown. Wings slightly smoky, the veins brown; the first posterior cell open. Length, 9 mm.; wing, $8\frac{1}{2}$ mm.

Hab. Mount Arthur, Nelson (Captain Broun).

Smaller than the other New Zealand species, and without any tufts of hair on the thorax. The eyes are naked. I have not seen the male.

Genus APATOLESTES, Williston (1885).

Third joint of the antennæ with seven or eight divisions, and without a tooth. Ocelli present. Proboscis short, scarcely extending beyond the palpi. Hind tibiæ with well-developed spurs. Anal cell closed, the anal vein not curved.

Apatolestes lutulentus, sp. nov.

Female. — Upper surface blackish-brown, with short scattered white hairs on the thorax and abdomen; a thicker layer of these hairs on the posterior margins of the abdominal segments. On the lower surface these white hairs are more abundant, especially under the head. First and second joints of the antennæ tawny; palpi yellow; eyes with short hairs. Tibiæ paler brown than the rest of the legs. Wings slightly tinged with brown, the stigma indistinct. Length, 15 mm.; wing, 11½ mm.; breadth of the abdomen, 6 mm.

Hab. Christchurch(?) (Clark).

The sides of the abdomen are straight, and its length is about one and two-thirds its breadth. The hind tibiæ have well-developed spurs. It is possible that this insect may have come from Taranaki, as I have never seen it at Christchurch.

Family ASILIDÆ.

"Three basal cells much prolonged. Third longitudinal furcate, the two intercalary veins always present. Third joint of the antennæ simple. Under-lip forming a horny sheath. Empodium a horny bristle" (Loew).

Key to the Genera.

Style short; third basal or anal cell open	*Saropogon.*
Style long; third basal or anal cell closed.	
Lower face not projecting	*Senoprosopis.*
Lower face projecting.	
Tibiæ red	*Itamus.*
Tibiæ brown	*Asilus.*

Sub-family **Dasypogoninæ**.

Second longitudinal vein running into the border of the wing.

Genus Saropogon, Loew (1847).

The first and second joints of the antennæ short, nearly equal; the third elongated, compressed, fusiform, the style short and conical, often of two distinct joints. Anterior tibiæ with a curved spine at the tip. Subcostal and four posterior cells open; two submarginal cells.

Key to the Species.

Bristles of the epistome black.	
Legs black.	
Tip of the wing clouded	*S. viduus.*
Tip of the wing clear	*S. clarkii.*
Legs ferruginous.	
A dark spot on costa of the wing	*S. extenuatus.*
No spot on costa of the wing	*S. chathamensis.*

Bristles of the epistome yellowish-white.
  Legs brown.
    Abdomen reddish-brown below .. .. *S. discus.*
    Abdomen black below.
      Thorax black .. .. .. *S. proximus.*
      Thorax golden .. .. .. *S. fugiens.*
  Legs ferruginous.
    Tip of the wing clouded .. .. .. *S. antipodus.*
    Tip of the wing clear .. .. .. *S. hudsoni.*

Saropogon viduus.

Dasypogon viduus, Walker, Cat. Dipt. in Brit. Mus., p. 354 (1849). *Saropogon viduus,* Hutton, Cat. Dipt. N.Z., p. 25.

Black. Face yellowish-white; the bristles of the epistome black, tipped with fulvous. Sides of the thorax silvery. Halteres pale-brown. Wings with a greyish tinge, darker at the tips; the costal cells, as well as the base of the marginal cell, pale-brown. Length, ♀ 14 mm.; wing, 13 mm.

Hab. North Island (Colenso); Great Barrier Island (Suter).

Saropogon clarkii, sp. nov.

Black. Face and sides of the thorax silvery. Bristles of the epistome black. Halteres pale-brown. Wings hyaline, the first costal and interior basal cells brown; veins pitch-brown. Length, ♂ 12 mm., ♀ 13 mm.; wing, ♂ 10 mm., ♀ 12 mm.

Hab. Taranaki (Clark).

Saropogon discus.

Dasypogon discus, Walker, Cat. Dipt. in Brit. Mus., p. 358 (1849). *Saropogon discus,* Hutton, Cat. Dipt. N.Z., p. 26.

Purplish-black above and reddish-brown below. Thorax above with two stripes of yellowish tomentum. Bristles of the epistome yellowish-white. Halteres yellow. Legs brown, the outer joints of the tarsi blackish in the female; in the male the whole of the legs are blackish above. Wings slightly tinged with brownish. Length, ♂ 10 mm., ♀ 11 mm.; wing, ♂ 9 mm., ♀ 10 mm.

Hab. Taranaki (Clark).

Saropogon proximus, sp. nov.

Female.—Face black; the bristles of the epistome yellowish-white. Thorax black, with black hairs above and yellowish hairs below, but no silvery tomentum. Abdomen purplish-black, both above and below. Halteres pitch-brown. Legs reddish-brown, the femora blackish above; the tarsi blackish. Wings slightly tinged with brown. Length, 12 mm.; wing, 11 mm.

Hab. Mount Peel, Nelson (Hudson).
I have not seen the male.

Saropogon fugiens, sp. nov.

Face golden; the bristles of the epistome white. Thorax blackish, with golden hairs above on the shoulders, on two longitudinal bands, on the sides, and on the scutellum. Abdomen purplish-brown, both above and below. Halteres brown. Wings slightly tinged with brown, the veins pitch-brown. Coxæ with silvery tomentum; femora and tibiæ reddish-brown, the femora and hind tibiæ darker above. Length, ♂ 10 mm., ♀ 12 mm.; wing, ♂ 9 mm., ♀ 11 mm.
Hab. Wellington (Hudson).

Saropogon antipodus.

S. antipodus, Schiner, Reise der "Novara," Dipt., p. 166 (1868); Hutton, Cat. Dipt. N.Z., p. 27.

Brownish-red, the thorax with golden tomentum. Bristles of the epistome yellowish-white. Legs dull-red; the tarsi, except the first joint, blackish-brown. In the male the first joint of the hind tarsi is blackish-brown, and the wings are nearly hyaline, but clouded at the tip, as in the female. Length, ♂ 14 mm., ♀ 15 mm.; wing, ♂ 10 mm., ♀ 12 mm.
Hab. Auckland ("Novara" expedition); Wellington (Hudson); Taranaki (Clark).

Saropogon hudsoni, sp. nov.

Brownish-black, with golden tomentum on the thorax. Bristles of the epistome pale-yellowish. Halteres brown. Wings slightly tinged with brown, no darker cloud at the tip; the veins piceous, except at the base, where they are ferruginous. Legs ferruginous, the four last joints of the tarsi blackish. Length, ♂ 12 mm., ♀ 14 mm.; wing, ♂ 10 mm., ♀ 11 mm.
Hab. Mount Peel, Nelson (Hudson).

Saropogon chathamensis, sp. nov.

Female.—Purplish-brown, the thorax probably with golden tomentum. Bristles of the epistome black. Halteres brown. Wings tinged with brownish; the veins pitch-brown, except near the base, where they are ferruginous. Coxæ purplish-black; the rest of the legs, except the two last joints of the tarsi, ferruginous. Length, 10 mm.; wing, 10 mm.
Hab. Chatham Islands (Fougère).
I have not seen the male. The specimens have been in spirit.

Saropogon extenuatus, sp. nov.

Reddish-brown, the face and a spot on the sides of the thorax golden. Thorax and scutellum with scattered golden hairs. Bristles of the epistome black. Antennæ and proboscis dark-brown. Wings strongly tinted with yellowish-brown, the tips fuscous; a dark spot on the costa, just inside the tip of the auxiliary vein, and extending backwards to the second longitudinal. Coxæ dark-brown, those of the fore and middle legs with silvery hairs. The rest of the legs, except the last joint of the tarsi, ferruginous. Length, 8½ mm.; wing, 8 mm.

Hab. Wellington (Hudson).

Sub-family **Asilinæ.**

Second longitudinal vein running into the first. Antennæ with a distinct terminal bristle.*

Genus ASILUS, Linnæus.

Two submarginal cells; the fourth posterior cell closed. Third joint of the antennæ long, compressed, with a rather long style. Face protruding below. Genitalia of the male slightly swollen. Tibiæ without a red band.

Asilus smithii, sp. nov.

Dark-brown, the abdomen with grey tomentum. Bristles of the epistome white, with a few black ones above. Face yellowish-white. Antennæ black, the second joint shorter than the first. Lower head and thorax with long white hairs. Thorax nearly black, with black hairs above and a little silvery tomentum on the sides. Halteres yellow. Wings nearly colourless, the veins black. Legs black, with grey hairs and black bristles. Length, ♂ 11 mm., ♀ 12 mm.; wing, ♂ 10 mm., ♀ 11 mm. In the male the first three segments of the abdomen have a series of long white hairs on their posterior margins.

Hab. Ashburton (W. W. Smith).

Genus ITAMUS, Loew (1849).

Wings and antennæ as in *Asilus.* Genitalia of the male much swollen. The tibiæ with a red band.

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* I omit *Promachus floccosus*, Kirby (Trans. Ent. Soc. London, 1884), from our list, as I think there must be a mistake in the locality. There is no such place as Opabo in New Zealand, and so conspicuous an insect could hardly have eluded all our collectors. Perhaps it was collected at Opobo, in West Africa. *Promachus* has three submarginal cells.

Itamus varius.

Asilus varius, Walker, Cat. Dipt. in Brit. Mus., p. 457 (1849); Hutton, Cat. Dipt. N.Z., p. 28.

Lower bristles of the epistome white, some of the upper ones black. Abdomen brown, the hind borders of the segments pale-yellow. Length, 18 mm.; wing, 12–13 mm.

Hab. Throughout New Zealand and the Great Barrier Island. Common.

Itamus bulbus.

Asilus bulbus, Walker, Cat. Dipt. in Brit. Mus., p. 465 (1849); Hutton, Cat. Dipt. N.Z., p. 29. *Itamus melanopogon*, Schiner, Reise der "Novara," Dipt., p. 190 (1868); Hutton, *l.c.*, p. 28. *Itamus inquisitor*, Nowicki, Mem. Krakauer Akad. Wissen., 2, p. 21 (1875); Hutton, *l.c.*, p. 27.

Bristles of the epistome black. Abdomen black. Length, 18 mm.; wing, 12–13 mm.

Hab. Auckland (Captain Broun); Wellington (Hudson).

Genus Senoprosopis, Macquart (1839).

"Body narrow. Face rounded, without any projection, very narrow; moustache mixed with some long and slender hairs. Front narrow. Eyes large. Abdomen slender; male organ small and but slightly projecting. Femora, tibiæ, and tarsi with long slender hairs below. Wings with the fourth posterior cell petiolate, the petiole rather long and the terminal nervure oblique" (Macquart).

In the New Zealand species the face projects slightly in the female, but not nearly so much as in *Asilus*. Also they have not the long drooping hairs on the front. But in other respects they closely resemble the type. The first joint of the antennæ is cylindrical, rather long and narrow in the male shorter in the female; the second cyathiform; the third subulate.

Senoprosopis lascus.

Asilus lascus, Walker, Cat. Dipt. in Brit. Mus., p. 466 (1849); Hutton, Cat. Dipt. N.Z., p. 30.

Vertex with yellow hairs, face black. Bristles of the epistome white. Antennæ black; second joint and base of the third joint brown in the male, yellow in the female. Abdomen dark-brown, with scattered yellow hairs; the posterior portions of the first six segments yellow. Wings grey. Legs yellowish-brown, the outer surface and the tarsi darker brown; the femora and tibiæ with a few long white hairs, in addition to the shorter ones. Length, 12 mm.; wing, 9½ mm.

Hab. Auckland (Captain Broun); Wellington (Hudson).

Senoprosopis meridionalis, sp. nov.

Face yellowish-white. Antennæ black in both sexes. Bristles of the epistome yellowish-white, with a row of black ones above. Thorax yellowish-brown above, with two longitudinal bands and some spots outside them dark-brown; the sides yellowish-brown, with few hairs. Abdomen almost hairless; the first three segments yellowish-brown with dark-brown rings, the posterior segments dark-brown. Halteres dark-brown. Wings greyish; veins black. Legs reddish-brown, the upper surfaces of the femora and the tarsi dark-brown; the hairs yellowish, the bristles black; some long hairs on the fore femora and tibiæ. Length, ♂ 12 mm., ♀ 14 mm.; wing, ♂ 6½ mm., ♀ 8 mm.

Hab. Christchurch (H. Clark).

In addition to the colours, the antennæ differ from those of the last species in having the first joint shorter in the male, and in the second joint being as long as the first.

Family BOMBYLIDÆ.

"Three basal cells much prolonged; anterior intercalary vein present, almost without exception; the posterior always wanting. Third joint of the antennæ simple; empodia quite rudimentary" (Loew).

Genus Fraudator, gen. nov.

Eyes contiguous, the facets coarser above than below. Face not projecting. Antennæ approximated at their bases; first and second joints short; the third much longer than the other two together, swollen near the base and gradually tapering to a long point, glabrous. Proboscis short. Abdomen narrow-linear. Tibiæ without spurs; no empodia. Third longitudinal vein branched near the end; no posterior intercalary vein; third basal cell closed, petiolate.

I include this genus in the *Bombylidæ* on account of the absence of the posterior intercalary vein, but it is very different in appearance from the other members of the family, having a superficial resemblance to *Heleodromia fumosa.* In the neuration of the wing it resembles *Oncodocera* (Macq.), but that genus has the abdomen broad and oval.

Fraudator perspicuus, sp. nov.

Eyes piceous; antennæ black. Thorax black, with a tawny patch on each shoulder; the posterior portion and scutellum yellowish, the sides silvery. Abdomen dark-brown, with scattered white hairs. Halteres white. Wings smoky, a clear patch just outside the stigma, which is large; fork of the third longitudinal vein leaving at a very acute angle, then curving forwards and joining the margin nearly at right angles;

anterior branch of the fourth longitudinal vein, beyond the discal cell, bent forwards, and then curving outwards to the margin of the wing. Legs dark-brown. Length, 7 mm.; wing, 8 mm.

Hab. Wellington (Hudson).

Family THEREVIDÆ.

"Three basal cells much prolonged; the two intercalary veins present; the third longitudinal forked. Antennæ with or without a style. No empodium. Under-lip fleshy" (Loew).

Genus Anabarhynchus, Macquart (1848).

Proboscis salient, thick, turned upwards, generally hiding the palpi. Antennæ inserted towards the lower part of the head; the first joint cylindrical, the second short, the third terminated by a short style. Fore and middle femora without bristles, hind femora with a few only. Neuration of the wing as in *Thereva*, but the fourth posterior cell is open. Female with the eyes further apart than in the male, and with a circle of setæ at the end of the abdomen.

Key to the Species.

Third joint of the antennæ longer than the first, glabrous or nearly so.
- Body black.
  - Tibiæ reddish .. .. *A. bilineatus.*
  - Tibiæ black .. .. *A. maori.*
- Body brown or dark-grey.
  - Legs piceous, with yellow knees .. .. *A. innotatus.*
  - Legs brownish-yellow.
    - Length of the wing, 9 mm. .. .. *A. luridus.*
    - Length of the wing, 6 mm.
      - Wings without spots .. .. .. *A. exiguus.*
      - Wings with spots .. .. .. *A. nebulosus.*

Third joint of the antennæ not longer than the first, hairy at the base.
- Length of the wing, 9 mm. or 10 mm.
  - Thorax with two golden bands .. .. *A. castaneus.*
  - Thorax with two silver bands .. .. .. *A. micans.*
- Length of the wing, 6 mm. .. .. .. *A. cupreus.*

Section A.

Abdomen rather broad, subconical, black or brown, with white hairs. Length of the first joint of the antennæ less than twice the breadth; second joint subquadrate; the third joint longer than the first, conical, naked or with a few hairs on the upper surface at the base.

Anabarhynchus bilineatus.

Bibio bilineata, Fabricius, Syst. Ent., p. 757 (1775). *Thereva bilineata*, Hutton, Cat. Dipt. N.Z., p. 32. *Saropogon viduus*, Hudson, Man. N.Z. Ent., p. 55, pl. vi., fig. 4.

Front, above the antennæ, brownish-white, the vertex black; antennæ and proboscis piceous; white hairs on the lower surface of the head and black on the crown. Thorax brownish-black, with two brownish-white conspicuous longitudinal bands, which do not pass on to the scutellum. Abdomen shining-black, with white tomentum below. Halteres black. Wings hyaline, the veins dark-brown. Legs black, except the tibiæ, which are yellowish-red with black apices. Length, 16 mm.; wings, 12½ mm.

Hab. Wellington (Hudson); Christchurch (H. Clark); Dunedin (F. W. H.).

This species appears to be rare.

Anabarhynchus maori, sp. nov.

Head with white hairs below, black on the crown; face black; first and second joints of antennæ black, the third joint piceous; proboscis black. Thorax black, with greyish tomentum and short black hairs; four darker longitudinal lines. Abdomen black, rather shining, covered on the sides and below with white hairs. Wings hyaline, the veins piceous. Legs black. Length, ♂ 10 mm., ♀ 12 mm.; wing, ♂ 9 mm., ♀ 10 mm.

Hab. Wellington (Hudson); Christchurch (H. Clark).

Anabarhynchus innotatus.

Thereva innotata, Walker, Insecta Saundersiana, vol. 1, p. 455 (1856).

"Cinereous, hardly pilose. Head, excepting the vertex, and pectus whitish. Thorax with a few black bristles on each side; scapulæ tawny. Abdomen hoary on each side and beneath towards the base. Legs piceous; knees tawny; tarsi black. Wings grey; veins and halteres brown. Length of the body, 5 lines (11 mm.); expanse of the wings, 8 lines (17 mm.)" (Walker).

Hab. Christchurch (F. W. H.); Ashburton (Smith).

I should call this species brownish-black or brown, but sometimes the abdomen is cinereous, owing to its being covered with grey tomentum. Length, ♂ 10 mm., ♀ 14 mm.; wing, ♂ 8 mm., ♀ 10 mm.

Anabarhynchus luridus.

Anabarhynchus luridus, Schiner, Reise der "Novara," Dipt., p. 148 (1868); Hutton, Cat. Dipt. N.Z., p. 32.

General colour brown, the thorax with darker streaks. Abdomen often cinereous, with grey tomentum. Legs tawny, the femora fuscous in the male but not in the female. Length, ♂ 10 mm., ♀ 10–13 mm.; wing, ♂ and ♀ 9 mm.

Hab. Christchurch (F. W. H.); Ashburton (Smith).

This, which is our commonest species, feeds on pollen. It is hardly distinct from the last, the colour of the legs being variable.

Anabarhynchus exiguus, sp. nov.

Brown, with grey hairs on the abdomen. Front, between the eyes, dark-brown, almost black; third joint of the antennæ nearly black. Thorax with yellowish-brown tomentum and scattered black bristles. Halteres pale-yellow. Wings yellowish, the veins near the base yellow; in the centre and posterior they are dark-brown. Legs and lower surface of the abdomen tawny. Length, ♂ 7½ mm., ♀ 7–9 mm.; wing, ♂ and ♀ 6 mm.

Hab. Christchurch (F. W. H.).

Anabarhynchus nebulosus, sp. nov.

Male.—Brown, with short white hairs all over the body. Short black hairs on the occiput, brown hairs on the vertex; hypostoma without hairs. Thorax with five indistinct, longitudinal, darker bands. Halteres yellow. Wings clear, with dusky clouds in the centres of the cells, except the first submarginal, in which the cloud is near the tip. Legs dusky, except the tibiæ, which are yellow. Length, 9 mm.; wing, 8 mm.

Hab. Wellington (Hudson).

I have not seen the female.

Section B.

Abdomen linear, reddish-brown. Length of the first joint of the antennæ more than twice its breadth; the second subglobular; the third not longer than the first, oval or linear, hairy at the base.

The species of this section have the third joint of the antennæ hairy, as in *Xestomyza*, but the shape of the antennæ is different, and the anterior legs are not elongated.

Anabarhynchus castaneus, sp. nov.

Chestnut-brown, the face and thorax with golden tomentum, which is denser on the scutellum and on two bands on the mesonotum. The first six segments of the abdomen fuscous posteriorly on the dorsum; under-surface and legs castaneous. Hairs on the front and antennæ black, those on the lower surface of the head white. Abdomen linear-conical, almost naked. Wings yellowish, the veins fuscous; no stigma, but a dusky cloud in the middle of the marginal cell, with a clear space inside it; another dusky cloud in the first posterior cell, close to its base; sometimes another in the base of the second submarginal and centre of the first posterior cells. Hypostoma with white hairs. Length, 12 mm.; wing, 10 mm.

Hab. Christchurch (H. Clark); Wellington (Hudson).

Anabarhynchus micans, sp. nov.

Dark castaneous, with two silver bands on the thorax and a longitudinal silver band along the dorsum of the abdomen from the scutellum to the fifth segment. Face with golden tomentum; no bristles on the lower surface of the head; hypostoma without hairs. Abdomen linear. Wings clear, except the tip and the costal cell, which are dusky, and with dusky clouds at the fork of the third longitudinal, at the base of the first posterior, and at the outer end of the discal cells; posterior cross-vein bordered with dusky. Legs yellow, except the tips of the femora, tibiæ, and metatarsi, as well as the other joints of the tarsi, which are fuscous. Length, ♂ and ♀ 10 mm.; wing, ♂ 9 mm., ♀ 8 mm.

Hab. Wellington (Hudson).

Anabarhynchus cupreus, sp. nov.

Dark reddish-brown, sparingly covered below with short white tomentum. Occiput white, the face piceous. Hypostoma without hairs. Antennæ piceous, the first joint elongated; the third sublinear, shorter than the first; the basal half covered with stiff hairs. Thorax with three white bands, the median one narrow, the outer pair much broader. Abdomen linear, shining. Wings clear, except the apex and a band from the stigma to the discal cell, which are fuscous; veins nearly black. Legs paler than the body, the base of the metatarsus paler than the rest. Length, 9 mm.; wing, 6 mm.

Hab. Wellington (Hudson).

Family CYRTIDÆ.

"Thorax and abdomen inflated. Eyes occupying the greatest part of the head. Tegulæ vaulted, exceedingly large. Wings naked, with variable neuration, sometimes very intricate, sometimes very incomplete; the basal cells, when present, are of considerable length. Terminal joint of the antennæ simple. Tibiæ without spurs; empodium much developed, pulvilliform" (Loew).

KEY TO THE GENERA.

Veins of the wing strong; proboscis long.
- Abdomen subcircular; eyes hairy .. .. .. *Apsoma.*
- Abdomen oblong; eyes bare .. .. *Helle.*

Posterior veins of the wing weak; proboscis short .. .. *Henops.*

Genus APSOMA, Westwood (1876).

Head roundly tranverse, eyes contiguous in front, hairy. Ocelli 3. Antennæ inserted in the middle of the face; first joint small, the second elongato-ovate at the base and produced into a long seta. Proboscis elongated, as long as the thorax ; the apex 2-lipped. Neuration nearly complete ; the third longitudinal vein curved downwards and forked after the cross-vein ; discal cell much elongated ; two distinct basal cells ; anal cell closed ; a triangular cell below the discal. Legs slender. Abdomen almost globose. Colour metallic.

Apsoma muscaria.

A. muscaria, Westwood, Trans. Ent. Soc. London, 1876, p. 510, pl. v., fig. 2.

"Very convex, shining, coppery-green, with yellowish pubescence ; proboscis and antennæ black. Legs dirty-yellow, middle of the femora darker. Wings hyaline, the veins black. Length, 8–9 mm. ; of proboscis, 4 mm. ; expanse of wings, 18 mm." (Westwood).

Hab. New Zealand (Hope collection, Oxford).

I have not seen this species. The figure shows the abdomen as broad as long, and pointed at the apex.

Genus Helle, Osten-Sacken (1896).

"Eyes glabrous, contiguous above the antennæ as far as the ocellar triangle. Three ocelli. Antennæ inserted about the middle of the head (seen in profile), very small ; second joint incrassate at the base and attenuated beyond it in the shape of an arista-like prolongation. Proboscis elongate. Hind part of the head swollen. Thorax gibbous; prothoracic lobes contiguous along a rather long suture, on both sides of which they expand hindwards, so that the hind margin of the prothorax shows a deep emargination. Neuration almost complete ; a single submarginal cell ; an elongate, somewhat pentagonal, discal cell ; four posterior cells, incomplete in consequence of the post-discal veins not reaching the margin ; two distinct basal cells ; the anal cell closed long before the margin, its petiole stunted a little before reaching the margin. Tegulæ large. Legs smooth, without spurs ; tarsi but little shorter than the tibiæ ; joints three and four are the shortest, both together nearly equal the first in length. Three pulvilli. Abdomen oval, with the first segment short ; the five other dorsal segments longer and nearly of the same length, with coarctations at the incisures" (Osten-Sacken).

The neuration closely resembles that of *Megaiybus pictus*, Westwood, Trans. Ent. Soc. London, 1876, pl. v., fig. 4*a*.

Helle longirostris.

Acrocera longirostris, Hudson, Man. N.Z. Ent., p. 56, pl. vii., fig. 4, 1892 (no description). *Helle longirostris*, Osten-Sacken, Ent. Mo. Mag., 2nd series, vol. vii., p. 16 (1896).

"Face brownish-yellow, its upper part and hind parts of the head black ; the latter with pale down. Upper part of the thorax greenish-bronze, densely marked with microscopic transverse striæ and covered with slight pale-golden down. Abdomen greenish-bronze, with pale-golden pubescence, the posterior edges of the segments yellowish-brown. Legs brown, the tibiæ and tarsi paler; joints of the latter pale-yellow at the base. Wings hyaline, slightly tinged with brownish; veins brown. Length, 5–6 mm." (Osten-Sacken).

Hab. Wellington and Nelson (Hudson). Rare.

I have not seen this species.

Genus Henops, Illiger (1806).

Proboscis not apparent. Antennæ inserted on the lower part of the head; the second joint bearing an elongated style with two short bristles at the end. Eyes glabrous. Neuration imperfect; the second longitudinal vein forked; the third longitudinal vein rudimentary; no discal cell; one distinct basal only; branches of the fourth longitudinal vein disconnected. Abdomen subglobose.

Henops brunneus.

H. brunneus, Hutton, Cat. Dipt. N.Z., p. 24 (1881); Maskell, Trans. N.Z. Inst., vol. xx., p. 106, pl. x.

Head black; antennæ pitch-brown. Thorax pitch-brown, with scattered tawny hairs. Abdomen brown, the posterior margin of each segment tawny. Legs pale-brown. Wings hyaline; the costa and second longitudinal vein brown. Length, 5–6 mm.; wing, 5–7 mm.

Hab. Otago (F. W. H.); Wairarapa (Maskell); Auckland (Broun).

Henops nitens, sp. nov.

Shining black, with black hairs on the thorax and abdomen. The tibiæ, except their bases, the tarsi, except the last joint of each, and a spot on each side of the second and third abdominal segments, tawny. Wings hyaline. Length, 5–6½ mm.; wing, 4½–5 mm.

Hab. Auckland (Broun); Wellington (Hudson).

Family EMPIDÆ.

"Three basal cells complete, rather large, the third shorter than the second; posterior basal cross-vein parallel to the border of the wing; third longitudinal frequently forked; anterior intercalary vein present, the posterior absent. First joint of the antennæ not much shortened, third joint with an apical bristle sometimes resembling a style. Empodium membranaceous and of a linear form" (Loew).

Key to the Genera.

Style shorter than third joint of antennæ; fore coxæ moderate.
  Proboscis longer than the head .. .. .. *Empis.*
  Proboscis not longer than the head .. .. .. *Hilara.*
Style longer than third joint of antennæ; fore coxæ elongated .. .. *Clinocera.*

Genus Empis, Linnæus.

Eyes contiguous in the male, remote in the female. Antennæ with the first joint cylindrical; the second cyathiform, about half the length of the first; the third subulate, compressed, longer than the style. Proboscis much longer than the head, directed downwards. Wings with the third longitudinal vein forked.

Key to the Species.

Fork of the third longitudinal leaving at an acute angle.
  Proboscis stout, more than twice the length of the head *E. hudsoni.*
  Proboscis slender, less than twice the length of the head .. .. *E. smithii.*
Fork of the third longitudinal leaving at almost a right angle .. .. *E. brouni.*

Empis hudsoni, sp. nov.

Dark-brown, almost black in some lights, the lower surface and femora silvery. Head, thorax, and legs thinly clothed with black hairs. Third joint of the antennæ pyriform, the style less than half the length of the joint. Proboscis very stout, more than twice the length of the head. Wings tinted with fuscous, and with a darker cloud in the marginal cell; the veins black; fork of the third longitudinal emerging at an acute angle. Length, 3–3½ mm.; wing, 4½ mm.

Hab. Wellington (Hudson).

Empis smithii, sp. nov.

Brown, the thorax dusted with yellow, and with four brown bands; a few scattered black hairs on the head, thorax, and legs. Proboscis slender, about one and a half times the length of the head; yellowish, with the front and tip piceous. Halteres tawny. Wings brown; the veins black. Legs tawny, the last joint of the tarsi fuscous. Wing as in the last species. Length, 5 mm.; wing, 6 mm.

Hab. Ashburton (Smith).

Empis brouni, sp. nov.

Brown, covered all over with grey tomentum. Proboscis brown, slender, about one and a half times the length of the head. Third joint of the antennæ subulate, the style short. Wings tinted grey; the fork of the third longitudinal leaves the vein almost at a right angle and proceeds straight forward to the margin. Length, 6 mm.; wing, 6 mm.

Hab. Auckland (Broun).

Genus Hilara, Meigen (1822).

Third joint of the antennæ with a short style; the first joint short. Proboscis straight, perpendicular, not longer than the head. Wings with the third longitudinal forked.

Hilara fulvipes, sp. nov.

Reddish-brown; the legs tawny, except the last four joints of the tarsi, which are fuscous. Third joint of the antennæ slightly swollen, the style about half as long as the joint. Proboscis shorter than the head, nearly vertical. The fork of the third longitudinal vein leaves nearly at a right angle and then curves outward, joining the margin acutely. Length, 4 mm.; wing, 4 mm.

Hab. Christchurch (F. W. H.).

The style is shorter than the third joint of the antennæ.

Genus Clinocera, Meigen (1822).

Proboscis thick. First joint of the antennæ short, the third shorter than the style. Fore coxæ elongated, the femora not thickened. Third longitudinal vein forked; discal and both basal cells present; four posterior cells; sixth longitudinal vein obsolete before reaching the margin.

Clinocera fumosa, sp. nov.

Eyes dark-red, the antennæ and proboscis black. Head and thorax black, the latter with some silvery down below, and faint indications of two pale bands on the mesonotum. Abdomen dark-brown, with scattered black hairs. Halteres white. Wings smoky, the stigma indistinct; veins nearly black; fork of third longitudinal vein leaving at an acute angle, not bent forwards; fourth longitudinal straight. Legs blackish-brown. Length, 7 mm.; wing, 6 mm.

Hab. Wellington (Hudson).

Family DOLICHOPODIDÆ.

"First basal cell rather short, the second united with the discal, the third small; auxiliary vein running into the first longitudinal vein; third longitudinal vein simple; the fourth sometimes furcate; no intercalary vein. Hypopygium symmetrical, bent under the abdomen. Empodium small, membranaceous, of a linear form" (Loew).

KEY TO THE GENERA.

Fourth longitudinal vein forked .. .. *Psilopus.*
Fourth longitudinal vein simple.
  Abdomen very short; posterior cross-vein near margin of wing .. .. *Liancalus.*
  Abdomen large; posterior cross-vein remote from the margin .. .. *Ostenia.*

Genus PSILOPUS, Meigen (1824).

Abdomen and legs slender; face broad in both sexes, the vertex concave. First joint of the antennæ naked, the second with bristles; the third short, and with an apical or subapical arista. Eyes generally hairy in the male. Fourth longitudinal vein forked.

In all the New Zealand species known to me the first longitudinal vein hardly reaches the middle of the wing, and the anterior branch of the fourth longitudinal emerges almost at a right angle and then curves outwards, reaching the margin above the apex and near the tip of the third longitudinal. The cilia on the squamæ are pale. In the males the costa has rather long bristles, which do not appear in the females. There are black bristles on the second joint of the antennæ, the vertex, and the thorax. There are white hairs on the face, behind the eyes, which are red, and not hairy.

KEY TO THE SPECIES.

Legs pale-yellow, the femora fuscous .. .. .. *P. restrictus.*
Legs fuscous, the knees yellow .. .. .. *P. mobilis.*
Legs black, the femora with green reflections.
  Arista dorsal .. .. *P. malitiosus.*
  Arista apical .. .. *P. fuscatus.*
Legs pale-yellow, the tips fuscous .. .. .. *P. gemmatus.*

Section A. Arista apical.

Psilopus mobilis, sp. nov.

Head and thorax bluish-green, with metallic reflections; abdomen bronzy, with dark bands. Antennæ black, the arista apical. Eyes red. Wings clear, the veins black. Legs fuscous, the knees tawny, the femora with green metallic reflections. Length, 5 mm.; wing, 5 mm.

Male.—Arista clubbed at the end. The anterior portion of each abdominal segment dark-brown.

Female.—The arista not clubbed at the end. The posterior portions of the abdominal segments brown above.

Hab. Christchurch (F. W. H.); Ashburton (Smith).

Probably related to *P. globifer* (Wied).

Peliopus fuscatus, sp. nov.

Male.—Head and thorax metallic blue; abdomen bronzy, with dark bands. Arista not clubbed at the end. Wings clear, the veins black. Legs black. Length, 4 mm.; wing, 4 mm.

Hab. Otago (F. W. H.).

The female is unknown.

Section B. Arista dorsal.

Psilopus restrictus, sp. nov.

Female.—Head bluish-green, thorax greenish-blue, abdomen brownish-green, all with metallic reflections. Arista long, subterminal. Wings greyish, the veins tawny. Femora fuscous, the tibiæ and tarsi tawny. Lengtb, 5 mm.; wing, 4 mm.

Hab. Christchurch (F. W. H.).

The male is unknown.

Psilopus malitiosus, sp. nov.

Female.—Head bluish-green, thorax and abdomen bronze-green, all with metallic reflections. Antennæ black, the arista subterminal. Wings greyish, the veins black. Legs fuscous, the femora with metallic reflections. Length, 4 mm.; wing, 4 mm.

Hab. Christchurch (F. W. H.); Ashburton (Smith).

The male is unknown.

Psilopus gemmatus.

P. gemmatus, Walker, Cat. Dipt. in Brit. Mus., p. 647 (1849); Hutton, Cat. Dipt. N.Z., p. 33.

"Bluish-green; abdomen golden-green, bluish-green at the base. Legs pale-yellow, tarsi pitchy towards their tips. Length, 5 mm." (Walker).

Hab. Auckland (Dr. Sinclair).

I have not seen this species.

Genus LIANCALUS, Loew (1857).

"Bristles on the body neither numerous nor long. Wings elongated; the posterior transverse vein less than its length from the margin of the wing. Legs elongated and slender; the first joint of the hind tarsi without bristles on the upper side, not shorter than the second, but generally longer. Face in both sexes broad, with a small tubercle upon the lowest third of each side of the orbit, and with an indistinct swelling running from one tubercle to the other. Antennæ rather short, the first joint without hairs; the apparently bare arista dorsal, distinctly two-jointed. The hypopygium of the male imbedded" (Loew).

Liancalus vagus, sp. nov.

Metallic greenish-bronze; the head dark-brown; the eyes red. Second joint of the antennæ with short bristles, the arista distinctly dorsal, rather short, curved. A few short bristles on the vertex and occiput. Wings clear, the veins piceous; the second longitudinal turning forwards at the tip; the third longitudinal curving backwards; the fourth longitudinal straight; posterior cross-vein nearer the margin than its length. Legs greenish-bronzy; the bristles of the fore femora equal, regular, rather distant; the lower edge of the fore tibiæ with a row of bristles shorter than those on the femur, but with a stronger one at the tip. The other legs with a few scattered bristles. Length, 3 mm.; wing, 4½ mm.

Hab. Christchurch (F. W. H.).

The scutellum has four bristles.

Genus Ostenia, gen. nov.

First joint of the antennæ rather long, nearly cylindrical, without hairs; the second joint very short, with a circle of bristles; the third joint short, transverse, with short hairs; the arista dorsal, strong, bent near its base, almost bare. Eyes with very short hairs. Front broad in both sexes; bristles on the vertex and occiput. Proboscis short and stout. Thorax convex above, with a transverse hollow before the scutellum; mesothorax and scutellum with bristles. Abdomen large, oval, depressed, with a few short bristles; apparently of five segments in the female, six in the male. Hypopygium not inflected under the abdomen, but apparently withdrawn into the sixth segment. Wings rather short and broad; the costa bristly. The auxiliary vein ends in the first longitudinal. The first longitudinal extends to nearly half the length of the wing; fourth longitudinal simple, nearly parallel to the third; posterior cross-vein distant from the margin by more than twice its length. Legs short and stout for the family; the femora and tibiæ with long scattered bristles.

This genus appears to come nearest to *Xanthochlorus*, Loew, but it differs in the first joint of the antennæ and the hypopygium, as well as in its robust form, oval abdomen, and short legs. I have named it after Baron Osten-Sacken.

Ostenia robusta, sp. nov.

Head and thorax brown, non-metallic; abdomen and legs darker, with submetallic reflections. Antennæ and proboscis piceous. Abdomen bluish-black in the male, greenish-black in the female. Wings brown; the veins dark-brown, lighter near the base; second longitudinal bent backwards near the tip; the third parallel to the second, but more bent down near the tip; the fourth nearly parallel to the third for three-quarters of its length, then bent slightly forwards towards the third, and backwards again near the tip, without any abrupt bends. Length, ♂ 7 mm., ♀ 8 mm.; wing, ♂ and ♀ 6 mm.

Hab. Christchurch (F. W. H.).

Series CYCLORRHAPHA ASCHIZA.

Family PHORIDÆ.

"Antennæ apparently single-jointed, with a long bristle. Wings with several stout veins running into the costa, and three or four weak ones, which run across the surface of the wings, and are not completely connected with the hindmost of the stout veins, from which they appear to issue. Femora flattened" (Loew).

Genus PHORA, Latreille (1796).

Small. Arista long and bare. Thorax short-elliptical. Wings rather longer than the body; costa ending before or a little beyond half the length of the wing; generally ciliated. Abdomen generally narrow and longer than the thorax. Legs rather long, with a few bristles.

Phora omnivora.

Phora omnivora, Hudson, Man. N.Z. Ent., p. 62, pl. vii., figs. 15, 15*a* (1892). The neuration of the wing is incorrect.

Black, the legs and palpi pale-brown, the latter with black hairs. Halteres yellowish. Costal vein with a double row of bristles extending to nearly the middle of the wing. Also some bristles at the anal angle of the wing. Auxiliary vein distinct, ending in the first longitudinal, which is two-thirds the length of the third longitudinal. Second longitudinal emerging from the third near its tip. A spurious veinlet (or fold of the membrane) extends from the tip of the third longitudinal to six-sevenths of the length of the wing. The fourth longitudinal is slightly curved backwards, reaching the margin above the tip of the wing. The fifth, sixth, and seventh are slightly undulated, the fifth reaching the margin below the tip and almost exactly under the end of the fourth longitudinal; the seventh ends opposite the end of the third. Middle and hind tibiæ spurred. Length, 2 mm.

Hab. Wellington, Christchurch, and Dunedin (F. W. H.).

This species is very like *P. rufipes*, Fabricius, but without European specimens for comparison I do not like to say that the two are identical.

Family SYRPHIDÆ.

"Three basal cells much prolonged; third longitudinal vein simple; a spurious longitudinal vein between the third and fourth. Fourth longitudinal united at its end with the third; no intercalary veins. Hypopygium unsymmetrical. No empodium" (Loew).

The third basal cell is closed, and there are three posterior cells, of which the first and second are closed and the third is open. In *Melanostoma decessa* the spurious longitudinal vein is absent.

Key to the Genera.

Abdomen broad; submarginal cell dilated.	
Marginal cell closed	*Eristalis.*
Marginal cell open	*Helophilus.*
Abdomen slender; submarginal cell not dilated.	
Anterior basal cell attaining to more than half the discal	*Milesia.*
Anterior basal cell attaining to less than half the discal.	
Scutellum pale	*Syrphus.*
Scutellum dark	*Melanostoma.*

Genus Eristalis, Latreille (1802).

Antennæ approximated, seated on a tubercle; arista at the base of the third joint. First and second longitudinal veins meeting before the margin of the wing. Halteres covered by the squamæ. Eyes contiguous in the male.

Eristalis tenax.

Musca tenax, Linn., Syt. Nat., ii., 984. *Eristalis tenax*, Hudson, Trans. N.Z. Inst., vol. xxii., p. 187.

Piceous, with tawny hairs. Abdomen with a large tawny spot on each side, which is much larger in the male than in the female. Hind borders of the segments tawny. Length, ♂ 13 mm., ♀ 15 mm.; wing, ♂ 11 mm., ♀ 12 mm.

Hab. Throughout New Zealand. Very abundant.

Introduced, probably from England. First noticed in Wellington in the spring of 1888, by Mr. G. V. Hudson. Mr. W. W. Smith took two specimens at Ashburton in November of the same year, and by 1890 it had become common.

Genus Helophilus, Meigen (1822).

Body broad. Eyes separated in both sexes. Face prominent. Antennæ inserted on a projection in front; the third joint almost circular; the style inserted near its base. Thorax hairy. Abdomen partly hairy or entirely naked. Legs hairy; the posterior femora thickened, the tibiæ incurved, produced into a tooth at the apex on the inner side.

Wings with the marginal cell open ; the submarginal pediform. The males are smaller than the females.

KEY TO THE SPECIES.

Abdomen black, with white spots	*H. cingulatus.*
Abdomen black, with yellowish-red spots.	
Second segment only with yellow spots.	
Yellow spots about half the depth of the segment	*H. trilineatus.*
Yellow spots nearly the whole depth of the segment	*H. vicinus.*
Second and third segments with yellow spots ..	*H. antipodus.*
Abdomen bronzy.	
Antennæ black	*H. ineptus.*
Antennæ red, with a black border	*H. chathamensis.*
Abdomen blue	*H. latifrons.*

Section A.

All the abdominal segments with close short hairs. No tooth on the hind tibiæ.

Helophilus cingulatus.

Syrphus cingulatus, Fabricius, Syst. Ent., p. 767 (1775). *Eristalis cingulatus*, Hutton, Cat. Dipt. N.Z., p. 40; Hudson, Man. N.Z. Ent., p. 57, pl. vii., fig. 2.

Front rather narrow, the sides parallel; forehead dark-chestnut, with a transverse chevron of reddish-white and some white at the base of the epistome; antennæ, epistome, and peristome dark-chestnut; third joint of the antennæ rather broader than long, the style naked. Thorax black, with reddish-black tomentum ; scapulæ ferruginous ; a pair of narrow longitudinal white lines on the dorsum, and a pair on each side, the latter with a sharp re-entering angle in the middle. Scutellum shining, dark-chestnut. Abdomen black, the greater part thickly covered with short hairs. At the base there is a band of long yellowish-white hairs, which are shorter in the middle ; second segment with a broad transverse white band interrupted in the middle ; third and fourth segments with four small round white spots, the outer pair on the fourth segment, with a tuft of white hairs. Outside the inner pair of spots on the third and fourth segments is a polished space without any hairs. Wings hyaline, the veins black ; submarginal cell closed, but not petiolate. Legs hairy, black ; the knees inside of the fore and middle tibiæ and the whole of the tarsi ferruginous. Length, 14–15 mm. ; wing, 12–13 mm.

Hab. Wellington (Hudson) ; Picton, Christchurch, and Dunedin (F. W. H.). Rare.

Section B.

First and second abdominal segments with close short hairs, the others shining, and with scattered hairs only. Hind tibiæ with a blunt tooth at the apex, on the inside.

Helophilus trilineatus.

Syrphus trilineatus, Fabricius, Syst. Ent., p. 766 (1775). *Helophilus trilineatus*, Voy. "Erebus" and "Terror," Insects, pl. 7, fig. 19; Hutton, Cat. Dipt. N.Z., p. 41; Hudson, Man. N.Z. Ent., p. 58, pl. vii., fig. 1.

Face golden. Thorax grey, with three strongly marked black bands; the sides covered with golden hairs. Abdomen black, with a large yellowish spot on each side of the second segment, which occupies rather more than the anterior half of the segment. Legs testaceous, the femora black, except the tip of those of the fore and middle legs.

Male.—The whole of the vertex black, the boundary between it and the yellow of the face being a well-defined straight line. Hind tibiæ black, with a broad median testaceous band.

Female.—Forehead often dark-grey; the black of the vertex confined to the ocellar triangle. Hind femora sometimes with a testaceous spot on both inner and outer sides; the hind tibiæ testaceous.

Length, ♂ 13 mm., ♀ 17 mm.; wing, ♂ 10 mm., ♀ 13 mm.

Hab. Throughout New Zealand.

Helophilus vicinus, sp. nov.

Like *H. trilineatus*, but the yellow spots on the second abdominal segment reach to the posterior margin.

Length, ♂ 12 mm.; wing, ♂ 11 mm.

Hab. Chatham Islands (Fougère).

I have not seen the female.

Helophilus antipodus.

H. antipodus, Schiner, Reise der "Novara," Dipt., p. 359 (1868). *Mallota antipoda*, Hutton, Cat. Dipt. N.Z., p. 40.

In this species the colours are almost the same as in *H. trilineatus*, but the abdominal spots are yellower, and occur on both the second and third segments. The vertex of the female is black, and resembles that of the male. In the male the yellow spots are larger than in the female, occupying nearly the whole of the second segment. The hind tibiæ are differently coloured in the two sexes, as in *H. trilineatus*. Length, ♂ 11 mm., ♀ 13–14 mm.; wing, ♂ 9 mm., ♀ 10–11 mm.

Hab. Throughout New Zealand. Not so common as *H. trilineatus*.

Section C.

All the abdominal segments nearly naked, shining. No tooth on the posterior tibiæ.

Helophilus ineptus.

H. ineptus, Walker, Cat. Dipt. in Brit. Mus., p. 608 (1849); Hutton, Cat. Dipt. N.Z., p. 41.

Face yellow, the vertex piceous. Thorax grey, with three black bands above and one on each side before the wings; silvery below. Abdomen metallic-bronze, the centre of the segments with a triangular dead-black mark.

Male.—Legs black, except the basal halves of the tibiæ, which are testaceous.

Female.—Femora black; the tibiæ and tarsi testaceous, except the bases of the hind tibiæ.

Length, ♂ 11 mm., ♀ 12 mm.; wing, ♂ 9 mm., ♀ 12 mm.

Hab. Throughout New Zealand.

Helophilus chathamensis, sp. nov.

Face grey, the vertex red. Third joint of the antennæ red, with a black border. Thorax dark-brown; the scutellum pale-tawny, blackish towards its base. Abdomen bronzy, with dead-black patches in the middle of each segment. Legs black, the knees and proximal portions of the tibiæ testaceous. Length, 9–11 mm.; wing, 8–10 mm.

Hab. Chatham Islands (Fougère).

My specimens have been in spirit, and the hairy covering is changed in appearance, and cannot be described.

Helophilus latifrons.

H. latifrons, Schiner, Reise der "Novara," Dipt., p. 359 (1868). *Mallota latifrons*, Hutton, Cat. Dipt. N.Z., p. 40. *H. hochstetteri*, Nowicki, Mem. Krakauer Akad. Wissen., ii., p. 23 (1875); Hutton, Cat. Dipt. N.Z., p. 42; Hudson, Man. N.Z. Ent., pl. vii., fig. 8.

Thorax black, with indistinct grey bands. Abdomen dark steel-blue. Antennæ reddish-yellow, with a black base. The tip of the scutellum and a tubercle under the wings are reddish-yellow. The legs are black, with the apex of the middle femora and the base of the middle tibiæ generally reddish-yellow. Length, 9–11 mm.; wing, 7–9 mm.

Hab. Throughout New Zealand. Abundant.

Genus Milesia, Latreille (1802).

Body narrow. Eyes nearly contiguous in the male. Wings incumbent in repose; the marginal cell open and the submarginal cell simple; the chief cross-vein nearer to the apex than to the base of the discal cell.

Milesia bilineata.

Milesia bilineata, Walker, Cat. Dipt. in Brit. Mus., p. 566 (1849); Hutton, Cat. Dipt. N.Z., p. 43.

Above black, with two pale-tawny stripes on the thorax. Clothed with tawny hairs below. Legs black. Length, 15 mm.

Hab. Wellington (Earl).

I do not know this species.

Genus Syrphus, Fabricius (1775).

Body narrow, linear or oblong; eyes contiguous in the male. Wings incumbent in repose; the submarginal cell simple; the chief cross-vein much nearer to the base than to the apex of the discal cell. Third joint of the antennæ oval or round. Abdomen with five visible segments.

Key to the Species.

Stripes on the abdomen interrupted in the middle.	
Face grey	*S. novæ-zealandiæ.*
Face yellow.	
Third joint of antennæ round, piceous ..	*S. ortas.*
Third joint of antennæ oval, yellow ..	*S. obesus.*
Second and third stripes on the abdomen continuous	*S. ropalus.*

Syrphus novæ-zealandiæ.

S. novæ-zealandiæ, Macquart, Dipt. Exot., Supp. 5, p. 115 (1855); Hutton, Cat. Dipt. N.Z., p. 44. *S. ortas*, Hudson, Man. N.Z. Ent., p. 56, pl. vii., fig. 3.

Face greyish-white; vertex and prominence shining-black. Antennæ black, the third joint subcircular. Thorax greenish-bronze; scutellum shining, fulvous, with a dark base. Abdomen black, second, third, and fourth segments with a narrow, transverse, subbasal fascia, broadly interrupted in the middle, which is yellow or orange dusted with white; the anterior angles of the sixth segment yellow. Legs dark-brown, the middle and fore tibiæ lighter. Veins of the wing black. Length, 8–10 mm.; wing, 8–9 mm.

Hab. Throughout New Zealand (very common); Chatham Islands. Said to be found also in Polynesia.

This species varies in the colour of the transverse abdominal bands as well as in their breadth; also in the colour of the legs, which are sometimes almost black. Both sexes have the abdomen linear, and both are of the same size.

Schiner has identified this species with the Australian *S. ambustus*, Walker (1852), but that species has the scutellum ferruginous, the abdomen brassy-green on the sides and hind borders of the segments, the legs black with ferruginous knees, and the veins of the wing tawny.

Syrphus ortas.

S. ortas, Walker, Cat. Dipt. in Brit. Mus., p. 585 (1849); Hutton, Cat. Dipt. N.Z., p. 43. *S. rectus*, Nowicki, *l.c.*, p. 24 (1875); Hutton, Cat. Dipt. N.Z., p. 44.

Face pale-yellow, the vertex black; antennæ piceous, ferruginous at the base. Thorax greenish-bronze, the scutellum fulvous. Abdomen black; the second, third, fourth, and fifth segments with oblique yellow bands interrupted in the middle. Legs fulvous, the tarsi and hind femora clouded with fuscous; darker in the male than in the female. Length, 9–12 mm.; wing, 7½–10 mm.

Hab. Auckland (Dr. Sinclair); Dunedin and Christchurch (F. W. H.). Apparently rare.

The oblique abdominal bands and the yellow face sufficiently distinguish this species from the last.

Syrphus ropalus.

S. ropalus, Walker, Cat. Dipt. in Brit. Mus., p. 593 (1849); Hutton, Cat. Dipt. N.Z., p. 44.

Face tawny; vertex coppery; antennæ tawny. Thorax coppery; the scutellum tawny or orange. Abdomen narrow, black, orange on each side of the base, and with four broad orange bands, of which the second and third are not interrupted, across the back. Legs tawny. Length, ♂ 7 mm., ♀ 9 mm.; wing, ♂ 6 mm., ♀ 8 mm.

Hab. Auckland (Dr. Sinclair); Kekerangu, 3,000 ft. (Hudson); Dunedin (F. W. H.). Rare.

The abdomen in the male is subcylindrical.

Syrphus obesus, sp. nov.

Face yellow, the vertex piceous; antennæ tawny, the third joint oval. Thorax piceous, with a tawny band on each side; the scutellum tawny, dull. Abdomen oblong in both sexes, black; the second, third, and fourth segments with a broad, tawny, transverse, basal fascia, all of which are narrowly interrupted in the female, but that of the fourth segment is continuous in the male. The segments are also narrowly margined with tawny. Legs tawny; the bases of the fore and middle femora and the whole of the hind femora black. In the male the hind tibiæ have a dusky band. Length, ♂ 8 mm., ♀ 9 mm.; wing, ♂ and ♀ 7 mm.

Hab. Auckland (Captain Broun).

Genus Melanostoma, Schiner (1860).

Medium size, nearly bare, metallic-black or greenish-black, the abdomen with lighter-coloured spots or bands. Antennæ short, third joint oval or a little elongate. Face tuberculate, black or black-green, never in ground-colour yellow, though frequently with whitish dust. Eyes bare, contiguous in the male. Thorax shining, without yellow or red marks. Abdomen elongate, slender, rarely oval, much flattened. Legs simple, the hind metatarsi sometimes a little thickened. Wings rather large, extending beyond the abdomen; marginal cell open; third longitudinal nearly straight; outer anterior angle of first posterior cell acute.

Plesia, of which *M. fasciatum* is the type, has priority of *Melanostoma.*

Key to the Species.

Abdomen with testaceous spots	*M. fasciatum.*
Abdomen black.	
Scutellum æneous	*M. apertum.*
Scutellum black..	*M. decessum.*

Melanostoma fasciatum.

Plesia fasciata, Macquart, Dipt. Exot., Supp. 4, p. 461, tab. 14, fig. 15 (1850); Hutton, Cat. Dipt. N.Z., p. 45.

Face and vertex black. Antennæ black, the third joint oval. Thorax and scutellum æneous. Abdomen oblong in the female, linear in the male; black; the second, third, and fourth segments with a large testaceous spot on each side, larger in the male than in the female; the fifth segment testaceous anteriorly. Legs tawny, the hind pair more or less fuscous. Length, 6 mm.; wing, 5 mm.

Hab. Christchurch, Whangarei, and Queenstown (F.W.H.).

The second longitudinal vein is nearly straight, very slightly curved forwards at the tip.

Melanostoma apertum, sp. nov.

Female.—Vertex and face black. Thorax and scutellum æneous. Abdomen oblong, bluish-black, without any bands. Legs tawny. Wings colourless, the stigma pale-yellow;

second longitudinal vein not sinuated near the tip; the third and fourth straight. Length, 6 mm.; wing, $5\frac{1}{4}$ mm.

Hab. Christchurch (F. W. H.).

My only specimen has, unfortunately, lost the antennæ; but it is so distinct in other respects that it will be easily recognised. The neuration of the wing agrees with that of *M. fasciata*.

Melanostoma decessum, sp. nov.

Male and Female.—Vertex black, the face silvery; antennæ piceous, the third joint oblong; tips of the proboscis and palpi fulvous. Thorax black, with slight æneous reflections; scutellum black. Abdomen oblong, black, without any bands. Femora black, the tibiæ and tarsi fulvous. Wings colourless, the stigma pale-brown; veins dark-brown; the spurious vein absent. Length, 8 mm.; wing, 7 mm.

Hab. Christchurch (Clark); Ashburton (W. W. Smith).

The eyes are hairy and contiguous in the male. The posterior cross-vein and the bend of the fourth longitudinal (apical cross-vein) are straight.

Series CYCLORRHAPHA SCHIZOPHORA.

Division I. MUSCIDEA CALYPTRATÆ.

Squamæ covering the halteres.

Key to the New Zealand Families.

Antennæ in rounded pits	*Œstridæ*.
Antennæ not in rounded pits.	
Fourth longitudinal vein bent forwards.	
Arista bare or pubescent	*Tachinidæ*.
Arista plumose at the base, bare at the tip ..	*Sarcophagidæ*.
Arista plumose	*Muscidæ*.
Fourth longitudinal vein not bent forwards ..	*Anthomyidæ*.

Family ŒSTRIDÆ.

Antennæ inserted in rounded pits; the middle part of the face very narrow; the opening of the mouth very small; the oral organs rudimentary.

Genus Gasterophilus, Leach (1817).

Body hairy; front broad. Antennæ very short, seated in a cavity of the face; the third joint round; arista bare. Squamæ very small. Fourth longitudinal vein nearly straight, slightly inclined backwards, and ending at some distance from the tip.

Gasterophilus equi.

Gastrus equi, Meigen, Dipt. iv., 175, i., pl. 38, figs. 21, 22.

Body tawny, with testaceous hairs. Wings with a transverse grey band beyond the middle. Male lighter in colour than the female. Length, 11–17 mm.; wing, 10 mm.

Hab. Throughout New Zealand. Introduced.

I first saw this species in 1892. Both it and the following species were exceedingly troublesome for the next two years, but since then their numbers have declined. In America it is thought that they are kept in check by sparrows feeding on the pupæ.

Gasterophilus hæmorrhoidalis.

Œstrus hæmorrhoidalis, Linnæus, Syst. Nat., ii., 970, 4 (1761).

Body black, with testaceous hairs. Abdomen with a black band in the middle, and pale-yellow hairs at both ends. Wings clear. Length, 10–11 mm.; wing, 9 mm.

Hab. Throughout New Zealand. Introduced.

Mr. M. Murphy, secretary to the Canterbury Agricultural and Pastoral Association, informs me that this fly was first noticed in the North Island in 1889, and in Canterbury in 1891. It is thought to have been introduced by some Mexican circus-horses from San Francisco.

Genus Œstrus, Linn. (1748).

Body pubescent, the front broad. Antennæ very short, seated in a cavity of the face, the third joint round; arista bare. Squamæ large. Fourth longitudinal vein bent forwards and joining the third longitudinal at a short distance from the tip of the latter.

Œstrus ovis.

Œstrus ovis, Linnæus, Syst. Nat., ii., 970. *Œstrus perplexus*, Hudson, Man. N.Z. Ent., p. 63, pl. vii., fig. 12.

Head and thorax pale-brown above, with numerous minute black tubercles. Abdomen dark-brown, tessellated with silvery. Legs pale-tawny. Wings clear. Length, 11 mm.; wing, 9½ mm.

Hab. Throughout New Zealand. Introduced.

I first noticed this species at Homebush Station, in Canterbury, in 1873, but it is not common.

Family TACHINIDÆ.

"Arista of antennæ bare, or with very short pubescence. Thorax short. First posterior cell closed or only slightly opened. Legs short" (Loew).

Parasitic insects which lay their eggs on the larvæ of other insects.

KEY TO THE NEW ZEALAND GENERA.

Abdomen oval or oblong, not curved under at the apex.	
Costa of the wing with a conspicuous bristle.	
Second joint of the arista elongated	*Calcager.*
Second joint of the arista quite short ..	*Tryphera.*
Costa of the wing without a conspicuous bristle.	
Abdomen hairy, and with macrochætæ.	
Facial ridges unarmed.	
First posterior cell ending near the tip of the wing	*Macquartia.*
First posterior cell ending considerably before the tip of the wing.	
Eyes hairy.	
Second joint of arista twice as long as broad.	
Abdomen oval, tawny ..	*Hystricia.*
Abdomen oblong, blue ..	*Occisor.*
Second joint of arista quite short	*Nemorœa.*
Eyes bare, or nearly so.	
Front smooth	*Tachina.*
Front longitudinally grooved.	
Mid-abdominal segments with discal setæ ..	*Proscissio.*
Mid-abdominal segments without discal setæ ..	*Peremptor.*
Facial ridges armed with a row of strong bristles.	
Eyes bare; antennæ covered ..	*Cerosomyia.*
Eyes hairy; antennæ exposed ..	*Phorocera.*
Abdomen glabrous, without macrochætæ ..	*Gymnophania.*
Abdomen nearly cylindrical, curved under at the apex ..	*Phania.*

The following is a systematic arrangement of the genera according to the plan followed by Mr. W. D. Coquillet in his "Revision of the Tachinidæ of America north of Mexico" (1897):—

First posterior cell ending close to the tip of the wing.	
Abdomen destitute of macrochætæ.	
Cheeks bare	*Phania.*
Cheeks with bristles	*Gymnophania.*
Abdomen bearing macrochætæ; cheeks bare	*Macquartia, Tryphera.*
First posterior cell ending some distance before the tip of the wing.	
Cheeks bare.	
Vibrissæ distinctly above the mouth.	
Eyes bare	*Calcager, Peremptor.*
Eyes hairy	*Nemoræa, Hystricia.*
Vibrissæ on a level with the anterior border of the mouth.	
Eyes bare	*Tachina, Proscissio, Cerosomyia.*
Eyes hairy	*Phorocera.*
Cheeks hairy; vibrissæ above the mouth	*Occisor.*

Genus Macquartia, R. Desvoidy (1830).

"Flies of moderate size, or small, with ovoid or oblong bodies. The males have the eyes approximate or contiguous, and hairy; in the female they are moderately separated, and often only pubescent. The antennæ are short, with a pubescent arista. Facialia unarmed; the cheeks bare, but the mentum, or chin, is hairy or bristly. The abdomen has both discal and marginal setæ. The wings have the fourth longitudinal vein bent in a curve or blunt angle, and the first posterior cell opens near the apex of the wing" (Meade).

Macquartia subtilis, sp. nov.

Male.—Front black, the face pale-yellow. Antennæ piceous; palpi tawny. Thorax dark-brown, with four indistinct longitudinal bands; the sides grey, some long yellow hairs below. Abdomen brown, tessellated on the sides with black and white. Legs black. Squamæ pale-brown. Wings tinged with brown; the fourth longitudinal vein sharply angled at a right angle, and then very gently curved outwards; a short cubital appendix. Length, 9 mm.; wing, 7 mm.

Hab. Wellington (Hudson).

The third joint of the antennæ is barely twice the length of the second; the arista distinctly pubescent. The eyes are hairy and closely approximated, but not touching. The fronto-orbital bristles do not extend beyond the bases of the antennæ; the cheeks are bare, but there is a well-developed beard. The forehead projects moderately. The abdominal segments have both discal and marginal setæ.

Macquartia vexata, sp. nov.

Antennæ dark-brown. Proboscis and palpi brown. Thorax dark-grey, with several indistinct longitudinal black bands; scutellum black. Abdomen dark-brown or black, the three last segments with irregular patches of silvery tomentum. Legs dark-brown. Squamæ brownish. Wings pellucid; the first posterior cell with two brown spots, and the discal cell sometimes with a single spot. Costal cell brownish, paler in the middle; subcostal cell with a brown spot near the end of the auxiliary vein; marginal and submarginal cells brownish; the cross-veins, the fifth longitudinal, and the bend of the fourth longitudinal margined with brown. The fourth longitudinal curves round to an acute angle with its former direction, and then curves rapidly outwards; the first posterior cell is closed, or nearly so.

Male.—Front dark-brown; cheeks brown, with silvery reflections. Eyes hairy, somewhat approximated. Length, 9 mm.; wing, 7 mm.

Female.—Front dark-brown; face grey, with a black oblique band on each side from the eye to the base of the antennæ. Eyes nearly bare, widely separated. Length, 6 mm.; wing, 5 mm.

Hab. Wellington (Hudson).

The third joint of the antennæ is hardly one and a half times the length of the second. The arista is very minutely pubescent. The lower halves of the cheeks are bare, the upper half is hairy. The forehead projects moderately, and the eyes are large. The vibrissæ are distinctly above the front edge of the mouth. The abdomen has discal and marginal setæ. There is no costal bristle, but the male has a few bristles at the junction of the third and second longitudinal veins, and in the female there are a few weak bristles at the base of the third longitudinal. The chief cross-vein is opposite the end of the first longitudinal. The first posterior cell ends near the tip of the wing.

Genus Tryphera, Meigen (1838).

Face vertical; eyes generally hairy; antennæ not reaching the epistome; the third joint twice the length of the second; arista bare. Abdomen oval. First posterior cell closed, with a short petiole, reaching nearly the posterior border; a bristle on the costa.

Tryphera sosilus.

Tachina sosilus, Walker, Cat. Dipt. in Brit. Mus., p. 796 (1849). *Melanophora (?) sosilus*, Hutton, Cat. Dipt. N.Z., p. 52.

Body and legs black. Wings white, the veins yellowish. First posterior cell closed, petiolate. Length, 3–4 mm.

I have two specimens, collected many years ago in Otago, which correspond very well to Walker's description, except that the first posterior cell, although closed, is not petiolate. It may be a different species, but it is, I think, sufficiently close to show that *T. sosilus* belongs to this genus, although it is an aberrant form. The costa has a well-marked bristle; the fourth longitudinal vein is bent in a curve, and there is no appendix; the third longitudinal is quite bare. The first posterior cell ends close to the tip of the wing. The eyes are naked. The second joint of the antennæ is not much elongated; and the third joint is also short, reaching about half-way to the epistome. The second joint of the arista is short. The abdomen has macrochætæ, and the cheeks are bare.

Length, 4 mm.; wing, 3 mm.

Genus Calcager, gen. nov.

Head rounded between the eyes, which are rather large and bare. A pair of ocellar bristles directed outwards. Palpi well developed. Epistome not very prominent; front wide, usually with two rows of fronto-orbital bristles; facial ridges bare or with slight hairs; vibrissæ above the edge of the mouth. Antennæ reaching rather below the middle of the face; the second joint conical, more or less elongated; the third joint less than twice the length of the second. Second joint of the arista more or less elongated, sometimes as much as one-half the length of the third joint, which is nearly bare. Face considerably shorter at the vibrissæ than at the base of the antennæ. Abdomen oval, with both marginal and discal setæ (macrochætæ). Wings with a strong and easily seen bristle on the costa near the end of the auxiliary vein; third longitudinal generally setigerous at the base; first posterior cell open or closed, and ending before the tip of the wing. Chief cross-vein opposite to or outside of the end of the first longitudinal; length of the fifth longitudinal from the posterior cross-vein to the margin of the wing about one-half of its length from the posterior to the basal cross-vein.

The association of a costal seta with the elongated second joint of the arista, the third joint of which is bare or nearly so, is sufficient to separate this genus from *Echinomyia* and its allies.

Key to the Species.

Wings spotted	*C. apertum.*
Wings unspotted.	
Legs brownish-black	*C. turbidum.*
Legs testaceous.	
Shoulders brown or grey	*C. temerarium.*
Shoulders testaceous	*C. humeratum.*

Section A.

First posterior cell open, ending much before the tip of the wing. Facial ridges with a row of fine hairs. Wing with a cubital appendix, and strong bristles on the third longitudinal vein.

Calcager apertum, sp. nov.

Head silvery, the face with a yellowish tinge; a dark-brown frontal band from the ocelli to the bases of the antennæ. Eyes reddish-brown, slightly hairy. Antennæ dark reddish-brown, the first and second joints with some silvery tomentum. Proboscis and palpi dark-brown. Thorax dark-brown, sprinkled with silvery tomentum; four short black lines from the anterior edge. Scutellum dark-brown. Abdomen dark greyish-brown with silvery reflections; the anterior portion of each segment silvery. Legs dark-brown. Squamæ white. Wings pellucid, brownish at the base, the two cross-veins and the bend of the fourth longitudinal bordered with brown; veins brown. Fourth longitudinal bent sharply forwards at a right angle, and then outwards almost at a right angle; an appendix at the first bend; the first posterior cell distinctly open; posterior cross-vein at right angles. Length, ♀ 9 mm.; wing, ♀ 6 mm.

Hab. Christchurch (F. W. H.). Male unknown.

The third joint of the antennæ is rather longer than the second, straight on the sides, and rounded at the end. Second joint of the arista one-third or one-fourth the length of the third. Facial ridges with a row of weak hairs. Head, thorax, abdomen, and legs with strong black bristles. The second abdominal segment has two pairs of discal setæ; on the third and fourth segments they are irregular. The setæ on the third longitudinal vein are strong, and extend up to or beyond the chief cross-vein.

Calcager turbidum, sp. nov.

Head yellowish-white; eyes reddish-brown, bare. Antennæ reddish-brown, the first and second joints with silvery tomentum. Proboscis and palpi dark-brown. Thorax, scutellum, and abdomen brownish-black, with some white tomentum on the anterior part of each abdominal segment. Legs brownish-black. Squamæ white. Wings pellucid, without spot; the veins dark-brown. The fourth longitudinal is bent sharply at an angle, which is slightly obtuse, from whence it is nearly straight; an appendix at the bend; first posterior cell distinctly open; posterior cross-vein oblique, parallel to the bend of the fourth longitudinal. Length, ♂ 6–7 mm., ♀ 7–8 mm.; wing, ♂ 5 mm., ♀ 5½ mm.

Hab. Christchurch (F. W. H.).

The third joint of the antennæ is about as long as the second, slightly concave in front and convex behind. Second joint of the arista between one-half and one-third of the third. Facial ridges with a row of weak hairs. In the male all the abdominal segments after the first have a row of marginal setæ, but in the female there are only two on the middle of the posterior margin of the second segment. The setæ on the third longitudinal vein are strong, and extend beyond the chief cross-vein.

Section B.

First posterior cell closed, ending rather before the tip of the wing. Facial ridges bare. Setæ on third longitudinal vein weak. No cubital appendix.

Calcager temerarium, sp. nov.

Head greyish-white, with a central band of dark-brown on the front, which is sometimes covered with white tomentum. Face and epistome tawny, with scattered white tomentum. Antennæ reddish-brown, the first and second joints with pale tomentum. Proboscis brown, palpi pale-tawny. Thorax greyish-brown, with four interrupted dark-brown stripes, the inner pair narrower than the outer. Scutellum greyish-brown. Abdomen greyish-brown, without spots. Legs testaceous, the tarsi black. Squamæ brownish-white. Wings spotless, the larger veins tawny. The fourth longitudinal is bent in a curve nearly to a right angle and meets the third at the tip. The posterior cross-vein is at right angles to the longitudinal, and is distinctly sinuated. Length, 7 mm.; wing, 5 mm.

Hab. Christchurch (F. W. H.).

The third joint of the antennæ is nearly one and a half times the length of the second; its anterior margin is concave and its posterior margin convex. The second joint of the arista is about one-third of the third joint. The facial ridges are bare. The eyes have a few hairs. The setæ on the third longitudinal are few, and placed at its junction with the second longitudinal. The costal seta is well marked. The second and third abdominal segments have one pair of discal setæ.

Calcager humeratum, sp. nov.

Head tawny, passing into brown on the front. First and second joints of the antennæ reddish-brown, the third almost black; palpi tawny. Eyes rather small, dark-brown, bare. Thorax blackish-brown, the shoulders and a band on each side, above the wing, tawny; apex of the scutellum tawny. Abdomen black, tessellated with grey tomentum. Legs tawny, the tarsi black. Squamæ and wings pale-brown, the veins dark-brown. Bend of the fourth longitudinal obtuse; posterior cross-vein at right angles to the longitudinals, but much sinuated. Bristles on the body and legs weak; very few on the abdomen. Length, 8 mm.; wing, 7 mm.

Hab. Wellington (Hudson).

The front is prominent and longitudinally grooved; the eyes are rather small, and the face projecting. The second joint of the antennæ is not much elongated, while the third is nearly twice as long. The second joint of the arista also is rather short, being about one-seventh of the length of the third joint. It connects *Calcager* with *Proscissio*.

Genus Nemoræa, R. Desvoidy (1830).

Large. Eyes hairy, more or less approximated in the male, always much shorter than the sides of the head; forehead prominent; antennæ drooping, with the second joint elongated, often nearly as long as the third. Facial ridges bare; cheeks sometimes clothed with soft hairs; chin large, extending far below the eyes, and setose. Abdomen oval, middle segments with or without discal setæ. Fore tarsi more or less dilated in the females. First posterior cell ending some distance before the tip of the wing.

Nemoræa mestor.

Tachina mestor, Walker, Cat. Dipt. in Brit. Mus., p. 741 (1849). *Miltogramma mestor*, Hutton, Cat. Dipt. N.Z., p. 51; Hudson, Man. N.Z. Ent., p. 59, pl. vii., fig. 5.

Front black, ferruginous near the antennæ; face ferruginous. The antennæ ferruginous, the third joint with darker reflections. Thorax nearly black, the sides ferruginous; scutellum testaceous. Abdomen oval, testaceous, the first and second segments black; the third and fourth with a black dorsal band, which widens posteriorly on each segment; fifth segment with a triangular black mark which does not reach the posterior margin of the segment. No discal setæ on the middle segments. Legs testaceous. Wings tinged greyish, the veins tawny. Length, 12 mm.; wing, 11 mm.

Hab. Auckland (Dr. Sinclair); Wellington (Hudson).

This species is a true *Nemoræa*, and is closely related to *N. rubrica*, of Europe. Walker's statement that the abdomen is narrow and nearly cylindrical must be a mistake, as the rest of his description corresponds very well with two specimens from Wellington, provided we interpret "interrupted black stripe" to mean that it does not reach the apex of the abdomen.

Genus HYSTRICIA, Macquart (1843).

Front moderately broad; the epistome salient. Antennæ not reaching the epistome; the second joint rather elongated, the third usually double the second; straight before and behind; arista minutely pubescent, the second joint elongated. Eyes large, hairy. Abdomen broader than the thorax, provided with strong bristles. First posterior cell slightly open, ending much before the tip of the wing.

Hystricia lupina.

Musca lupina, Swederus, Nya Handl., viii., p. 289 (1787). *Tachina zelica*, Walker, Cat. Dipt. in Brit. Mus., p. 711 (1849). *Hystricia zelica*, Hutton, Cat. Dipt. N.Z., p. 46.

Abdomen bright-tawny, the hind border of each segment black. Length, 18 mm.; wing, 16 mm.

Hab. Auckland (Dr. Sinclair and Captain Broun); Great Barrier Island (H. Suter).

In my specimens the third joint of the antennæ is concave in front, and there are no discal setæ on the middle segments of the abdomen.

Hystricia pachyprocta.

H. pachyprocta, Nowicki, Mem. Krakauer Akad. Wissen., 1875, p. 25; Hutton, Cat. Dipt. N.Z., p. 47. *Tabanus impar*, Hudson, Man. N.Z. Ent., p. 54, pl. vi., fig. 6.

Abdomen bright-tawny, with a black longitudinal band which widens posteriorly, so that the last segment is altogether black. Length, 11–16 mm.; wing, 10–13 mm.

Hab. Wellington (Hudson); Canterbury and Otago (F. W. H.).

The middle abdominal segments have both discal and marginal setæ.

Genus Occisor, gen. nov.

Head rather produced in front, rather shorter at the vibrissæ than at the base of the antennæ. Eyes hairy, widely separated in both sexes, but rather nearer in the male. Fronto-orbital bristles hardly extending below the bases of the antennæ; cheeks with hairs, but no macrochætæ; facial ridges bare; vibrissæ distinctly above the anterior edge of the mouth. Second joint of the antennæ conical, various in length; third joint from two to four times the length of the second; second joint of the arista about twice as long as broad; third joint bare, not much swollen at the base. Abdomen oblong, with marginal but no discal setæ on the middle segments. The first posterior cell is open, and ends considerably before the tip of the wing; the posterior cross-vein is nearer to the margin of the wing than to the chief cross-vein; the length of the last section of the fifth longitudinal vein is less than one-fourth of the length of the preceding section.

This genus differs from *Brachycoma* in the third joint of the antennæ being longer, and in the abdomen being without spots.

Occisor inscitus, sp. nov.

Front smooth, black, the sides and face yellowish-white. Second joint of the antennæ elongated, rather less than one-half of the length of the second joint; the first and third joints piceous. Proboscis black, the palpi tawny. Thorax and scutellum black, a red spot at the base of the wings. Abdomen dark-blue. Legs black, the knees testaceous. Wings pellucid; the last section of the fifth longitudinal vein between one-fourth and one-fifth the length of the preceding section Length, 10–11 mm.; wing, 7–9 mm.

Hab. Christchurch (F. W. H.).

The eyes are thinly covered with hairs. The second abdominal segment has a pair of marginal setæ in the middle and one on each side; the third segment has a complete row on the posterior margin.

Occisor versutus, sp. nov.

Front smooth, piceous; the face brown. Third joint of the antennæ about four times the length of the second, tawny at the base, the rest piceous. Palpi and epistome tawny, the proboscis piceous. Thorax and scutellum black, a red spot at the base of the wings. Abdomen bluish-black. Legs black, the knees testaceous. Wings pellucid; the last section of the fifth longitudinal vein less than one-sixth of the length of the preceding section. Length, 10 mm.; wing, 8 mm.

Hab. Christchurch (F. W. H.).

The eyes are distinctly hairy, more so than in the last species. The second abdominal segment has a pair of marginal setæ in the middle and a pair on each side; the third segment has a complete row of marginal setæ.

Genus TACHINA, Meigen (1803).

"Eyes bare or finely pubescent, rather widely separated in both sexes, but nearer together in the males than in the females. Forehead usually not very prominent; facial angle almost straight. Antennæ nearly drooping, with the second joint elongated, half, or rather more than half, as long as the third joint; arista bare, and usually thickened for half its length. Facial ridges bare, or only ciliated along their lower halves with short fine bristles; cheeks bare; fronto-orbital setæ usually extending half-way down the face. Abdomen mostly conico-elliptical in the male, ovoid in the female, and either with or without discal setæ on the middle segments. Wings with the fourth longitudinal vein usually bent at a sharp angle, and often furnished with a spurious, or nearly spurious, cubital appendix" (Meade).

Tachina clarkii, sp. nov.

Male.—Front dark reddish-brown, with a little silvery tomentum on each side bordering the eyes; cheeks yellow; lower face brown. First and second joints of the antennæ dark-brown, the third orange. Thorax with grey tomentum and four indistinct black bands; scutellum greyish-black. Abdomen dark-blue, metallic. Femora and tarsi black; the tibiæ dark-brown, the knees tawny. Squamæ white. Wings with a red spot at the base; veins dark-brown, margined with brown. Length, 12 mm.; wing, 10 mm.

Hab. Christchurch (H. Clark).

The eyes are approaching and bare. The forehead is prominent; the cheeks bristly in the upper half; the fronto-orbital setæ do not extend much below the base of the antennæ The second joint of the antennæ is not much elongated; the third is about one and a half times the length of the second, and reaches rather more than halfway to the epistome. The abdomen is ovate, and has no macrochætæ on the middle segments. The first posterior cell is open, and ends before the tip of the wing; the fourth longitudinal vein curves sharply round to an acute angle with its former direction, and then curves outwards more gently; the last section of the fifth longitudinal is between one-fourth and one-fifth the length of the previous section.

I place this species with great doubt in *Tachina.*

Genus Proscissio, gen. nov.

Head much produced and wedge-shaped in front, the frontal band deeply grooved; but the head is not much longer at the base of the antennæ than at the vibrissæ. Eyes small, about half the length of the head, bare or nearly so. Antennæ rather short, but reaching more than halfway to the epistome; the third nearly three times the length of the second. Second joint of the arista longer than broad; the third joint minutely pubescent. Frontal bristles in a single row in both sexes, not descending below the bases of the antennæ. Cheeks and facial ridges bare; vibrissæ only slightly above the anterior edge of the mouth. Proboscis and palpi long. Abdomen oblong, the middle segments with a pair of discal setæ. Wings without any conspicuous seta on the costa, but sometimes one of the short bristles near the end of the auxiliary vein is rather longer than the others; fourth longitudinal vein usually bent sharply at a right angle and then curved gently outwards; the first posterior cell is open, and ends a little before the tip of the wing; the posterior cross-vein is nearer to the margin than to the chief cross-vein; and the last section of the fifth longitudinal is about one-fifth of the length of the preceding section.

The small eyes and prominent forehead are sufficient to distinguish this genus from *Tachina.*

Key to the Species.

Second joint of the antennæ pale-brown.. .. .. *P. modica.*
Second joint of the antennæ dark-brown.
  Knees black.
    Thorax with white tomentum .. .. .. *P. cana.*
    Thorax with yellow tomentum .. .. .. *P. valida.*
  Knees tawny .. .. *P. montana.*

Proscissio cana, sp. nov.

Head brown, with grey tomentum on the face. Antennæ dark reddish-bown, the third joint with grey tomentum.

Proboscis and palpi dark-brown. Thorax with silvery tomentum and four black longitudinal bands; the scutellum grey. Abdomen grey, tessellated with black and white. Legs black, the femora with greyish tomentum. Squamæ white. Wings pellucid, slightly tinged with brown at the base; veins dark-brown; fourth longitudinal vein sharply bent at a right angle and then curved gently outwards; a cubital appendix present or absent. Length, 11 mm.; wing, 8 mm.

Hab. Wellington (Hudson); Christchurch (F. W. H.).

Proscissio modica, sp. nov.

Face brown, covered with pale-yellow tomentum, the frontal band dark-brown. Second joint of the antennæ pale-brown, the first and third dark-brown. Proboscis dark-brown; the palpi tawny. Thorax greyish-black, with four indistinct black longitudinal bands, the sides with grey tomentum; scutellum brown, black at the base. Abdomen blackish-brown, tessellated with silvery tomentum. Legs blackish-brown, the femora with greyish tomentum. Squamæ brownish-white. Wings pellucid, brownish at the base; the veins brown. Fourth longitudinal vein curved round to an acute angle with its former direction, and then curved outwards. A short cubital appendix present or absent. Length, 11 mm.; wing, 8 mm.

Hab. Wellington (G. V. Hudson).

Proscissio valida, sp. nov.

Head brown, with pale-yellow tomentum on the face. Antennæ, proboscis, and palpi dark-brown. Thorax with pale-yellow tomentum and four dark longitudinal bands; the scutellum yellowish-grey. Abdomen blackish-brown, tessellated on the sides with black and white tomentum. Legs blackish-brown. Squamæ white. Wings pellucid, brownish at the base; the veins brown; fourth longitudinal curved sharply round to a right angle with its former direction, and then curved more gently outwards. No cubital appendix. Length, 15 mm.; wing, 11 mm.

Hab. Taranaki (Clark).

Proscissio montana, sp. nov.

Head brown, with pale-yellow tomentum on the face. Antennæ, proboscis, and palpi dark-brown. Thorax with pale-yellow tomentum and four dark longitudinal bands; scutellum yellowish-grey, with irregular dark markings. Abdomen black, with white tomentum on the anterior portion of each segment. Legs blackish-brown, the knees tawny. Squamæ brownish-white. Wings pellucid, brownish near the base; the veins brown. Fourth longitudinal bent sharply at a right angle and then curved gently outwards. Length, 13 mm.; wing, 12 mm.

Hab. Mount Peel, Nelson, 5,000 ft. (G. V. Hudson).

Genus Peremptor, gen. nov.

Head much produced and grooved in front, and longer at the base of the antennæ than at the vibrissæ. Eyes bare, widely separated, small, about half the length of the head. Fronto-orbital bristles stopping at the bases of the antennæ. Cheeks and facial ridges bare; vibrissæ considerably above the level of the mouth. Antennæ very short, the third joint not much longer than the second; second joint of the arista quite short, the third minutely pubescent. Proboscis and palpi long. Abdomen oval, the middle segments without discal setæ. First posterior cell open, and ends rather before the tip of the wing; the posterior cross-vein is nearer to the margin than to the chief cross-vein; the length of the last section of the fifth posterior vein is less than a sixth of the length of the preceding section.

This genus differs from *Miltogramma* in the head not being swollen, the facial ridges not being thickened, the antennæ being exposed, the vibrissæ being well developed, as well as by the shape of the abdomen, and the small eyes.

Peremptor pavida, sp. nov.

Head brown, with yellowish-white tomentum on the face. First and second joints of the antennæ tawny; the third dark-brown, with a little silvery tomentum. Proboscis brown, palpi pale-tawny. Thorax grey, with four indistinct dark bands; scutellum brown. Abdomen black, with white tomentum on the anterior portions of the segments. Legs tawny, the tarsi black. Squamæ white. Wings slightly tinged with brown, the veins pale-brown. Fourth longitudinal curved round to right angles with its former direction, and then gently curved outwards; no cubital appendix. Length, 11 mm.; wing, 9½ mm.

Hab. Ashburton (W. W. Smith).

Peremptor egmonti, sp. nov.

Head brown, with pale-yellow tomentum on the face. Antennæ dark reddish-brown, the third joint with silvery tomentum. Thorax with grey tomentum above, yellowish on the sides; no longitudinal bands; scutellum grey. Abdomen brown, with pale-yellow and grey tessellations. Legs black. Squamæ white. Wings pellucid, the cross-veins margined with brown; veins dark-brown. The fourth longitudinal bent sharply at an acute angle and then very gently curved outwards; a cubital appendix. Length, 12½ mm.; wing, 10½ mm.

Hab. Mount Egmont, Taranaki (Captain Broun).

Genus CEROSOMYIA, gen. nov.

Vertex produced forwards and upwards into a blunt hollow process, which forms a hood over the bases of the antennæ, completely hiding their first and second joints, and sending downwards, on each side, a ridge which runs outside the facial ridges. These genal ridges are bare, but the facial ridges inside them are armed with setæ throughout their whole length. Antennæ long, reaching the epistome, lodged in a deep facial groove; the second joint short, the third more than four times its length; arista minutely pubescent, the second joint short. Eyes bare, or nearly so. Front broad, slightly grooved in the middle, with several rows of bristles on each side, of which the inner row is longer than the others. Cheeks bare. Vibrissæ just above the upper edge of the mouth. Face shorter at the mouth than at the bases of the antennæ. Wings without any conspicuous costal bristle. First posterior cell open, and ending before the tip of the wing; last section of the fifth longitudinal vein about one-fourth the length of the previous section; the chief cross-vein lies inside the end of the first longitudinal. Abdomen with discal and marginal setæ.

A remarkable genus, easily recognised by the frontal process.

Cerosomyia usitata, sp. nov.

Front dark-brown, with some grey tomentum; frontal projection blackish-brown; cheeks reddish-brown, the lower face with silvery tomentum. Proboscis and palpi brown. Thorax dark-brown, the scutellum tawny. Abdomen dark-brown, tessellated on the sides with black and white. Legs black. Squamæ white. Wings pellucid, the veins brown. Fourth longitudinal bent at an obtuse angle, the bent portion nearly straight; posterior cross-vein slightly sinuated. Length, 10 mm.; wing, 6½ mm.

Hab. Christchurch (F. W. H.).

A single specimen.

Genus PHOROCERA, R. Desvoidy (1830).

Ocellar bristles pointing forwards; cheeks bare; facial ridges armed with bristles throughout the greater part of their length; vibrissæ on a level with the front edge of the mouth. Eyes hairy. First posterior cell ending at some distance in front of the tip of the wing; the last section of the fifth longitudinal vein less than one-third of the preceding vein. In the New Zealand species here included the third joint of the antennæ is nearly four times the length of the second. The first posterior cell is generally open, but sometimes closed; never petiolate. Most have discal as well as marginal setæ on the abdomen. The individuals of a species vary much in size.

Key to the Species.

Scutellum blue margined with testaceous.	
Abdomen blue	*P. marginata.*
Abdomen greenish-black	*P. atrox.*
Scutellum blue	*P. nefaria.*
Scutellum testaceous or fulvous.	
First abdominal segment brown, the others blue..	*P. feredayi.*
Abdomen blue or bluish-black.	
Thorax blue or black.	
Second, third, and fourth abdominal segments with red spots	*P. clathrata.*
Third and fourth abdominal segments without spots	*P. nyctemeriana.*
Thorax greenish-black	*P. perniciosa.*
Abdomen greenish-black	*P. atrox.*
Abdomen brown, not tessellated	*P. orasus.*
Abdomen brown, tessellated on the sides ..	*P. efferata.*
Scutellum black	*P. funerata.*

Phorocera feredayi.

Eurigaster feredayi, Hutton, Cat. Dipt. N.Z., p. 50 (1881).

Vertex dark-brown, lower face grey, epistome yellow; antennæ, proboscis, and palpi brown. Thorax dark-brown; scutellum and posterior corners of mesonotum light-brown. First segment of the abdomen brown, the three last metallic-blue. Legs brown. Length, 7 mm.

Hab. Dunedin (F. W. H.).

I have no specimens of this species, so that I cannot add to the description.

Phorocera clathrata.

Eurigaster clathratus, Nowicki, Mem. Krakauer Akad. Wissen., band 2, ged. Auf., p. 27 (1875); Hutton, Cat. Dipt. N.Z., p. 51.

Black, the second, third, and fourth segments of the abdomen with a large red spot on each side, the anterior portions of the segments tessellated with white. Palpi tawny. Length, 10 mm.; wing, 9 mm.

I do not know this species.

Phorocera nyctemeriana.

Nemoræa nyctemerianus, Hudson, Trans. N.Z. Inst., vol. xv., p. 218 (1883); and Man. N.Z. Ent., p. 59, pl. vii., fig. 6.

Vertex grey, the frontal band black; lower face silvery; antennæ and proboscis black. Thorax black; scutellum testaceous. Abdomen bluish-black, a testaceous spot generally present on each side of the second segment. Femora and tarsi black, the tibiæ brown. Length, 10 mm.; wing, 9 mm.

Hab. Wellington (Hudson); Christchurch and Queenstown (F. W. H.).

The first posterior cell is distinctly open, and the abdominal segments have discal as well as marginal setæ.

The type has no testaceous spots on the abdomen, but there are so many intermediate varieties between large spots and none that I include them in a single species.

Phorocera marginata.

Eurigaster marginatus, Hutton, Cat. Dipt. N.Z., p. 51 (1881); Hudson, Man. N.Z. Ent., p. 60, pl. vii., fig. 7.

Vertex dark-grey, the frontal band dark-brown; face and cheeks with silvery reflections; antennæ, proboscis, and palpi piceous; epistome testaceous. Thorax dark-blue; scutellum margined with testaceous; a tawny spot at the base of the wings. Abdomen blue. Legs black. Length, 6–10 mm.; wing, 6–7 mm.

Hab. Wellington (Hudson); Christchurch and Dunedin (F. W. H.).

The first posterior cell is narrowly open. The abdomen has discal as well as marginal setæ. The statement in my original description that the intermediate and hind tibiæ are rufous in the middle is a mistake. Sometimes the thorax has greenish-blue reflections.

Phorocera nefaria, sp. nov.

Vertex bluish-grey, the frontal band black; antennæ, proboscis, and palpi piceous. Thorax, scutellum, and abdomen blue. A red spot at the base of the wings. Legs black. Length, 8–10 mm.; wing, 7–9 mm.

Hab. Christchurch (F. W. H.).

The first posterior cell is open. In the large specimens—which I take to be the females—there is only one pair of discal setæ on the fourth segment, but in the small specimens the discal setæ are more numerous.

Phorocera efferata, sp. nov.

Vertex grey; frontal band reddish-brown; cheeks yellowish-brown; face white; epistome tawny. Antennæ, proboscis, and palpi piceous. Thorax black; scutellum testaceous or fulvous. Abdomen brown, tessellated on each side with black and white. Legs black, the tibiæ dark-brown. Length, 7–10 mm.; wing, 5–7 mm.

Hab. Christchurch and Wellington (F. W. H.).

The first posterior cell is closed. The larger specimens—which I suppose to be the females—have no discal setæ on the middle segments, while the smaller specimens have well-developed setæ.

Phorocera orasus.

Tachina orasus, Walker, Cat. Dipt. in Brit. Mus., p. 741 (1849). *Nemoræa orasus*, Hutton, Cat. Dipt. N.Z., p. 49.

Vertex dark-grey, the frontal band reddish-brown, grooved. Face yellowish-white, with a dark reddish-brown spot on each side. Second joint of the antennæ and palpi tawny; the rest, as well as the proboscis, piceous. Thorax black; scutellum dark-fulvous. Abdomen dark-brown, not tessellated. Legs black, the tibiæ brown. Wings brown near the base. Length, 8 mm.; wing, 6 mm.

Hab. Auckland (Dr. Sinclair); Christchurch (F. W. H.); Ashburton (W. W. Smith).

The first posterior cell is open. There are no discal setæ on the middle segments of the abdomen.

The South Island specimens may be distinct from those from Auckland, but, as I have none from the latter place for comparison, I keep them together for the present.

Phorocera atrox, sp. nov.

Head and cheeks brown; the face white. Antennæ, proboscis, and palpi piceous. Thorax and abdomen greenish-black; the scutellum fulvous, or margined with fulvous. Legs black. Length, 10 mm.; wing, 8 mm.

Hab. Napier (F. W. H.).

The green colour of this species distinguishes it from any of the others. The first posterior cell is open.

Phorocera funesta, sp. nov.

Vertex black, face grey. Antennæ, proboscis, and palpi piceous. Thorax, scutellum, abdomen, and legs black. Length, 6–7 mm.; wing, 5 mm.

Hab. Christchurch (F. W. H.).

The first posterior cell is open. Some specimens have no discal setæ on the middle abdominal segments, while in others they are well developed. Perhaps this is a sexual difference.

Phorocera perniciosa, sp. nov.

Vertex grey, the frontal band dark-brown; lower face white. Antennæ, proboscis, and palpi piceous. Thorax black, with green reflections; scutellum fulvous. Abdomen black, with greenish-blue reflections. Legs black, the tibiæ dark-brown. Length, 11 mm.; wing, 9 mm.

Hab. Christchurch (Clark).

In this species the fronto-orbital bristles descend lower than in the others, reaching to about the middle of the face. The first posterior cell is open.

Genus GYMNOPHANIA, Brauer and Bergenstamm (1889).

Lower part of the cheeks with strong bristles. Proboscis not much longer than the height of the head, the palpi well developed. Abdomen shining, without any tomentum, and without macrochætæ. First posterior cell of the wing ending near the tip.

Gymnophania pernix, sp. nov.

Entirely black, the eyes dull-red. Squamæ dark in the centre. Scutellum with a marginal row of long hairs. Length, 7 mm.; wing, 6 mm.

Hab. Christchurch (Clark); Lincoln (Hilgendorf).

The first posterior cell is closed, but not petiolate; the posterior cross-vein is nearer to the margin than to the chief cross-vein; the third longitudinal is bare; the fourth longitudinal curves forwards at an obtuse angle; the last section of the fifth longitudinal is about one-sixth of the length of the preceding section. The front is shining-black; the eyes are bare, and the facial ridges unarmed; the vibrissæ are about on a level with the anterior edge of the mouth.

Genus PHANIA, Meigen (1824).

Third joint of the antennæ compressed, longer than the second. Abdomen rather elongated; the male organ long, bent under the body. First posterior cell open.

Phania verecunda, sp. nov.

Hudson, Man. N.Z. Ent., pl. vii., fig. 11. (Not named.)

Vertex velvety-black, face silvery. Antennæ, proboscis, and palpi piceous. Thorax and scutellum black. First three segments of the abdomen orange, the others black. Legs black. Squamæ and wings pale-orange, the latter darker towards the base; veins orange. Length, 7 mm.; wing, 6 mm.

Hab. Wellington (Hudson); Christchurch (Clark).

The eyes are bare and approximated, but not touching, in the male. The third joint of the antennæ is about twice the length of the second. The arista is bare. There is a pair of long setæ on the vertex, but no fronto-orbital bristles. The thorax has a few scattered bristles, and there is a marginal row on the scutellum; the abdomen has very few, and no hairs. The fourth longitudinal vein curves at an obtuse angle, and the first posterior cell is rather widely open; the posterior cross-vein is straight.

Family SARCOPHAGIDÆ.

"Arista plumose or hairy, with the apex bare. First posterior cell only slightly opened, or closed. Squamæ large; legs stout" (Loew).

The eyes are distant in both sexes.

Genus Sarcophaga, Meigen (1826).

Third joint of the antennæ usually three times the length of the second; arista plumose or tomentose. Abdomen of the male subfusiform, tumid at the apex; subovate in the female. First posterior cell open.

Sarcophaga impatiens.

Sarcophaga impatiens, Walker, Cat. Dipt. in Brit. Mus., p. 828 (1849).

Frontal band and antennæ black, face golden; proboscis and palpi black. Thorax black, with a pair of longitudinal bands which are white in some lights and yellow in others; sides with a broader pale band of the same character. Scutellum black, the sides pale. Abdomen blackish-brown, tessellated with greyish reflection on the sides, arranged in two rows of spots on each side. Legs black. Wings pellucid, tawny at the base; veins piceous; fourth longitudinal sharply bent at a right angle and arched; posterior cross-vein nearly straight. Length, 8–9 mm.

Hab. Whangarei (F. W. H.), very abundant; Banks Peninsula (Hilgendorf), a single specimen; Christchurch, Feb., 1901 (F. W. H.). Probably introduced from Australia, where it is also found, as it was not sent to England by the early collectors.

The first posterior cell is open; the posterior cross-vein is nearly in a line with the upper part of the bend of the fourth longitudinal; and the first longitudinal vein is not bristly. Abdomen without discal setæ, and with marginals on the last segment only. There is a pair of large orbital setæ in each sex.

Family MUSCIDÆ.

"Arista entirely plumose or pectinated. Body never slender; thorax short. First posterior cell only slightly opened, or else closed at the border of the wing. Squamæ large. Legs stout" (Loew).

The abdomen has no macrochætæ.

KEY TO THE GENERA.

Proboscis short and stout, arista plumose.
  First posterior cell narrowly open, or closed.
    Fourth longitudinal sharply bent, nearly at a right angle.
      Thorax metallic .. .. *Lucilia.*
      Thorax not metallic .. .. .. *Calliphora.*
    Fourth longitudinal gradually curved.
      Middle tibiæ with one or two bristles on the inner side .. .. *Sepimentum.*
      Middle tibiæ without bristles on the inner side .. .. *Musca.*
  First posterior cell widely open .. .. .. *Muscina.*
Proboscis long and slender; arista pectinated .. .. *Stomoxys.*

Genus LUCILIA, R. Desvoidy (1830).

"Head depressed. Epistome not salient. Antennæ reaching the epistome; the third joint four times as long as the second; arista plumose. Abdomen generally short, rounded. Wings open; first posterior cell reaching the border a little in front of the apex; fourth longitudinal vein more or less arched and concave after the bend" (Macquart).

Lucilia cæsar.

Musca cæsar, Linnæus, Syst. Nat., ii., 989 (1761).

Bright bluish-green or golden-green. Head with silvery-white tomentum; vertex black, face reddish, epistome testaceous; palpi tawny; antennæ black. Legs black; femora bluish. Length, 5–9 mm.

Hab. Throughout New Zealand. Introduced.

The facial ridges are armed with bristles for one-third of the length. This fly was not to be found in Auckland, Wellington, or Dunedin in 1874. In 1872 I observed it at Christchurch, but it had not arrived at Dunedin in December, 1879. It is now common from Whangarei to Queenstown.

Genus CALLIPHORA, R. Desvoidy (1830).

"Facial ridges bordered with hairs; epistome a little projecting; antennæ nearly reaching the epistome, the third joint four times as long as the second; arista plumose. Abdomen short. First posterior cell reaching the border of the wing a little before the extremity; fourth longitudinal vein generally strongly arched after the bend" (Macquart).

The eyes are contiguous or subcontiguous in the male. The fourth longitudinal vein bends at a right angle to its former direction.

Key to the Species.

Abdomen metallic-blue.	
Abdomen with silvery reflections on the sides ..	*C. erythrocephala.*
Abdomen without silvery reflections.	
Eyes hairy.	
Palpi fulvous	*C. quadrimaculata.*
Palpi black	*C. hortona.*
Eyes bare.	
Third joint of antennæ black ..	*C. icela.*
Third joint of antennæ orange ..	*C. antennatis.*
Abdomen fulvous, with golden reflections.. ..	*C. læmica.*

Calliphora erythrocephala.

Musca erythrocephala, Meigen, Zw., v., 62, 2 (1826). *M. vomitoria*, Hudson, Trans. N.Z. Inst., vol xxii., p. 187.

Eyes bare; vertex black, face and epistome reddish-brown; antennæ piceous, red at the tip of the second and base of the third joints. Chin with black hairs. Thorax with four black stripes. Abdomen blue, with shining white tomentum forming large spots on each side. Length, 9–11 mm.; wing, 7–9 mm.

Hab. Throughout New Zealand. Introduced.

This insect was first noticed in New Zealand by Mr. G. V. Hudson in June, 1889, at Wellington. In Christchurch I observed it first in the summer of 1893–94. It is now abundant from Dunedin to Whangarei.

Up to the present time the introduction of this species does not appear to have affected to any appreciable extent the two native species (*C. quadrimaculata* and *C. icela*), with which, no doubt, it competes. All three are equally common.

Calliphora quadrimaculata.

Musca quadrimaculata, Swederus, Nya Handling, viii., p. 289, No. 49 (1787). *Call. dasyophthalma*, Macquart, Dipt. Exot., part v., p. 287, pl. 16, fig. 2 (1843). *Musca violacea*, Walker, Insecta Saundersiana, Dipt., p. 335 (1856), not of Macquart. *C. quadrimaculata*, Hudson, Man. N.Z. Ent., p. 60, pl. vii., fig. 9.

Head piceous, a fulvous spot on each cheek between the base of the antennæ and the eye, below which is a narrow pale band. Antennæ piceous, the second joint fulvous at the tip, and the third joint whitish at the base. Eyes hairy. Palpi fulvous. Thorax with an oval orange spot on each side in front, and a smaller one at the base of the wing. Abdomen brilliant violet-blue; legs black. Wings with a golden spot at the base. Length, 12–13 mm.

Hab. Throughout New Zealand, and in the Auckland Islands.

The eyes in the male are contiguous.

Calliphora hortona.

Musca hortona, Walker, Cat. Dipt. in Brit. Mus., p. 894 (1849). *Pollenia aureonotata*, Macquart, Dipt. Exot., Supp. 5, p. 135 (1854).

Head and antennæ piceous, a reddish or fulvous patch at the base of the antennæ. Eyes hairy. Palpi and proboscis piceous. Thorax with a pyriform yellowish fulvous spot on each side in front. Abdomen brilliant violet-blue. Wings with a fulvous spot at the base. Length, 9–10 mm.

Hab. Wellington and Christchurch (F. W. H.); on the sea-beach.

In this species the antennæ are short, not reaching the epistome, the third joint being only about twice the length of the second. Also, the hairs on the arista are not so long as usual in the genus. I have a specimen in which they are developed only on the upper side, as in *Idia*. Also, the fourth longitudinal vein is very slightly arched after the bend.

Calliphora icela.

Musca icela, Walker, Cat. Dipt. in Brit. Mus., p. 897 (1849). *Call. aureopunctata*, Macquart, Dipt. Exot., Supp. 5, p. 130 (1854).

Vertex blackish-brown, cheeks yellowish-white in the male, passing into tawny on lower face and abdomen. In the female there is on each upper cheek, from the upper facial ridge to the eyes, a reddish-brown patch, margined above and below with yellowish-white, and the lower face is brown. Antennæ piceous, the second joint reddish. The eyes are bare, and only approximate in the male. The palpi orange or fulvous. The thorax has an oval fulvous or orange spot on each side in front. Abdomen brilliant blue, sometimes with faint-green reflections. Wings with a fulvous spot at the base. Length, 7–9 mm.

Hab. Throughout New Zealand.

Calliphora antennatis.

Calliphora antennatis, Hutton, Cat. Dipt. N.Z., p. 60 (1881).

Vertex blackish-brown, with some grey reflections in the female. In the male the eyes are subcontiguous, and the face is brown, with two silvery transverse bands from the eyes to the facial ridges. In the female the face is brown, with a large orange or fulvous spot between the eyes and the upper facial ridges. The eyes are bare. Third joint of the antennæ and the palpi orange or fulvous. Thorax with a round fulvous or orange spot just in front of the insertion of the wings. Abdomen brilliant violet-blue. Legs black, the knees tawny. Wings rather smoky, no spot at the base. Length, 10 mm.

Hab. Dunedin and Christchurch (F. W. H.). Rare.

The fourth longitudinal vein is strongly arched after the bend. The antennæ are rather short, the third joint being not more than twice the length of the second. The hairs on the arista are also short.

Calliphora læmica.

Musca læmica, White, in Dieffenbach's "New Zealand," vol. ii., p. 291 (1843); Voy. "Erebus" and "Terror," Insects, pl. 7, fig. 18: Walker, Cat. Dipt. in Brit. Mus., p. 906 (1849). *Sarcophaga læmica*, Hudson, Man. N.Z. Ent., p. 61, pl. vii., fig. 10.

Vertex dark-brown; cheeks yellowish-white, with brown marks; lower face tawny, with golden hairs. First and second joints of the antennæ ferruginous; the third piceous, four times as long as the second. Eyes bare, contiguous in the male. Thorax dark-grey, with black longitudinal bands above, fulvous below. Abdomen fulvous, with bronzy reflections, with yellow hairs on the sides and below. Legs tawny or ferruginous, the tarsi darker. Length, 7–12 mm.

Hab. Throughout New Zealand. Probably introduced from Australia, where it is also found, as well as in Polynesia.

This species has been abundant in the North Island for a long time, and it extended as far south as Christchurch in 1874, but it was not common. I never found it in Otago up to 1879, when I was living there, but this year (1900) I saw it at Queenstown. It thus appears to have come down from the North. Walker considered it to belong to *Pollenia*, to which genus it should, perhaps, be referred.

Genus Sepimentum, gen. nov.

Eyes bare, subcontiguous in the male, a pair of orbital bristles on each side in the female. Antennæ rather short, not reaching the epistome; third joint about three times the length of the second; arista plumose on both sides, the tip sometimes bare, especially in the female. Outer and lower cheeks hairy. Facial ridges with some hairs on the lower fourth. Epistome slightly projecting. Thorax with six rows of dorso-central bristles. Abdomen without either discal or marginal macrochætæ. Tibiæ with one or two bristles on the inner side. Fourth longitudinal vein curving round at an obtuse angle and then straight; first posterior cell generally closed, sometimes shortly petiolate, sometimes very narrowly open. Posterior cross-vein sinuated.

This genus differs from *Pollenia* in the thorax and abdomen not being thickly set with short hairs, and from *Calliphora* by the direction of the fourth longitudinal vein, as well as by the closed apical cell.

Sepimentum fumosum, sp. nov.

Antennæ ferruginous, the third joint with grey tomentum; palpi tawny. Thorax and abdomen greyish-brown, not metallic, the thorax with indistinct brown bands. Wings tinted brown; the veins dark-brown. Halteres ferruginous. Squamæ dark smoky-brown. Length, 7–8 mm.; wing, 6–7 mm.

Male.—Vertex black, face grey. Femora and tarsi black, the tibiæ dark-tawny.

Female.—Frontal band ferruginous; ocellar triangle and face grey. Legs tawny, the tarsi blackish.

Hab. Christchurch (H. Clark); Ashburton (W. W. Smith).

There are two bristles on the inner side of the middle tibiæ in both sexes. In the female two bristles are also present on the inner side of the fore and hind tibiæ; but these are sometimes absent in the male.

Sepimentum demissum, sp. nov.

Female.—Vertex and antennæ ferruginous, the frontal band rather darker; face tawny; proboscis and palpi dark-brown. Thorax and abdomen blackish, the latter with submetallic bronzy-green reflections. Legs tawny. Squamæ ferruginous. Wings tawny, distinctly deeper in colour near their bases; the veins tawny. Length, 6 mm.; wing, 5 mm.

Hab. Wellington (G. V. Hudson).

There is one strong bristle on the inner side of the middle tibiæ, none on the inner side of the fore and hind tibiæ. I have not seen the male.

Genus MUSCA, Linnæus (1761).

Epistome not prominent. Antennæ nearly reaching the end of the face; the third joint three or four times the length of the second; arista plumose on both sides. Abdomen not metallic. Middle tibiæ without any long bristles on the inner side. First posterior cell narrowly open; the fourth longitudinal vein curving at an obtuse angle, and afterwards a little concave to the margin.

Musca domestica.

M. domestica, Linnæus, Syst. Nat., ii., 990 (1761). *Musca vicaria*, Walker, Insecta Saundersiana, vol. i., p. 348 (1856).

Face yellowish or white or almost black. Thorax brown, with four black stripes. Abdomen in the female brown, tesselated with yellowish-white; in the male the sides of the abdomen are reddish. Wings colourless; the posterior cross-vein nearly straight, and situated at about its length from the bend of the fourth longitudinal vein, and at about half its length from the margin of the wing. Legs black. Length, 6–8 mm.

Hab. Throughout New Zealand. Introduced.

Very variable in the colouring of the abdomen. The face is generally yellow in the female, but often white in the male. The front and vertex are usually black, but there is a distinct variety in which they are reddish-brown.

The statement that the introduced house-fly has displaced the native blow-flies, which have practically disappeared,* is quite erroneous. I doubt whether they compete in any way.

Musca taitensis.

Musca taitensis, Macquart, Dipt. Exot., part v., p. 310, pl. 20, fig. 8 (1843); Hutton, Cat. Dipt. N.Z., p. 61.

"Face and front black, the sides with whitish down. Palpi and antennæ black. Thorax black, with white bands. Abdomen marked with black and yellow in the female. Wings slightly brownish, halteres yellowish. Legs black. Length, 5 mm." (Macquart).

Hab. Auckland (Dr. Sinclair); Tahiti (Paris Museum).

Dr. Sinclair's specimens were identified by Mr. Walker. I do not know the species. The brownish wings would seem to show that it is not correctly placed in *Musca*.

Genus Muscina, Desvoidy (1830).

Epistome not prominent; antennæ not reaching the abdomen; the third joint at least three times the length of the second; the arista plumose. Eyes bare. Fourth longitudinal vein convex after the bend; first posterior cell widely open.

Muscina stabulans.

Musca stabulans, Meigen, Diptera, v., 75, 42, pl. 43, fig. 35.

Frontal band black, face and sides of the front silvery; antennæ piceous, the base of the third joint ferruginous. Palpi ferruginous. Thorax grey, with four black bands; the tip of the scutellum ferruginous. Legs ferruginous, the bases of the femora and the tarsi blackish. Length, 7–8 mm.

Hab. Auckland (Reise der "Novara," 1859); Whangarei and Christchurch (F. W. H.).

More common in the North than in the South.

Genus Stomoxys, Geoffroy (1764).

Proboscis slender, elongated. Front broad in both sexes. Third joint of the antennæ three times the length of the

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* Trans. N.Z. Inst., vol. xxviii., p. 5.

second; arista pectinated. Fourth longitudinal vein slightly bent; the first posterior cell widely open.

Stomoxys calcitrans.

Musca calcitrans, Fabricius, Sp. Ins., ii., 467, 4.

Frontal band black; ocellar triangle and face silvery; antennæ black; palpi fulvous. Thorax brownish-grey, with four black bands. Abdomen brownish-grey, with two spots on each segment and an interrupted dorsal band dark-brown. Legs dark-brown. Length, 7 mm.

Hab. Christchurch (F. W. H.). Introduced.

The male is darker than the female, the wings are brown, and the palpi long. The spots on the abdomen are larger, and the dorsal band is less interrupted in the male than in the female. It is commonly known as the horse-fly.

Stomoxys ænos.

Stomoxys ænos, Walker, Cat. Dipt. in Brit. Mus., p. 1160 (1849); Hutton, Cat. Dipt. N.Z., p. 57.

Thorax black, with indistinct tawny stripes. Abdomen black, tinged with yellowish-brown, two tawny stripes on the under-side. Legs black. Length, 5 mm.

Hab. Auckland (Dr. Sinclair).

I do not know this species.

Family ANTHOMYIDÆ.

"Thorax with a complete transverse suture. Fourth longitudinal vein straight or nearly so, hence the first posterior cell is fully open. Squamæ well developed, although in many cases of no large size" (Loew).

Key to the New Zealand Genera.

Wings dark-brown, nearly as broad as long	*Exsul.*
Wings of the ordinary shape and colour.	
Eyes approximated or subcontiguous in the male.	
Eyes hairy; arista pubescent	*Trichophthicus.*
Eyes bare; arista minutely pubescent or bare.	
Sixth longitudinal vein reaching the margin	*Phorbia.*
Sixth longitudinal not reaching the margin.	
Sixth longitudinal longer than seventh	*Limnophora.*
Sixth longitudinal shorter than seventh	*Homalomyia.*
Eyes widely separated in both sexes.	
Arista slightly pubescent or bare	*Cœnosia.*

Genus Trichophthicus, Rondani (1870).

"Eyes hairy, and contiguous or subcontiguous in the males. Arista pubescent or bare; epistome sometimes prominent. Squamæ moderately developed, with unequal scales.

Sixth longitudinal vein not prolonged to the margin of the wing" (Meade).

In the New Zealand species the eyes are approximated in the male; the arista is distinctly pubescent, and the sixth longitudinal vein is short, reaching about halfway from the basal cell to the border of the wing; the third and fourth longitudinal veins diverge slightly outside the chief cross-vein.

KEY TO THE SPECIES.

Wings spotted	*T. maculipennis.*
Wings unspotted.	
Third joint of the antennæ less than twice the length of the second.	
Face yellowish	*T. dolosus.*
Face white.	
Length, 8 mm. to 9 mm.	*T. melas.*
Length, 5 mm.	*T. limpidus.*
Face black	*T. carbonarius.*
Third joint of antennæ more than three times the length of the second	*T. ordinatus.*

Trichophthicus melas.

Aricia melas, Schiner, Reise der "Novara," Dipt., p. 302 (1868); Hutton, Cat. Dipt. N.Z., p. 63.

Frontal band dark, face silvery. Thorax dark-grey, with three indistinct black bands. Abdomen dark-grey, the middle segments with a pair of triangular black marks separated by a pale band, which has a thin black line down the centre. Legs piceous, knees tawny. Wings brownish, darker anteriorly and at the base; squamæ brownish. Length, 8–9 mm.; wing, 7–8 mm.

Hab. Throughout New Zealand.

The facial ridges are not ciliated, but the fronto-orbital bristles extend halfway down the eyes. The third joint of the antennæ is not much longer than the first. The auxiliary and first longitudinal veins are not distinctly separated for the greater part of their length. The posterior cross-vein is sometimes sinuated, but more often it is nearly straight.

Trichophthicus dolosus, sp. nov.

Frontal band black, face pale-fulvous; antennæ piceous. Thorax greyish-brown, with three dark longitudinal streaks; scutellum greyish-brown. Abdomen grey; each of the middle segments with a pair of triangular dark spots, and a central narrow dark stripe; apical segment with a central triangular dark spot, the apex of which does not reach the end of the abdomen. Femora grey; tibiæ dark-fulvous; the tarsi blackish. Squamæ brownish. Wings tinted brownish, darker along the anterior portion and at the base; veins brown. The auxiliary vein is distinct from the first longitudinal throughout its length. Length, 7–9 mm.; wing, 6–8 mm.

Hab. Christchurch (F. W. H.); Ashburton (W. W. Smith).

The eyes are only slightly hairy. The third joint of the antennæ is about one and a half times the length of the second. The abdomen is marked as in *T. melas*, but it is lighter in colour. The facial ridges are ciliated on their lower half.

Trichophthicus carbonarius, sp. nov.

Frontal band black, edged with white; face blackish; antennæ piceous. Thorax blackish, with three longitudinal darker bands; scutellum blackish. Legs black. Squamæ white, with a dark margin. Wings pellucid; veins black. Abdomen blackish, each segment with a pair of grey semicircular spots on the posterior margin. Length, 7 mm.; wing, 6 mm.

Hab. Wellington (G. V. Hudson).

The arista is finely pubescent. The facial ridges are bare. Third joint of the antennæ about twice the length of the second.

Trichophthicus maculipennis, sp. nov.

Frontal band black, margined with silvery, which extends round the eyes; face pale-brown; antennæ black. Thorax brownish-grey, with three broad black bands; scutellum brownish-grey, black on the sides. Abdomen dark-brown, with a large semicircular grey mark on the posterior margin on each side; apical segment with a central black band. Legs blackish-brown. Squamæ nearly white. Wings pellucid, the veins blackish-brown; a round black spot on the chief cross-vein, and a smaller one where the posterior cross-vein meets the fourth longitudinal. Posterior cross-vein slightly sinuated. Length, 8 mm.; wing, 7 mm.

Hab. Christchurch (F. W. H.).

The eyes are hairy; the third joint of the antennæ is about one and a half times the length of the second. The facial ridges are ciliated.

Trichophthicus limpidus, sp. nov.

Male.—Frontal band brown, face white; eyes approximated. Thorax blackish-brown. Abdomen dark-grey, with blackish irregular marks. Legs blackish-brown.

Female.—Frontal band brown, margined with yellowish-white, which colour extends over the face. Thorax pale-brown, with three narrow black lines; scutellum pale-brown. Abdomen grey, the middle segments with a pair of black triangular marks; last two segments without marks. Femora fuscous, tibiæ and tarsi tawny. Length, 6 mm.; wing, 6 mm.

Hab. Christchurch (F. W. H.).

In both sexes the wings are clear, the veins brown, and the posterior cross-vein is slightly sinuated. The eyes are slightly hairy; the arista is shortly pubescent. The third joint of the antennæ is about one a half times the length of the second; the facial ridges are bare.

Trichophthicus ordinatus, sp. nov.

Frontal band black, margined with white, which extends over the face; antennæ piceous. Thorax grey, with three long broad black bands; scutellum grey, the sides and a spot at the base black. Abdomen grey; the first segment black; the second, third, and fourth with a large triangular black spot on each side which nearly meet in the middle on the fourth segment; fifth segment with a central black band, which extends to the apex. Legs black. Squamæ slightly brownish. Wings pellucid, the veins blackish; the chief cross-vein slightly margined with brown; the posterior cross-vein slightly sinuated. Length, 8–9 mm.; wing, 7–8 mm.

Hab. Wellington (G. V. Hudson).

The third joint of the antennæ is four or five times the length of the second. The eyes are rather nearer in the male, and more hairy, than in the female. The facial ridges are strongly ciliated for the greater part of their length.

Genus Limnophora, R. Desvoidy (1830).

Eyes bare, contiguous or approximate in the males; arista slightly pubescent or bare. Abdomen oval or conical, and always marked on the dorsum with four or six large triangular or subquadrate spots. Squamæ well developed, considerably larger than the antisquamæ. Sixth longitudinal vein not reaching the margin of the wing.

Limnophora rapax, sp. nov.

Frontal band brown, margined with white, which colour extends over the face. Thorax pale-grey, with five longitudinal black lines; scutellum grey. Abdomen pale-grey; the three middle segments with a pair of triangular dark spots, rather distant from each other; apical segment with a central dark band. Femora grey, tibiæ tawny; tarsi blackish. Squamæ brownish. Wings pellucid, the veins brown; posterior cross-vein sinuated. Length, 10 mm.; wing, 8½ mm.

Hab. Christchurch (F. W. H.).

The facial ridges, as well as the eyes, are bare; the second joint of the antennæ is rather long; the third about one and a half times the length of the second; arista minutely pubescent. The first posterior cell gradually widens to the margin of the wing; the sixth longitudinal vein extends about three-quarters of the way from the basal cell to the margin of the wing.

Genus HOMALOMYIA, Bouché (1834).

Head smooth and semicircular; eyes large, covering the sides of the head; bare and subcontiguous or approximate in the male. Arista subpubescent or bare, with the second joint often rather elongated. Squamæ moderate, larger than the antisquamæ. Abdomen mostly elliptical and flattened in the males, and marked with an angulated dorsal stripe; oval and immaculate in the females. Wings with the sixth longitudinal vein shortened, and the seventh longitudinal curved towards its extremity.

In the New Zealand species the eyes and facial ridges are bare, and the arista is pubescent. The antennæ are short, and the third joint is about twice the length of the second. There is no tubercle or thickening on the middle tibiæ of the males. In the females the squamæ are small, and not much larger than the antisquamæ. A short costal bristle is sometimes present.

KEY TO THE SPECIES.

Abdomen diaphanous near the base	*H. canicularis.*
Abdomen not diaphanous near the base.	
Legs fulvous	*H. fulvescens.*
Legs black.	
Wings smoky	*H. fuliginosa.*
Wings clear.	
Distance between cross-veins one and a half times the length of the posterior ..	*H. rava.*
Distance between cross veins rather more than length of posterior cross-vein.	
Body brown	*H. badia.*
Body grey	*H. fraxinea.*

Homalomyia canicularis.

Musca canicularis, Linn., Syst. Nat., ii., 992 (1761).

Head silvery. Thorax grey, with four brown stripes. Abdomen testaceous, and semidiaphanous towards the base, with the exception of a dorsal stripe, which is dilated on the borders of the second and third segments. Length, 5–6 mm.; wing, 5–6 mm.

Hab. Throughout New Zealand. Introduced.

Homalomyia fulvescens, sp. nov.

Female.—Frontal band dark-brown; the ocellar triangle, margins of vertex, and face yellowish-white. Antennæ testaceous. Thorax yellowish-brown, with indistinct darker bands; scutellum yellowish-brown, bordered on the sides with darker. Abdomen dark-brown, the middle segments with a semicircular yellowish-brown spot on each side at the posterior margins, and an irregular central yellowish-brown band; apical segment with a central yellowish-brown band. Legs fulvous, the tarsi blackish. Squamæ and halteres white. Wings pellucid, the veins piceous; the distance between the cross-vein and the posterior cross-vein about the length of the latter. Length, 5 mm.

Hab. Christchurch (F. W. H.).

The arista is slightly pubescent. I have not seen the male.

Homalomyia fuliginosa, sp. nov.

Male.—Frontal band black, the forehead black, with grey reflections, which colour goes halfway down the eyes; face grey. Thorax and scutellum black. Abdomen brown, with grey reflections; the middle segments with a dark triangular spot on each side; the apical segment with a dark central band. Legs black. Squamæ and halteres brownish-white. Wings smoky-brown; the distance between the two cross-veins about equal to the length of the posterior cross-vein. Length, 4–6 mm.

Hab. Christchurch (F. W. H.).

The arista is slightly pubescent, and the eyes are approximated

Homalomyia badia, sp. nov.

Cheeks grey, showing a black spot in certain lights; antennæ dark-brown. Thorax and abdomen brown, the former with indistinct darker bands, the latter with indistinct darker marks. Legs dark-brown. Halteres pale-yellow. Wings pellucid, sometimes brownish near the base; distance between the two cross-veins rather more than the length of the posterior cross-vein. Length, 4–5 mm.

Male.—Eyes subcontiguous; frontal band black, face grey.

Female.—Face grey, the frontal band rather darker.

Hab. Christchurch and Rotorua (F. W. H.).

Homalomyia rava, sp. nov.

Female.—Vertex reddish-brown, passing into yellow-brown over the antennæ. It is bordered on each side with yellowish-white, which colour extends over the face. Thorax and abdomen light-grey. Legs blackish-brown. Wings pellucid; distance between the cross-veins about one and a half times the length of the posterior cross-vein. Length, 5 mm.

Hab. Christchurch (H. Clark).

Homalomyia fraxinea, sp. nov.

Thorax and scutellum pale-grey, the former with some indistinct dark lines. Abdomen pale-grey, the middle segments with a pair of indistinct dark spots. Legs blackish-grey. Squamæ white. Halteres yellow. Wings pellucid, the veins piceous; distance between the two cross-veins rather more than the length of the posterior cross-vein. Length, 5–6 mm.

Male.—Head and front silvery, except the ocellar triangle, which is grey, and a very narrow black frontal band, which is sometimes absent.

Female.—Frontal band reddish-brown, broadly margined with grey; ocellar triangle and face grey.

Hab. Christchurch (F. W. H.).

Genus EXSUL, gen. nov.

Eyes slightly hairy. Arista minutely pubescent. Cheeks hairy. Abdomen oblong, unspotted. Squamæ and antisquamæ well developed, nearly equal. Wings very broad, the shoulder arched; third and fourth longitudinals parallel; the fifth diverging widely, making the posterior cross-vein longer than the distance between it and the chief cross-vein; sixth longitudinal reaching about two-thirds of the distance between the third basal cell and the margin of the wing; seventh longitudinal shorter than the sixth. The chief cross-vein lies inside the end of the first longitudinal.

A very remarkable genus, very different in appearance from any other fly, but clearly belonging to the *Anthomyidæ.*

Exsul singularis, sp. nov.

Frontal band black; the face greyish-white; antennæ piceous. Thorax dark-grey, with two distinct black longitudinal stripes, and two indistinct ones inside them. Abdomen dark-grey, the sides and apex with scattered, long, fulvous hairs. Legs jet-black. Halteres brownish. Squamæ nearly white. Wings dark-brown, with pale spots in the subcostal, anterior, and posterior basal cells, and a deep pale indentation at the apices of the submarginal and first posterior cells. Length, 12 mm.; length of wing, 13 mm., its breadth 10 mm.

Hab. Milford Sound (Professor Wall).

Two specimens of this very remarkable fly were seen, but only one was captured.

Genus PHORBIA, R. Desvoidy (1830).

"Eyes bare, contiguous or subcontiguous in the males, remote in the females. Arista tomentose or bare. Face slightly prominent. Abdomen depressed, oblong or linear. Squamæ small, not much larger than the antisquamæ. Wings with the anal veins prolonged to the margin. Legs black" (Meade).

Phorbia novæ-zealandiæ, sp. nov.

Female. — Greyish-brown, the frontal band and eyes brownish-red; the antennæ and legs black. Thorax with a central dark band, and two rows of dark spots on each side of it. Abdomen with an interrupted central dark band. Squamæ white, margined with rusty. Halteres yellowish-white. Wings pellucid, the veins black. The distance between the two cross-veins is about one and a half times the length of the posterior cross-vein; the distance of the posterior cross-vein from the margin is about three-fourths of its length. Length, 5 mm.; wing, 5 mm.

Hab. Christchurch (F. W. H.).

The squamæ and antisquamæ are moderate in size, and nearly equal. The sixth longitudinal vein reaches the margin of the wing.

Genus Cœnosia, Meigen (1826).

Eyes bare, widely separated in both sexes; arista pubescent or bare. Forehead not projecting. Squamæ larger than the antisquamæ. Abdomen of the male generally subcylindrical and thickened at the end. Sixth longitudinal vein more or less abbreviated.

Key to the Species.

Cross-veins of wing bordered with dusky.
  Thorax grey .. .. *C. spinipes.*
  Thorax reddish-brown .. .. *C. smithii.*
Cross-veins of wing not bordered.
  Vertex dark reddish-brown .. .. .. *C. rubriceps.*
  Vertex brownish-white.
    Antennæ fulvous .. .. *C. purgatoria.*
    Antennæ piceous .. .. *C. algivora.*

Cœnosia spinipes.

Cœnosia spinipes, Walker, Cat. Dipt. in Brit. Mus., p. 969 (1849); Hutton, Cat. Dipt. N.Z., p. 64.

"Cinerea, capite fulvo, thorace fusco trivittato, abdomine maculis sex trigonis canis ornato, palpis fulvis, antennis nigris, articulo 2° ferrugineo, pedibus fulvis, tarsis nigris, alis cinereis." Length, 5 mm. (Walker.)

Hab. New Zealand (Voyage "Erebus" and "Terror").

I have not seen this species; probably it was taken at the Bay of Islands.

Cœnosia smithii, sp. nov.

Vertex reddish-brown, with tawny reflections; face yellowish-white; antennæ reddish-brown. Thorax reddish-brown, blackish below, with a pale-grey band on each side. Abdomen dark-grey, with tawny reflections; unspotted. Legs black, the femora with grey tomentum. Halteres and squamæ yellowish-brown. Wings pellucid, brownish at the base; veins tawny; the cross-veins bordered with fuscous. Length, 5 mm.

Hab. Ashburton (W. W. Smith).

The distance between the cross-veins is about one and three-quarters the length of the posterior cross-vein. The distance of the latter from the margin of the wing is rather less than its own length. The chief cross-vein lies outside the end of the first longitudinal.

Cœnosia rubriceps, sp. nov.

Vertex dark-reddish; the ocellar triangle and the face dark-grey; antennæ piceous. Thorax dark-grey, with three indistinct darker bands. Abdomen dark-grey, unspotted. Legs, including the tarsi, tawny. Halteres and squamæ brownish-white. Wings pellucid; the veins tawny; cross-veins not bordered. Length, 5 mm.

Hab. Otago (F. W. H.); on the sea-coast at Waikouaiti.

The distance between the cross-veins is more than twice the length of the posterior cross-vein. The distance of the latter from the margin is about three-fourths of its length. The chief cross-vein lies inside the end of the first longitudinal.

Cœnosia purgatoria, sp. nov.

Male.—Head yellowish or brownish-white, a round brown spot at the ocelli; frontal band with brown reflections; antennæ tawny. Thorax pale yellowish-grey, without any marks. Abdomen pale-grey, unspotted. Femora dark-grey; the tibiæ and tarsi tawny. Halteres pale-brown. Squamæ white. Wings pellucid, the veins tawny. End of the abdomen swollen.

Female.—Ash-grey; the face white. Legs and wings as in the male.

Length, ♂ 6 mm., ♀ 7 mm.

Hab. Wellington (G. V. Hudson).

The distance between the cross-veins is about one and three-fourths the length of the posterior cross-vein. The distance of the latter from the margin is rather more than half its length. The chief cross-vein lies just outside the end of the first longitudinal.

Cœnosia algivora, sp. nov.

Female.—Vertex tawny; face yellowish-white, with yellow reflections. Antennæ piceous. Thorax pale yellowish-grey, with indistinct longitudinal dark bands. Abdomen pale yellowish-grey. A large rather darker triangular mark covers the centres of the second and third segments, its broad base being on the posterior border of the latter segment. The fourth segment has three indistinct dark spots; the fifth segment is irregularly marked. Legs dark-grey. Halteres brown. Squamæ white. Wings pellucid, the veins piceous. Length, 6 mm.

Hab. Christchurch (F. W. H.); on the sea-shore.

The distance between the cross-veins is about one and a quarter times the length of the posterior cross-vein. The distance of the latter from the margin is less than half its length. The chief cross-vein is just beyond the end of the first longitudinal.

Division II. MUSCIDEA ACALYPTRATÆ.

Squamæ absent.

Key to the New Zealand Families.

First joint of the posterior tarsi longer than the second.	
Auxiliary vein more or less separated from the first longitudinal.	
Oral vibrissæ present.	
Costa with distant long bristles	*Helomyzidæ.*
Costa without distant long bristles.	
Third joint of the antennæ oblong ..	*Cordyluridæ.*
Third joint of the antennæ round ..	*Phycodromidæ.*
Oral vibrissæ absent.	
Basal cells large.	
Tibiæ with a preapical bristle ..	*Sciomyzidæ.*
Basal cells small.	
Tibiæ with a preapical bristle ..	*Sapromyzidæ.*
Tibiæ without a preapical bristle ..	*Opomyzidæ.*
Auxiliary vein completely united to the first longitudinal.	
Basal cells complete, large	*Piophilidæ.*
Basal cells complete, small	*Agromyzidæ.*
Basal cells incomplete.	
Mouth large	*Ephydrinidæ.*
Mouth of ordinary size.	
Oral vibrissæ present; claws very small	*Drosophilidæ.*
Oral vibrissæ absent; claws of ordinary size	*Oscinidæ.*
First joint of the posterior tarsi shorter than the second	*Borboridæ.*

Family CORDYLURIDÆ.

"Neuration of the wings complete; both posterior basal cells of considerable size; auxiliary vein well separated from the first longitudinal; first longitudinal bare. Whole lateral border of the front bristly; anterior border of the mouth with strong, usually numerous, vibrissæ" (Loew).

Genus CORDYLURA, Fallen (1819).

Front broad; face vertical; antennæ not reaching the epistome; the third joint linear, longer than the second, somewhat truncated at the tip; arista plumose or nearly bare. Legs stout, bristly. Abdomen in the male linear and thickened at the tip, in the female fusiform.

Cordylura debilis, sp. nov.

Vertex reddish-brown, the face yellow; antennæ and proboscis piceous. Thorax reddish-brown, with a grey band on each side. Abdomen and legs brown, the femora dusted with grey. Wings slightly tinged with brown; the veins dark-brown; the two cross-veins margined with fuscous, which is more distinct when viewed obliquely. The chief cross-vein lies outside the end of the first longitudinal; the distance between the two cross-veins is about one and three-quarter times the length of the posterior cross-vein, which lies at a distance of about one and a half times its own length from the margin of the wing. Length, 5 mm.; wing, 4 mm.

Hab. Christchurch (H. Clark, F. W. H.).

The antennæ do not reach the epistome; the third joint is oblong, and about twice the length of the second. The arista is short and minutely pubescent. The abdomen is about as long as the head and thorax; linear and thickened at the end in the male, elliptical in the female.

Family PHYCODROMIDÆ.

"Thorax, scutellum, and abdomen flat; pleuræ excised above the coxæ. Front bristly; border of the mouth hairy, with no distinct vibrissæ. Legs stout; tibiæ with spurs, and each with an erect hair, or small bristle, on the outside before the tip; the first joint of the posterior tarsi not abbreviated; last joint of all the tarsi enlarged, with stout claws and long pulvilli. Neuration of the wings complete; auxiliary vein distinct in its whole length; costa without bristles; basal cells not small" (Loew).

Genus CŒLOPA, Meigen (1830).

Face short, very concave. Antennæ very short; the third joint nearly round, not longer than the second; arista bare or pubescent. Legs hairy, the tibiæ slightly curved.

Cœlopa littoralis.

C. littoralis, Hutton, Cat. Dipt. N.Z., p. 69 (1881); Hudson, Man. N.Z. Ent., p. 63, pl. vii., fig. 13.

Vertex nearly black, the ocellar triangle brown, face grey; antennæ and proboscis reddish-brown. Thorax brown, the sides and lower surface grey. Abdomen greyish-brown. Legs pale-brown, the upper surfaces of the femora dark-brown. Halteres yellow. Wings slightly tinged with brown; the veins brown. Length, ♂ 5½ mm., ♀ 7 mm.; wing, ♂ 5 mm., ♀ 6 mm.

Hab. Wellington; on the sea-beach.

The body is slightly and the legs very hairy. The face is deeply concave, and has but few hairs. The thorax is not very flat. The chief cross-vein lies just opposite the end of the first longitudinal; the distance between the two cross-veins is about twice the length of the posterior cross-vein, and the distance of the latter from the margin is about one-half of its own length.

Cœlopa monstruosa, sp. nov.

Colours like the last, but the legs redder brown. The middle legs elongated, considerably longer than the hind legs, and their tibiæ and tarsi thickly clothed with long hairs. Length, 8 mm.; wing, 8½ mm.

Hab. Fortrose, Southland (Mrs. Haswell).

The elongated middle legs seem adapted for swimming or walking on water. The chief cross-vein lies just outside the end of the first longitudinal; the distance between the two cross-veins is about two and a half times the length of the posterior cross-vein, the distance of which from the margin is about half its own length.

Family HELOMYZIDÆ.

"Neuration of the wings complete; costa bristly; first longitudinal vein not abbreviated, but bare; the auxiliary vein often approximated to it. Front bristly on its upper side only; a strong bristle on each side of the anterior border of the mouth. All the tibiæ with spurs and with an erect bristle on the outer side before their apices" (Loew).

KEY TO THE GENERA.

Third joint of the antennæ oval	*Helomyza.*
Third joint of the antennæ nearly circular	*Leria.*

Genus HELOMYZA, Fallen (1839).

Antennæ rather short, the third joint oval; arista plumose or pubescent. Wings moderately long, the costa setigerous. Legs hairy, with a few bristles. Abdomen linear in the male, obconical in the female. A humeral bristle is always present.

The two following species have the head and eyes nearly round; the second joint of the antennæ is short and conical, the third is oval and considerably longer than the second; the arista is minutely pubescent. The costa of the wing is setigerous from the centre of the costal cell nearly to the tip, but there are no bristles on any of the longitudinal veins. The middle tibiæ have strong spurs, but they are small or absent on the hind tibiæ.

Key to the Species.

Distance between the cross-veins one and a half times the length of the posterior	*H. scutellata.*
Distance between the cross-veins two and a half times the length of the posterior	*H. hudsoni.*

Helomyza scutellata, sp. nov.

Head and antennæ dark-brown; the face tawny, with grey tomentum. Abdomen dark-brown. Legs pale-tawny. Wings brownish; veins tawny; the cross-veins bordered with fuscous. The chief cross-vein lies considerably outside the end of the first longitudinal; the distance between the two cross-veins is about one and a half times the length of the posterior cross-vein, and the posterior cross-vein lies at a distance of two-thirds of its own length from the margin of the wing. Length, 5 mm.; wing, 5 mm.

Male.—Thorax and scutellum pale-brown above, the sides dark reddish-brown, with a longitudinal white band to the base of the wings; tawny below.

Female.—Thorax brown, darker on the sides; lower surface, and a band on each side meeting at the apex of the scutellum, pale-yellow.

Hab. Wellington (G. V. Hudson).

The third joint of the antennæ is broadly oval, about three times the length of the second. The setæ on the costa are short, and easily overlooked.

Helomyza hudsoni, sp. nov.

Front testaceous, the ocellar triangle brown; face yellowish-white; antennæ dark-ferruginous. Thorax reddish-brown, indistinctly banded, the sides with a yellowish-white band. Abdomen and legs tawny. Wings brownish, the chief cross-vein broadly and the posterior cross-vein narrowly bordered with brown. Length, 5 mm.; wing, 5 mm.

Hab. Wellington (Hudson); Christchurch (F. W. H.).

The first longitudinal vein is short, the chief cross-vein lying just outside its end; auxiliary vein closely approximated to the first longitudinal for the greater part of its length, but distinct from it. The distance between the two cross-veins is about two and a half times the length of the posterior cross-vein, the distance of which from the margin of the wing is about one-half of its own length.

Genus Leria, R. Desvoidy (1830).

Head slightly produced, front flat, epistome rather prominent. Palpi nearly filiform. Antennæ very short, the third joint round, rather longer than the second ; arista long, bare. Costa of wing armed with short spines. Legs slender, pubescent, with a few bristles.

Leria placata, sp. nov.

Brown or dark-tawny, the abdomen rather darker than the legs ; ocellar triangle and face yellowish ; halteres rusty-white. Wings almost colourless, unspotted ; the veins tawny. Posterior cross-vein straight. Length, 7 mm. ; wing, 6 mm.

Hab. Christchurch (H. Clark).

The head in profile is oblong, higher than long, and the face is distinctly excavated. The eyes are small and round. The antennæ are placed in grooves on the face, their bases partly hidden by the projecting front ; the first and second joints are very small, the third is larger and nearly circular. The arista is pubescent and very long in the male ; a bristle is present on the humeral callus. The costa is setigerous from the middle of the costal cell nearly to the tip of the wing. None of the longitudinal veins have bristles. The chief cross-vein lies outside the end of the first longitudinal. The distance between the two cross-veins is about one and a half times the length of the posterior cross-vein, which lies at about one-half of its own length from the margin of the wing. Middle tibiæ with strong spurs ; the fore and hind tibiæ without spurs.

Leria fulva, sp. nov.

Fulvous or testaceous, with grey tomentum on the upper surface of the head, thorax, and abdomen, seen only in certain lights. A broad grey stripe on each side from the prothorax through the base of the wing. Wings ochraceous ; veins tawny ; the cross-veins narrowly bordered with fulvous. Length, 5 mm. ; wing, 5 mm.

Hab. Christchurch (H. Clark).

The third joint of the antennæ is nearly circular. The middle tibiæ have strong spurs, the hind tibiæ without spurs. A bristle is present on the humeral callus. The costa of the wing has short distant bristles to beyond the end of the first longitudinal vein. The chief cross-vein lies outside the end of the first longitudinal. The distance between the cross-vein is about twice the length of the posterior cross-vein, and the distance of the latter from the margin of the wing is one-half of its own length.

Family SCIOMYZIDÆ.

"Neuration of the wing complete; two basal cells of rather considerable size; auxiliary vein well separated from the first longitudinal. On the lateral border of the front, before the vertical bristles, there are a pair of bristles. Face proportionately long, without distinct grooves for the antennæ; border of the mouth sharp, without vibrissæ. Middle tibiæ with a number of bristles on the tip; all the tibiæ on the outside, before the tip, with a small upright bristle" (Loew).

KEY TO THE GENERA.

Third joint of the antennæ oval.	
Antennæ short	*Tetanocera*.
Antennæ elongate	*Limnia*.
Third joint of the an'ennæ nearly circular.	
Face strongly receding	*Trigonometopus*.
Face slightly receding	*Sciomyza*.

Genus SCIOMYZA, Fallen (1839).

Antennæ not reaching the epistome, the third joint nearly circular, much longer than the second. Head large, face slightly receding; epistome not projecting. Abdomen depressed, linear in the male, fusiform in the female. Legs pubescent, slightly bristly.

Sciomyza nigricornis.

S. nigricornis, Macquart, Dipt. Exot., Supp. iv., p. 250, pl. 25, fig. 11 (1850); Hutton, Cat. Dipt. N.Z., p. 67.

"Testacea. Antennis nigris, basi testaceis. Pedibus flavis. Femoribus apice nigris, anticis spinosis; tibiis apice nigris. Alis flavis." Length, 8 mm. (Macquart.)

Hab. Akaroa, New Zealand, and Tasmania (Paris Museum).

I do not know this species.

Genus TETANOCERA, Dumeril (1809).

Face oblique. Antennæ elongate; second joint long; the third oval, a little longer than the second. Legs stout, hairy, with a few bristles; the hind femora not much thickened. Abdomen nearly linear in the male, subfusiform in the female.

Tetanocera rara, sp. nov.

Male.—Front and antennæ reddish-yellow; lower face, palpi, and proboscis pale-tawny; arista dark, pubescent. Dorsum of the thorax and scutellum golden-yellow, the sides reddish-brown, with a grey band; lower surface grey. Abdomen dark-brown, the apex paler. Legs pale-tawny, the apices of the middle and hind femora, as well as of the hind tibiæ, dark-brown. Wings orange, unspotted, the subcostal cell brown; veins tawny; posterior cross-vein straight. Length, 9½ mm.; wing, 9 mm.

Hab. Wellington (G. V. Hudson).

The second joint of the antennæ is short, about one-third of the length of the third joint, which is oval. The costa has strong rather distant bristles from the middle of the costal cell nearly to the tip of the wing. There are no vibrissæ. The chief cross-vein lies just inside the end of the first longitudinal; the distance between the two cross-veins is about two and a half times the length of the posterior cross-vein, which is situated at about its own length from the margin of the wing. The middle tibiæ are spurred, but not the hind tibiæ.

Genus Limnia, R. Desvoidy (1830).

Front projecting. Antennæ as long as the head; second joint broad, compressed, equal in length to the third. Posterior femora not elongated or thickened; middle tibiæ terminated by two long spines.

In the New Zealand species put into this genus the eyes are prominent, the face is slightly excavated, and the third joint of the antennæ is oval.

Key to the Species.

Wings not ocellated; posterior cross-vein strongly sinuated.
- Wings with nine or ten spots .. .. .. *L. sigma.*
- Wings with numerous spots .. .. .. *L. tranquilla.*

Wings ocellated; posterior cross-vein moderately sinuated.
- Tibiæ not darker at the tips .. .. .. *L. transmarina.*
- Tibiæ darker at the tips .. .. .. *L. obscura.*

Limnia sigma.

Tetanocera sigma, Walker, Cat. Dipt. in Brit. Mus., p. 1084 (1849). *Cylindra sigma*, Hutton, Cat. Dipt. N.Z., p. 65.

Vertex and antennæ bright-tawny, the lower face white. Thorax brownish-grey above, with four brown bands; the sides reddish-brown, with a white band; under-surface white. Abdomen reddish-brown, darker in the female than in the male. Legs ferruginous. Wings slightly yellow; costa piceous, veins tawny. The marginal cell has three or four brown spots, and there is another at the end of the second longitudinal vein. A spot on the chief cross-vein, and one at the anterior end of the posterior cross-vein ; the first posterior cell has one or two spots near its apex, and one on the anterior margin of the second posterior cell. The posterior cross-vein is strongly sinuated. Length, 7 mm. ; wing, 7½ mm.

Hab. Canterbury (H. Clark) ; Otago (F. W. H.).

Limnia tranquilla, sp. nov.

Dark-ferruginous, the vertex bright yellowish-tawny. Tibiæ, except their apices, and tarsi, except their two last joints, tawny. Wings yellow, spotted with brown ; the subcostal cell dark ; the veins piceous, tawny at their bases ; posterior cross-vein strongly sinuated. The marginal cell has from four to six spots, the submarginal five to seven. The first posterior cell has four or five, the outer one of which is ringed but not ocellated. The second posterior cell has two spots. The anal and auxiliary cells are clouded, and the cross-veins are bordered with brown. Length, 7 mm. ; wing, 7 mm.

Hab. Auckland (Captain Broun).

Limnia transmarina.

L. transmarina, Schiner, Reise der "Novara," Dipt., p. 234 (1868) ; Hutton, Cat. Dipt. N.Z., p. 65.

Pale-tawny, the vertex and antennæ yellowish. Thorax grey, with two brown lines ; the sides brown, with a white band ; lower surface white. Tips of the femora brown. Wings yellow, the posterior cross-vein moderately sinuated. The marginal cell has four large spots and usually two smaller ones. The rest of the wing is vaguely ocellated with pale-grey. Length, 6½ mm. ; wing, 6½ mm.

Hab. Auckland (Voy. "Novara") ; Christchurch (H. Clark).

Limnia obscura, sp. nov.

Cylindra sigma, Hudson, Man. N.Z. Ent., p. 62, pl. vii., fig. 14.

Vertex and antennæ bright-tawny, the frontal band darker ; face yellowish-white. Thorax tawny above, with two obscure brown lines ; a white stripe on each side, below which is a brown stripe ; under-surface white. Abdomen dark-tawny. Legs tawny ; the upper surfaces of the femora, the apices of the tibiæ, and the last two joints of the tarsi dark-brown. Wings pale-yellow, ocellated, the posterior cross-vein moderately sinuated. The marginal cell has four large brown spots, the two inner of which cross the subcostal cell and reach the costa. Submarginal and first and second posterior cells with ocellated spots. Anal and auxiliary cells with simple spots. Cross-veins broadly margined; the second posterior cell with a sinuated, transverse, pale line. Length, 9 mm.; wing, 8 mm.

Hab. Auckland (Captain Broun); Wellington (Hudson).

Genus Trigonometopus, Macquart (1835).

Head projecting in front, the face strongly receding. Third joint of the antennæ rounded, or a little elongated. Cheeks with a row of well-developed bristles situated on a ridge descending from the front near the eye and extending back to the occiput.

Trigonometopus bipunctatus, sp. nov.

Front dark reddish-brown, with a narrow pale central line; the face grey. Antennæ dark-ferruginous. Thorax brownish-grey, with four broad reddish-brown bands; the sides and under-surface grey. Abdomen brown, with grey reflections on the sides and posterior margins of the segments. Legs tawny in the male, brown in the female. Wings pellucid, the two cross-veins broadly margined with brown. Length, 7 mm.; wing, 8 mm.

Hab. Chatham Islands (J. Fougère).

The second joint of the antennæ is rather long and conical; the third joint is nearly circular; the arista is bare. There is a small curved ridge on each cheek, running from near the base of the antenna to about the level of the opening of the mouth, which bears fine hairs; the cheeks outside this ridge are slightly hairy. The costa of the wing is setigerous from the end of the auxiliary vein nearly to the tip; none of the longitudinal veins have bristles. The chief cross-vein lies just inside the end of the first longitudinal. The distance between the two cross-veins is about two and a half times the length of the posterior cross-vein, which is situated about one-half of its own length from the margin of the wing. The middle tibiæ only are spurred.

Family SAPROMYZIDÆ.

"Neuration complete; auxiliary vein of the usual structure, frequently very much approximated to the first longitudinal; costa of the wing without bristles or marginal spine; longitudinal veins without peculiar hairs; posterior basal cells small. Front with a single row of bristles on each side; no vibrissæ on the border of the mouth; clypeus rather rudimentary. Only the middle tibiæ have terminal spurs; all the tibiæ with a small erect bristle on the exterior side, before the tip. Ovipositor of the female not horny" (Loew).

KEY TO THE GENERA.

Third joint of antennæ oval	*Sapromyza.*
Third joint of antennæ linear	*Lauxania.*

Genus SAPROMYZA, Fallen (1820).

Head subhemispherical; face a little inclined backwards; epistome bare, not projecting. Antennæ short, the third joint generally oblong, compressed, the extremity obtuse, the arista pubescent.

KEY TO THE SPECIES.

No white streaks on the margin of the eyes	*S. dichromata.*
White streaks on the margin of the eyes.	
Coxæ and bases of femora yellow	*S. sciomyzina.*
Coxæ and bases of femora brown	*S. decora.*

Sapromyza dichromata.

Sap. dichromata, Walker, Cat. Dipt. in Brit. Mus., p. 988 (1849); Hutton, Cat. Dipt. N.Z., p. 66.

Tawny, except the abdomen, which is dark-brown. Length, 5–5½ mm.

Hab. Throughout New Zealand.

The third joint of the antennæ is oval, about twice the length of the second; arista minutely pubescent. The auxiliary vein is closely approximated to the first longitudinal for about two-thirds of its length.

Sapromyza sciomyzina.

Sap. sciomyzina, Schiner, Reise der "Novara," Dipt., p. 278 (1868); Hutton, Cat. Dipt. N.Z., p. 67.

Head black, margins of the eyes with white streaks; antennæ blackish-brown. Thorax ferruginous. Abdomen black. Legs blackish-brown, the coxæ and bases of the femora yellow; the middle and hinder tarsi light-brown. Wings tinged brownish. Length, 5½ mm.

Hab. Auckland (Voyage of the "Novara").

I do not know this species.

Sapromyza decora.

Sap. decora, Schiner, Reise der "Novara," Dipt., p. 277 (1868); Hutton, Cat. Dipt. N.Z., p. 67.

Head brown, front paler with a tawny centre, margins of the eyes with white streaks; lower face tawny. Thorax brown, with two white streaks. Abdomen dark-brown. Legs brown; almost the whole of the middle tibiæ and the middle part of the hind tibiæ yellowish. Wings slightly tinted with yellow. Length, 4 mm.

Hab. Auckland (Voyage of the "Novara").

I do not know this species.

Genus Lauxania, Latreille (1805).

Body dark, shining; antennæ reaching the epistome, the third joint elongated, linear; face receding.

Lauxania bilineata, sp. nov.

Dark-brown, shining, with two white bands extending from the head, just inside the eyes, along the thorax; the front between the white bands jet-black. Antennæ piceous. Legs dark-brown, the distal ends of the middle and hind tibiæ as well as all the tarsi tawny. Wings ochraceous, the veins tawny. Length, 5 mm.; wing, 4 mm.

Hab. Otago and Canterbury (F. W. H.).

There are two fronto-orbital bristles, but none on the front. No vibrissæ. The third joint of the antennæ is linear, its length about three and a half times its breadth; the arista is minutely pubescent. The tibiæ have a preapical bristle. The chief cross-vein lies outside the end of the first longitudinal. The distance between the cross-veins is about one and a half times the length of the posterior cross-vein, and the distance of this from the margin is about one-half of its length.

Family OPOMYZIDÆ.

"Front with stout bristles above; clypeus rudimentary; border of the mouth either pubescent or with long hairs, the foremost of which sometimes forms a distinct vibrissa. Proboscis short; palpi rather small. Middle tibia with a distinct, posterior tibia with a very short, spur; the exterior side of the tibiæ without an erect bristle before the tip; claws and pulvilli small. Wings elongated and narrow, with no bristles on the costa; the axillary incision wanting or very small. First longitudinal vein much abbreviated; the auxiliary vein becomes obsolete before reaching the first longitudinal; the latter emits, shortly before its end, towards the costa, a branch, which may be considered as the end of the auxiliary vein. Basal cells small" (Loew).

Genus Opomyza, Fallen (1820).

Head and thorax convex, with a few bristles. Antennæ short, the first and second joints minute, the third round; arista pubescent. Abdomen sublinear. Wings generally spotted; the first longitudinal vein ending at one-fourth the length of the wing. Legs moderate.

Opomyza apicalis.

Op. apicalis, Walker, Cat. Dipt. in Brit. Mus., p. 114 (1849); Hutton, Cat. Dipt. N.Z., p. 69.

Head and thorax pale-tawny; abdomen dark-brown. Legs tawny. Wings colourless, a dusky spot at the apex of the submarginal cell. Length, 4 mm.

Hab. Bay of Islands (Sir J. Hooker); Christchurch (H. Clark).

The auxiliary vein is almost entirely amalgamated with the first longitudinal.

Family PIOPHILIDÆ.

"Auxiliary vein coalescent with first longitudinal. Front with some small bristles above; border of the mouth with a vibrissa on each side. Clypeus rudimentary. Legs rather stout; the middle tibiæ with spurs; no erect bristle on the outside before the tip" (Loew).

Genus Piophila, Fallen (1820).

Body shining, not bristly. Head nearly round; mouth not prominent. Antennæ short, not reaching the epistome; the third joint a little longer than broad, about twice the length of the second; arista bare. Abdomen nearly linear, a little longer than the thorax. Basal cells of the wing large. Legs pubescent.

Piophila smithii, sp. nov.

Vertex of head and thorax shining-black; antennæ and lower face tawny or testaceous. Second joint of the arista rather elongated, tawny; the third joint black, bare. Abdomen dark-brown. Legs dark-brown or black; the coxæ, knees, fore and middle tibiæ, and all the tarsi tawny. Wings clear, the veins tawny. Costa very thick, extending round the wing to the tip of the fourth longitudinal; distance between the two cross-veins about one and a half times the length of the posterior cross-vein; the distance of the posterior cross-vein from the margin of the wing is about half its own length. Length, 4 mm.; wing, $3\frac{1}{2}$ mm.

Hab. Ashburton (W. W. Smith).

The auxiliary vein is united to the first longitudinal for its whole length, but it can be recognised without difficulty.

Family EPHYDRINIDÆ.

"Face convex, without distinct grooves for the antennæ. Clypeus very much developed; opening of the mouth large; proboscis thickened, with a swollen chin. Auxiliary vein distinct only at its base; the foremost of the two small basal cells united with the discal cell. Middle tibiæ with spurs" (Loew).

Key to the Genera.

Mouth very large	*Ephydra.*
Mouth moderate; arista pectinated	*Domina.*

Genus Ephydra, Fallen (1813).

Face vaulted and projecting; eyes bare; opening of the mouth very large, ciliated on its border; clypeus concealed in the oral cavity; arista pubescent. Claws long and nearly straight; pulvilli indistinct. No vibrissæ.

Ephydra aquaria, sp. nov.

Vertex dark-brown, with slight æneous reflections; the face brownish-yellow. Antennæ and proboscis piceous. Thorax brown, shining, the sides and under-surface brownish-yellow. Abdomen dark-brown, with bronzy reflections. Legs black. Wings clear; the veins black. Chief cross-vein opposite the end of the first longitudinal; distance between the two cross-veins rather more than twice the length of the posterior, which is situated at about one-half of its length from the margin of the wing. Length, 5 mm.; wing, 4½ mm.

Hab. Christchurch (F. W. H.).

The third joint of the antennæ is oval and about twice the length of the second; the arista is pubescent. There are no small basal cells in the wing.

Genus Domina, gen. nov.

Head vertical; face broad; mouth rather large; the clypeus prominent. Eyes bare. Third joint of the antennæ large, nearly round; the arista pectinated. Bristles on the vertex, but none round the mouth; a pair of vibrissæ considerably above the oral opening. Fore femora not thickened. Wings without the small basal cells. First longitudinal vein attaining to about one-fifth of the wing, the second to three-fourths, and the third to the tip. The costa stops at the end of the third longitudinal vein.

Domina metallica, sp. nov.

Æneous, shining; the tarsi tawny. Wings pale-brownish, the veins piceous. The chief cross-vein lies just inside the end of the first longitudinal; the distance between the two cross-veins is about three times the length of the posterior cross-vein, which is placed rather more than its own length from the margin of the wing. Length, 2 mm.

Hab. Christchurch (F. W. H.).

The third joint of the antennæ is rather longer than broad. The arista carries six or eight long hairs on the upper side only.

Family DROSOPHILIDÆ.

"Front with bristles above; face with distinct subantennal grooves; a feeble, often rather indistinct, vibrissa at the border of the mouth. Middle tibia with very feeble spurs; on the exterior side there is either a very small or no erect bristle before the tip. Wings without bristles on the costa; the first longitudinal vein much abbreviated; the auxiliary vein rudimentary; the discal cell usually, but not in all genera, united with the foremost of the two basal cells. Claws and pulvilli very small" (Loew).

Genus Drosophila, Fallen (1820).

Head and thorax convex, with a few bristles. Antennæ short, the third joint nearly linear; arista with five or six long hairs on each side. Abdomen linear in the male, elliptical in the female.

Key to the Species.

Thorax tawny, unspotted	*D. brouni.*
Thorax tawny, spotted with brown	*D. marmoria.*
Thorax dark-brown	*D. clarkii.*

Drosophila brouni, sp. nov.

Tawny, the under-surface and legs paler, yellowish; eyes and antennæ darker, brown. Abdomen dark-brown above, tawny below. Wings nearly colourless, the veins dark-brown; chief cross-vein opposite the end of the first longitudinal; distance between the cross-veins about two and a half times the length of the posterior cross-vein; the distance of the latter from the margin of the wing is about equal to its own length. Length, 3 mm.; wing, 3 mm.

Hab. Auckland (H. Suter).

The arista has about ten long hairs.

Drosophila marmoria, sp. nov.

Head and thorax tawny mottled with dark-brown; abdomen dark-brown. Halteres and legs pale-yellow, fuscous on the outer side of the femora and tibiæ. Wings colourless; the chief cross-vein lies rather outside the end of the first longitudinal; the distance between the cross-veins is two and a half times the length of the posterior cross-vein; the distance of the latter from the margin of the wing is about equal to its own length. Length, 3 mm.; wing, 3 mm.

Hab. Auckland (H. Suter).

The arista has about eight long hairs.

Drosophila clarkii, sp. nov.

Rather dark-brown; the lower surface and the legs pale-tawny; antennæ dark-brown. Wings clear, the veins piceous. The chief cross-vein lies a little outside the end of the first longitudinal; the distance between the cross-veins is about three times the length of the posterior cross-vein; and the distance of the posterior cross-vein from the margin of the wing is about equal to three-fourths of its length. Length, $2\frac{1}{2}$ mm.; wing, $2\frac{1}{2}$ mm.

Hab. Christchurch (H. Clark).

The mouth has a row of short bristles on each side. The arista has twelve or fourteen long hairs.

Family OSCINIDÆ.

"Front without bristles, the crown having only a few short ones; border of the mouth without vibrissæ, but sometimes a small hair on each side. Middle tibiæ with small spurs; none of the tibiæ with erect bristle on the outside before the tip. Costa of the wing without bristles. Auxiliary vein completely wanting; the anterior of the two small basal cells united with the discal cell, the posterior one totally wanting" (Loew).

Genus Oscinis, Latreille (1804).

Head transverse; front prominent, face oblique. Antennæ short, not reaching the epistome; third joint nearly round, twice the length of the second; arista bare. Costa extending to the tip of the fourth longitudinal vein. Legs moderate, the hind femora slender; the tibiæ straight.

Oscinis badia, sp. nov.

Uniform blackish-brown; the third joint of the antennæ and the tarsi dark-tawny. Wings clear, veins piceous. The chief cross-vein lies opposite the end of the first longitudinal; the distance between the two cross-veins is about twice the length of the posterior cross-vein; and the posterior cross-vein is distant from the margin of the wing about two and a half times its own length. Length, 3 mm.; wing, $2\frac{1}{2}$ mm.

Hab. Queenstown (F. W. H.).

The mouth has a pair of small vibrissæ, and the vertex has a row of short bristles. Eyes with very short hairs. Third joint of the antennæ nearly round; the arista bare and bent down. The fore femora are rather thickened.

Family AGROMYZIDÆ.

"Front with strong bristles; border of the mouth with a vibrissa on each side. Middle tibiæ with a terminal spur; none of the tibiæ have an erect bristle on the outside before the tip. Wings without bristles on the costa; first longitudinal vein very short, and the auxiliary vein connected with it at the tip; basal cells present, but small; posterior cross-vein generally far distant from the border of the wing" (Loew).

Genus AGROMYZA, Fallen (1823).

Antennæ short, the first and second joints very small, the third round; arista bare. Wings moderately long; first longitudinal vein reaching to about one-third of the length of the wing.

Agromyza australensis.

Agr. australensis, Mik., Verh. z.-b. Wien, xxxi., p. 202, pl. xiii., fig. 15 (1881).

Greyish-brown; the abdomen, in some lights, luminous grey; middle and hind legs pale-tawny. (The fore legs missing.) Posterior cross-vein about twice its length from the chief cross-vein, and about one and a half times its length from the margin. Length, $1\frac{3}{4}$ mm.; wing. 2 mm.

Hab. Auckland Islands (Dr. Krone).

Agromyza fulvifrons, sp. nov.

Grey; the frontal band pale-tawny. Ocellar triangle darker; face white, with yellowish reflections; antennæ piceous; proboscis and palpi dark-brown, with light tips. Thorax with very indistinct dark lines. Femora and tibiæ black, dusted with grey; the tarsi tawny. Wings clear, the veins piceous. The cross-vein lies outside the end of the first longitudinal; the distance between the cross-veins is about one and a quarter times the length of the posterior cross-vein, and the distance of the latter from the margin of the wing is about one and a half times its length. Length, 3–4 mm.

Hab. Christchurch (F. W. H.); on the sea-beach.

Family BORBORIDÆ.

"Thorax, scutellum, and abdomen flat; front bristly; face excavated, with a vibrissa on each side of the border of the mouth; clypeus developed. First joint of the posterior tarsi abbreviated. Neuration of the wing incomplete, only a commencement of the auxiliary vein being at most visible. The hindmost two basal cells are not complete in all the genera" (Loew).

Genus APTERINA, Macquart.

Wings absent or rudimentary.

I have seen no good description of this genus, consequently the following species is placed in it provisionally.

Apterina trilineata, sp. nov.

Wingless. Black, shining. Head ferruginous, with three longitudinal yellow-ochre bands on the front. Eyes reddish-brown. Tarsi and knees of the middle and hind legs fulvous. Length, 2 mm.

Hab. Howick, near Auckland (Captain Broun).

The head is as broad as the thorax, the eyes very wide apart; mouth large; antennæ short, the third joint oval, pointed at the end, not much longer than the second; arista bare. A long bristle on each side of the mouth and a pair of bristles on the vertex, but no fronto-orbital bristles. Thorax rounded. Abdomen naked. Legs stout, all the tibiæ widening gradually towards their distal ends, bristly, a strong bristle near the end, and several on the middle tibiæ. Tarsi hairy, the first joint of the posterior pair short, not much longer than broad, shorter than the second joint. Ungues rather large. Wings and halteres absent.

Captain Broun informs me that this little fly is found on the ground, and is capable of jumping.

Genus Borborus, Meigen (1803).

Wings fully developed; the fourth longitudinal developed, but the fifth incomplete beyond the discal cell.

Borborus empiricus, sp. nov.

Uniform dark-brown; legs black. Wings tinged with brown, the veins dark-brown, the second section of the fourth longitudinal only faintly developed; distance between the two cross-veins about two and a half times the length of the posterior cross-vein; fifth longitudinal convex posteriorly, so that the discal cell is broader in the middle than at either end. Scutellum with bristles. Fore femora not thickened; middle tibiæ with stout bristles; hind tibiæ without spurs. Length, 2 mm.

Hab. Christchurch (F. W. H.).

The first longitudinal vein reaches to about one-third the length of the wing; the second to about two-thirds; while the third ends a little before the tip. The costa stops at the end of the third longitudinal. The third section of the costal vein is nearly as long as the second. The hind metatarsi are but slightly dilated, and about three-quarters of the length of the second joint. The hind tibiæ are nearly bare. The fore tibiæ have some slight bristles, not so stout as those on the middle tibiæ.

The following species have been omitted as not inhabiting New Zealand:—

Pelecorhynchus ornatus, *Schiner* = P. personatus, *Walker* from Queensland.

Comptosia bicolor, *Macquart;* East Australia (Macquart), Auckland (Reise der "Novara").

Comptosia fasciata, *Fabricius;* Polynesia (Fabr.), Auckland (Reise der "Novara").

Lampria æneа, *Fabr.;* Solomon Islands and New Ireland (Macquart), New Zealand (Nowicki).

Midas macquarti, *Schiner;* East Australia (Macquart), Auckland (Reise der "Novara").

Promachus floccosus, *Kirby,* Trans. Ent. Soc. London, 1884, p. 273.

Syritta oceanica, *Macquart;* Tahiti and New Zealand (Bigot).

Hystricia orientalis, *Schiner;* Auckland (Reise der "Novara").

Demoticus australiensis, *Schiner;* Auckland (Reise der "Novara").

Micropalpus brevigaster, *Macquart;* Tasmania (Bigot), Auckland (Reise der "Novara").

Chlorogaster ruficeps, *Schiner;* Auckland (Reise der "Novara").

Rutilia leucostica, *Schiner;* Auckland (Reise der "Novara").

Rutilia pelluceus, *Macquart;* Australia (Macquart), Auckland (Reise der "Novara").

Bothrophora zelebori, *Schiner;* Auckland (Reise der "Novara").

Microtropesa sinuata, *Donovan;* Tasmania (Macquart), Auckland (Reise der "Novara").

Amenia leonina, *Fabricius;* Australia, New Zealand (Reise der "Novara").

Amenia parva, *Schiner;* New Zealand(?) (Reise der "Novara").

Dexia rubricarinata, *Macquart;* Tasmania (Macquart), Auckland (Reise der "Novara").

Idia murina, *Schiner;* Auckland (Reise der "Novara").

Calliphora violacea, *Macquart;* Africa (Macquart), New Zealand (Nowicki).

Lamprogaster strigipennis, *Macquart;* Australia (Macquart), Auckland (Reise der "Novara").

Lamprogaster cærulea, *Macquart;* Sydney (Macquart), Auckland (Reise der "Novara").

Art. II.—*Note on* Chrysophanus feredayi.

By Captain F. W. Hutton.

[*Read before the Philosophical Institute of Canterbury, 4th July, 1900.*]

There seems to be some doubt in the minds of entomologists as to what is the insect described as *Chrysophanus feredayi* by Mr. H. W. Bates. Mr. G. V. Hudson, in his "New Zealand Moths and Butterflies," says that it appears to be a variety of *C. salustius* (pp. 116, 117), and he includes *C. rauparaha*, of Fereday, as a variety also.

As the collection of the late Mr. Fereday has come into the possession of the Canterbury Museum, I am in a position to clear up this ambiguity, for the collection contains the type of *C. rauparaha* and a cotype of *C. feredayi.*

The following is the original description of *C. feredayi*, by Mr. Bates:—

"*C. ednæ*, Doubled., simillimus; differt palpis antice griseoalbo et nigro hirsutis, alis posticis subtus brunneo nebulosis, ♂ ♀."

"Similar in size, form, and colours to *C. edna*, but differs from all the varieties of that species in the palpi in front being clothed with whitish hairs mixed with black instead of yellow hairs. The black marks of the upper surface are also larger and more confluent, and the under-surface of the hind wings is yellow, with a broad curved discal patch and a wide posterior border (confluent at the apex) violet-brown. The wings above are violet-black, with the discal area and a macular belt of six quadrate spots on both wings shining-fulvous, the discal area in the fore wing being divided by three spots and the black nervures, and on the hind wing by one spot. There is a submarginal row, also of three fulvous spots, near the anal angle of the hind wing, and the basal fourth of both wings is clothed with tawny-brown hairs. Both sexes are alike in colours and markings."

This description agrees accurately with the cotype in the collection. It also agrees with the description and figures of *C. enysi* by Mr. A. G. Butler, and no doubt the two are identical.

The species described and figured by Mr. Butler as *C. feredayi* is a different species, and is identical with the *C. rauparaha* of Mr. Fereday. Mr. Hudson thinks that this is only a variety of *C. salustius*, but it can be distinguished from that species not only by the fuscous shade of the lower surface of the hind wings, but by the palpi, which are white, with long black hairs as well as a few white ones, in this respect resembling *C. feredayi*. But from *C. feredayi* it differs in the colour of the lower surface of the hind wings, and in the male and female being unlike, as in *C. salustius*.

The following is the synonymy as well as references:—

Chrysophanus feredayi.

C. feredayi, Bates, Ent. Mo. Mag., vol. iv., page 53, Aug., 1867.

C. feredayi, Fereday, Trans. N. Z. Inst., vol. x., p. 255, pl. 8, figs. D and 3 (1878).

C. enysi, Butler, Ent. Mo. Mag., vol. xiii., p. 153, Dec., 1876; Trans. N.Z. Inst., vol. x., p. 274, pl. 12, figs. 4 to 6 (1878); Cat. Butterflies of N.Z., p. 16, pl. 3, figs. 10 to 12, Christchurch, N.Z. (1880).*

C. enysi, Hudson, "New Zealand Moths and Butterflies," p. 117, pl. 12, figs. 22 to 24 (1898).

Chrysophanus rauparaha.

C. feredayi, Butler, Trans. N.Z. Inst., vol. x., p. 275, pl. 12, figs. 7 to 9; Cat. Butterflies of N.Z., p. 17, pl. 3, figs. 7 to 9 (1880), (not of Bates).

C. rauparaha, Fereday, Trans. N.Z. Inst., vol. x., p. 255, pl. 8, figs. E and 4 (1878).

C. salustius, Hudson, "New Zealand Moths and Butterflies," pl. 12, fig. 21.

ART. III.—*Note on the Distribution of some Australasian* Collembola.

By ARTHUR DENDY, D.Sc., Professor of Biology in the Canterbury College, University of New Zealand.

[*Read before the Philosophical Institute of Canterbury, 7th November, 1900.*]

SOME years ago I sent specimens of some large *Collembola*, collected in Tasmania and New Zealand, to Sir John Lubbock (Lord Avebury), who kindly examined them and published descriptions of them in the "Proceedings of the Linnæan Society of London" (Zoology, vol. 27, p. 334). Unfortunately, a slight error seems to have crept in with regard to the

* In both the last descriptions there is a misprint. On page 274, line 4 from the bottom, the word "female" should be omitted.

locality from which one of the species was obtained, and it is with a view to rectifying this error, and at the same time extending our knowledge of the distribution and calling the attention of New Zealand zoologists to the subject, that the present note is written.

Lord Avebury distinguished three species in the collection, which he named *Anoura tasmaniæ*, *Anoura dendyi*, and *Anoura spinosa*. Each of these is said to come from Tasmania in the specific diagnosis, but the introductory paragraph mentions New Zealand and Tasmania. I believe the first two are really Tasmanian and the last New Zealand.

Anoura spinosa, indeed, which may be readily recognised from the description and figures, appears to be very widely distributed in New Zealand, but I have no recollection of seeing it in Tasmania. Last summer I obtained about a dozen specimens near Lake Te Anau and one at Milford Sound, and in July last Professor Wall obtained a specimen near Auckland. For the information of local collectors, I may mention that it is a small, soft-bodied, wingless insect, somewhat oval in shape, and about $\frac{1}{5}$ in. long, of a bluish-grey colour, with numerous short yellow spines on the back and a pair of short antennæ in front.* On the lower surface are three pairs of short legs, followed by a pair of fleshy-looking sucker-like organs. It lives in rotten wood, and, though widely distributed, is by no means abundant. It is of interest as an unusually large representative of a group of insects of an extremely primitive character, the study of which may throw much light upon the ancestral history of insects in general.

For further information on this group the reader is referred to Sir John Lubbock's well-known monograph on the *Collembola* and *Thysanura*, published by the Ray Society. The investigation of these animals in New Zealand can hardly fail to yield valuable results.

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* In all the specimens which I now have in my possession the spines on the antennæ are obsolete, though indications of them may sometimes be seen.

Art. IV.—*On a New Zealand Fresh-water Leech* (Glossiphonia (Clepsine) novæ-zealandiæ, *n. sp.*).

By Arthur Dendy, D.Sc., Professor of Biology in the Canterbury College; and Margaret F. Olliver, M.A., Senior Scholar in Zoology, New Zealand University.

[*Read before the Philosophical Institute of Canterbury, 4th July, 1900.*]

Introductory Remarks.

The specimens upon which this communication is founded were collected by Mr. Henry Suter, who discovered them living attached to the underside of stones near the margin of Lake Takapuna, in the North Island of New Zealand, in company with fresh-water Mollusca and sponges. Exceptional interest attaches to this discovery because it is generally supposed that leeches are absent from the land and fresh-water fauna of New Zealand. Thus in Parker and Haswell's "Text-book of Zoology" (vol. 1, p. 481) we find the statement, "Hitherto no member of the class has been found in New Zealand, with the exception of the marine *Branchellion.*"

It should be pointed out, however, that a land-leech (*Geobdella limbata*) has been recorded from New Zealand. The only literature upon this species which we have been able to obtain is Moore's paper on the leeches of the United States National Museum,* in which two specimens collected by the United States Exploring Expedition are stated to have come from New Zealand. It seems highly improbable that so aggressive an animal as a land-leech should remain unknown to the numerous local collectors who have explored the New Zealand bush, and we prefer to believe that some mistake has been made in the labelling of the two specimens in the United States National Museum.

Owing to the extremely small size of our species, the irregularity of the annulation in front, and the absence of any papillæ or colour-markings on the integument, we have found it impossible to determine the segmental arrangement of the various organs with that exactness which has of late years been customary with the describers of leeches.†

Our observations have been made upon both living and preserved specimens, and the internal anatomy has been investigated by means of transverse and longitudinal vertical serial sections, as well as by dissection and the examination of

* "Proceedings of the United States National Museum," vol. xxi., p. 563.

† Compare Whitman, "The Segmental Sense-organs of the Leech," *American Naturalist*, October, 1884; and "Description of *Clepsine plana*," *Journal of Morphology*, vol. iv., No. 3, 1891.

entire specimens stained and cleared. From the point of view of the comparative anatomist the results obtained are hardly sufficient to compensate for the large expenditure of time and trouble, as in most respects the anatomy seems to agree very closely with that previously known for other species of the genus. The structure and arrangement of the nephridia, however, appear to be very peculiar, though we have not succeeded in working them out in detail, and the presence of only two annuli in the typical somite appears to distinguish our species not only from others of the same genus, but from all other *Rhynchobdellidæ*.*

External Characters.

In contracted specimens the body is ovoid; emarginate and somewhat broader behind; strongly convex above and concave beneath, so that there is a large hollow space below the body which serves as a brood-pouch; with no distinct head. The length of a spirit-preserved specimen was 6 mm., and the width 4 mm., with posterior sucker 1·5 mm. in diameter. Another specimen, when extended in life, measured as much as 18 mm. in length. The animal in life is of a very pale dull orange or flesh-colour, semitransparent, with no papillæ nor colour-markings except microscopic pigment-cells. In spirit the colour is almost white, opaque.

The posterior sucker (disc) is flat, and usually nearly circular in outline; in contracted specimens scarcely visible from above. The much smaller anterior sucker appears to be made up of from five to eight annuli† (it is impossible to determine the exact number), and its anterior margin, forming the extreme anterior end of the body, bears a slight median notch.

On the dorsal surface of the body about fifty-five annuli may commonly be counted, but the annulation is not sufficiently distinct and regular to make an exact count practicable. In the middle region of the body it is evident, from the arrangement of the nephridial apertures and various internal organs, that each somite is composed of two annuli.

The eyes are four in number, placed two on each side of the middle line, those of the same side very close together, sometimes touching one another, so as to appear as one in contracted specimens, but separated from those of the opposite side by a fairly wide interval. Their position is about on a level with the hinder margin of the anterior sucker. Those of one side may be distinctly in advance of those of the other side, and the position as regards the annuli of the head seems

* See Postscript, however.

† In counting the annuli we assume throughout this paper that the head (anterior sucker) is made up of eight.

to be slightly variable, owing probably to the irregularity of the annulation. In a young specimen no eyes were visible at all. The form of the eye, when viewed from above, is crescentic, and on each side the two eyes lie back to back, with the concavities of the pigment-cups facing away from one another, one looking forwards and the other backwards.

The mouth is placed well in front of and above the middle of the anterior sucker, only a short way behind the marginal median notch.

The anus lies dorsally a short way in front of the posterior sucker; it may be separated from the sucker by two annuli.

The male genital opening lies in what we count as the thirteenth annulus behind the anterior sucker, so that if we assume that the anterior sucker is composed of eight annuli the male aperture may be located in annulus 21. The aperture itself has tumid lips, and the annulus in its neighbourhood is much swollen. Probably this annulus is composed of two fused together, between which the aperture lies,* but we have thought it desirable not to attempt a theoretical analysis. Some three or four of the annuli behind and in the neighbourhood of the male aperture may exhibit a well-marked longitudinal wrinkling.

The actual female aperture was unrecognisable in our specimens, but sections show that it must lie close behind the male aperture, apparently in the groove between the 21st and 22nd annuli. Nephridial apertures could not be recognised externally, but longitudinal sections showed seven pairs, lying on annuli 31, 33, 35, 37, 39, 41, 43.

Some specimens carried a number of eggs attached to the ventral surface of the body in the brood-chamber before mentioned. These eggs are ovoid in shape, and about 0·5 mm. in longer diameter.

Internal Anatomy.

The general anatomy agrees very closely with that of other species, as described, for example, by Oka in his "Beiträge zur Anatomie der Clepsine."†

Alimentary Canal.—The mouth appears as a narrow transverse slit in the cup-like anterior sucker. It leads into a narrow tubular buccal cavity, through which the long muscular proboscis can be protruded. When the proboscis is retracted the buccal cavity extends back to about the 11th annulus. The proboscis, or pharynx, is long and cylindrical, and in a state of retraction extends from about the 11th to about the 25th annulus, lying in the middle of the body. From the posterior end of the pharynx the narrow œsophagus runs for-

* Compare *Clepsine plana*, Whitman, *loc. cit.*

† "Zeitschrift für wissenschaftliche Zoologie," band 58, 1894.

wards dorsally (when the pharynx is retracted) to about the 22nd annulus, and then turns backwards to open into the large thin-walled crop. The crop gives off six pairs of lateral diverticula, increasing in size from in front backwards, the 1st pair being very small and lying at the sides of the pharynx, while the 6th pair are large, sacculated on the outer sides, and turn backwards so as to run almost longitudinally to the level of the posterior sucker. The lateral diverticula of the crop spring from the median portion opposite to annuli 25, 27, 29, 31, 33, and 35. Following the crop there comes a curious sacculated portion of the alimentary canal, which we propose to consider as the stomach, and which consists of a median portion giving off four pairs of crowded lateral diverticula opposite to annuli 36, 37, 38, and 39. Then follows the intestine, the front half of which is greatly dilated to form a pear-shaped sac, tapering off behind into a narrow portion, which opens posteriorly at the anus.

Nervous System.—The cerebral ganglia lie above the alimentary canal about opposite to the 13th annulus. The nerve-collar runs round the anterior portion of the pharynx and connects the cerebral with the subœsophageal ganglia. The subœsophageal ganglia and the three succeeding pairs of the ventral chain lie in front of the male genital aperture. The 5th pair (counting the subœsophageal as the first of the chain) lies immediately behind the male aperture, opposite the 21st annulus. The 6th to the 17th pair inclusive lie in alternate annuli from the 23rd to the 45th. The remaining ganglia, about six in number, are fused together, and extend from about the 47th annulus into the posterior sucker.

Circulatory Organs.—The arrangement of the vessels and sinuses in the genus *Clepsine* has been very fully worked out by Oka,* and we have not thought it worth while to investigate it in detail in the species under discussion.

Nephridia.—The nephridia seem to exhibit great peculiarities, and we regret that owing to the difficulties of the investigation we are unable to give a complete account of them. We have found in sections seven funnels, with corresponding capsules, on each side; these lie opposite to annuli 23, 25, 27, 29, 31, 33, and 35, and seem to agree closely with the corresponding structures as figured by Oka.* We have also found seven pairs of external openings in the integument, but these are placed on annuli 31, 33, 35, 37, 39, 41, and 43. We do not doubt that these are the nephridial apertures, but we have been unable to trace any connection between them and the internal funnels, and it seems strange that they should be so widely separated from the latter.

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* *Loc. cit.*

Each external aperture appears to be eight annuli or four somites behind the corresponding internal funnel. Of course, it is quite possible that some mistake has been made here, but the coincidence of the numbers on both sides of the animal (investigated by longitudinal sections) is very remarkable. It may be that the external apertures have been overlooked in the anterior four pairs of nephridia and the internal portions in the posterior four pairs, and perhaps this is the most likely explanation. If it be so, then we have indications of eleven pairs of nephridia.

Reproductive Organs.—There are normally six pairs of testes, opposite annuli 24, 26, 28, 30, 32, and 34, but they are not always regular, and may even differ in arrangement on the two sides of the same animal. The testes lie between and below the diverticula of the crop, and are vertically compressed from in front backwards, so that in the adult animal they form flattened plates. The vasa deferentia in the adult animal are very long and coiled. Each commences in front of the testes amongst the copious glands at the sides of the pharynx, and, passing backwards, coils about, finally turning forwards and inwards to meet its fellow of the opposite side at the male genital aperture, each duct ending in a conspicuous round swelling.

The ovaries are contained in two elongated sacs which pass gradually into the oviducts, the latter uniting together in the middle line just behind the point of union of the vasa deferentia. In the young animal the two ovaries and their ducts lie tranversely across the body in the same straight line. In older animals they turn backwards, extending about as far as the fifth division of the crop and then turning aside.

[*Postscript.*—A copy of this paper, with illustrations, was sent to the Melbourne meeting of the Australasian Association for the Advancement of Science in January, 1900, but want of funds has prevented its publication. Meanwhile a paper has appeared, by J. P. Moore,* describing a biannulate Glossiphonid from North Carolina, for which he proposes the new genus *Microbdella*. *Microbdella biannulata*, Moore, very closely resembles our species, and its discovery in America adds greatly to the interest attaching to the New Zealand form, which is, however, evidently specifically distinct. It appears† that Oka, in 1895, had already described a biannulate leech, but this was an Ichthyobdellid belonging to the genus *Ozobranchus*.]

* "A Description of *Microbdella biannulata*, with Especial Regard to the Constitution of the Leech Somite" ("Proceedings of the Academy of Natural Sciences of Philadelphia," 1900).

† Compare Moore, "Note on Oka's Biannulate Leech" ("Zoologischer Anzeiger," 3rd September, 1900).

Art. V.—*On a Collection of* Hymenoptera *made in the Neighbourhood of Wellington by Mr. G. V. Hudson, with Descriptions of New Genera and Species.*

By P. Cameron, of Stockport, Cheshire.

Communicated by Captain F. W. Hutton.

[*Read before the Philosophical Institute of Canterbury, 4th July, 1900.*]

Mr. Hudson, of Wellington, has been good enough to submit for my examination a small collection of *Hymenoptera*, which contains some new and interesting species. As so little is known regarding the distribution of the New Zealand *Hymenoptera*, I have enumerated all the species.

EVANIIDÆ.

Gasteruption pedunculatum, Sm. (see Schletterer).

BRACONIDÆ.

Fhogra, gen. nov.

Wings with two cubital cellules; the transverse cubital nervure and the cubitus near it obliterated, so that the first cubital cellule is not separated from the second and from the discoidal. Radial cellule wide, reaching to the apex of the wing; the transverse median nervure is almost interstitial. In the hind wings the radius and cubitus are continued to the end of the wing; the præbrachial nervure is interstitial; the probrachial is widely separated from it. Antennæ filiform. Thorax distinctly trilobate; all the lobes raised and clearly separated. Scutellum roundly convex. Median segment not quite so long as the mesothorax, slightly depressed at the base, and slightly curved upwards; closely rugose. Abdomen with a short projecting ovipositor; the petiole is not quite so long as the second segment; the base behind the tubercles is distinctly narrowed; from there it becomes gradually, but not much, thickened towards the apex; the basal half is distinctly grooved on the lower side. Legs slender.

Allied to *Meteorus*, from which it differs in having only one transverse cubital nervure, and in the cubital cellules being confluent, through the obliteration of the nervures, with the discoidal at the recurrent nervure. We find an obliteration of the nervures and a consequent fusion of the cellules in *Perilitus*, &c.; but in these it is the base of the cubitus which is obliterated, so that the first cubital cellule becomes united with the prædiscoidal, while in the present genus these are separated, the cubitus being distinct at the base.

The radial areolet in the hind wings is not geminated by a transverse nervure.

Fhogra rubromaculata, sp. nov.

Nigra, prothorace mesonotoque brunneis; pedibus testaceis, femoribus posticis fuscis; alis hyalinis, stigmate fusco, basi pallido. ♀.

Long., 3·5 mm.; terebra, 1 mm.

Antennæ black. Head smooth, shining, impunctate. Thorax black; the prothorax entirely rufous; the middle lobe of the mesonotum, the sides of the lateral lobes broadly, and the greater part of the mesopleuræ dark-rufous. The three lobes of the mesonotum are clearly separated; the furrows bordering the middle lobe are obscurely striated; a narrow but distinct knee separates the lateral lobes. Metanotum closely and finely rugosely punctured, opaque, and sparsely covered with longish pale hairs. Legs testaceous, brighter at the base; the hinder femora and tibiæ infuscated. Wings hyaline, the nervures fuscous, the stigma pale at the base; the second transverse cubital nervure is fainter than the first; the first is faint below, and the cubitus is faint where it is received. Petiole closely rugosely punctured, dilated at the sides near the base; the tracheal grooves are distinct; the other segments are smooth. The antennæ are 31-jointed. There is no transverse nervure in the hind wings. The basal half of the second abdominal segment is depressed at the sides, and bears there two or three striæ.

OPHIONIDES.

Paniscus ephippiatus, Smith.

Limneria hudsoni, sp. nov.

Nigra, pedibus abdomineque rufis; alis hyalinis, nervis nigris; tegulis flavis. ♀.

Long., 10 mm.; terebra, fere 4 mm.

A larger species that *L. zealandica*, Cam., which may be known from it by the hinder coxæ being black and the trochanters yellow.

Antennæ black, the scape covered with white pubescence; below rufous. The clypeus and inner orbits densely covered with white pubescence; the face shagreened, as are also the front and vertex; mandibles and palpi rufous; the mandibular teeth black, their base thickly covered with white pubescence. The eyes have a green tinge. Thorax entirely black, shagreened, the median segment more strongly than the rest; the paraptidal furrows are distinct at the base. At the base of the post-scutellum are two large foveæ. Near the base of the median segment is a transverse keel, which is roundly curved backwards in the middle; near the apex is, on either side, another keel; and on the apex in the middle are two short oblique ones. The apical furrow on the mesopleura is stoutly crenulated; the central furrow on the mesosternum is smooth. Wings hyaline, with a slight fulvous tinge; the nervures and stigma black, the latter fuscous on lower side; areolet oblique, almost appendiculated; the second transverse cubital nervure longer than the first; the recurrent nervure is almost united to it. Legs entirely ferruginous; the hinder tibiæ darker, almost fuscous in colour. Abdomen ferruginous; the narrowed basal part of the petiole black; the basal ventral segments (beyond the petiole) yellow, the apical black.

Lissonota rubriplagiata, sp. nov.

Rufa, capite thoraceque flavo-maculatis; metanoto petioloque late nigris; alis hyalinis, stigmate fusco, nervis nigris. ♀.

Long., fere 9 mm.; terebra, 7 mm.

Antennæ black, almost glabrous. Head rufous; the eye-orbits all round, more broadly on the inner than on the outer side and below extending to the mandibles, the clypeus, except at the apex, and the base of the mandibles broadly lemon-yellow; the occiput, the ocellar region, and the front, except at the orbits and near the ocelli, black. Vertex minutely and closely punctured; the front closely transversely striated; on its upper half is a shallow longitudinal furrow. There is a black patch above the sides of the clypeus; the mandibles are broadly yellow, the teeth black, the part behind them rufous; palpi black. Thorax rufous; the middle of the mesonotum between the yellow lines, the sides of the scutellum, the part bordering the post-scutellum, a broad mark on the metanotum roundly narrowed towards the apex and not reaching to the edge of the slope, the middle of the propleuræ, an oblique mark on the base of the mesopleuræ between tubercles, and the lower yellow mark and the oblique slope of the base of the mesosternum, black. On the mesonotum are two yellow lines, dilated outwardly at the base and extending shortly beyond the middle. A mark on the base of the scutellum triangularly incised in the middle, the post-scutellum, the lower third of the propleuræ, a mark on the top in front of the tegulæ, a triangular mark under the hind wings, a mark narrowed at the apex on the lower side of the mesopleuræ at the base, and a large oblique mark of equal width throughout, and extending from the base to the apex on the metapleuræ, lemon-yellow. Legs rufous; the middle coxæ entirely and a large mark on the hinder pair narrowed at the apex lemon-yellow. Wings clear, hyaline, the nervures black, the stigma fuscous. Abdomen rufous, the basal two-thirds of the petiole and the other segments at the sides broadly black. The anterior coxæ are black above, yellow below. The middle coxæ are yellow, except for a rufous mark, narrowed towards the apex, on the basal two-thirds; the middle trochanters are black, yellow in the middle below; the hinder are entirely black; palpi dark-rufous.

Comes nearest to *L. flavo-picta*, Smith, which has the ovipositor longer than the body, the metanotum without a large black mark, all the coxæ yellow above, the scutellum entirely yellow, &c.

DUSONA, gen. nov.

Areolet present, minute; the transverse cubital nervures united at the top. Metathoracic spiracles elongate, about three times longer than broad. Spiracles on petiole placed at the base of the apical third, at the base of the post-petiole. Claws simple. Clypeus not separated from the face by a suture. Mandibles at the apex, with two teeth of equal size. Transverse basal nervure interstitial.

The eyes are distinctly sinuate above the middle on the inner side, and do not quite reach to the base of the mandibles. The mandibles are large, and have on the lower edge a distinct projecting keel on the outer side. The legs are of normal size; the base of the anterior tarsi incised; the tarsi spinose. Scutellum roundly convex, not keeled laterally at the base. The depression at the base of the post-scutellum is distinctly keeled laterally. There are no keels on the median segment, which is obliquely narrowed at the base. Legs normal, the claws simple. Radial cellule wide; the basal and apical obscissæ of the radius distinctly oblique and curved. Areolet small; the recurrent nervure is received in the middle. Petiole long, the post-petiole not much dilated; the apical segments widened; the ovipositor largely projects. There is a short longitudinal furrow on the mesopleuræ; above it, at its apex, is a wider oblique one.

The oval metathoracic spiracles ally this genus to *Campoplex* and *Anomalon*. The former may be readily known from it by the pectinated claws, the latter by the want of an areolet in the wings. *Limneria*, the only New Zealand genus with which it could be confounded, has round, not oval or elongated, metathoracic spiracles. The abdomen is twice longer than the head and thorax united.

Dusona stramineipes, sp. nov.

Nigra; mandibularum basi, palpis, femoribus, tibiis, tarsisque anterioribus, basique tibiarum posticarum late, flavis; alis hyalinis, nervis stigmateque nigris. ♀.

Long., 10–11 mm.

Head alutaceous, the face and clypeus minutely punctured, thickly covered with white pubescence. Mandibles, except the teeth, and the palpi yellow. The inner eye-orbits distinctly margined. Clypeal foveæ deep; there is an indistinct one in the middle. Mesonotum minutely and closely punctured; its middle slightly raised at the base. Median segment depressed slightly in the middle, closely transversely striated; the centre with a narrow longitudinal furrow. Pleuræ minutely closely punctured; the propleuræ towards the apex closely striated; the apical furrow deep, crenulated. The four anterior legs are lemon-yellow; the tarsi infuscated, lighter coloured at the base; the hinder legs black, except for a broad lemon-yellow band at the base, extending beyond the middle, but not to the extreme base; the posterior calcaria pallid-testaceous. Abdomen smooth and shining; the apical segments are thickly covered with pale pubescence.

TRYPHONIDES.

Mr. Hudson sends a *Bassus*, which is perhaps different from *B. generosus*, Cam. I have a suspicion, however, that *Scolobates varipes*, Smith,* may be really a *Bassus*. It certainly agrees very closely with *generosus* so far as can be made out from the description given by Mr. Smith, who, furthermore, places it in the *Tryphonides*, while *Scolobates* belongs to the *Ophionides*. *Scolobates intrudens*, Sm.,† is certainly not a *Scolobates*. It may be a *Meteorus*.

The investigation of the New Zealand *Hymenoptera* would be greatly facilitated by a critical examination of the species in the British Museum. At present one is not always sure that they have been correctly referred to the genera as now limited by Hymenopterists.

CRYPTIDES.

Mesostenus albipectus, Sm. This pretty species is probably common.

ICHNEUMONIDES.

Amblyteles zealandicus, sp. nov.

Niger, apice scutelli flavo; abdominis medio rufo; pedibus pallide rufis; coxis trochanteribus apiceque tibiarum posticarum nigris; alis hyalinis, stigmate nervisque testaceis. ♂.

Long., 15 mm.

Antennæ stout, distinctly tapering towards the apex. Head entirely black, closely, almost rugosely, punctured; behind almost striated; the ocellar region less closely punc-

* Trans. Ent. Soc., 1878, p. 3.

† *Loc. cit.*

tured; the punctures on the clypeus are large and more widely separated than they are on the face. Mandibles rufous before the middle; palpi testaceous, black at the base. Mesonotum closely but not very strongly punctured; the middle of the scutellum is broadly yellow, its apex minutely striated. Median segment coarsely, closely, rugosely punctured; the posterior median area almost square; the apex without central keels. Pleuræ closely and distinctly punctured. Sternum less strongly punctured than the pleuræ. Legs pale-ferruginous; the coxæ and trochanters black; the apex of the hinder femora slightly, of the hinder tibiæ more widely, blackish; the hinder tarsi slightly fuscous. The areolet at the top is as wide as the space bounded by the recurrent and the second transverse cubital nervures; the recurrent is received shortly beyond the middle. Abdomen black; the extreme apex of the petiole and the second and third segments ferruginous; gastracœli deep, smooth.

Amblyteles hudsoni, sp. nov.

Ferrugineo; capite thoraceque nigro flavoque maculatis; coxis femoribusque anterioribus flavis, posticis nigro-maculatis; alis hyalinis, stigmate nervisque fuscis. ♂.

Long., 8 mm.

Antennæ fuscous, paler beneath; the scape yellowish-testaceous, marked with black above. Head rufous; the inner and lower outer orbits, the face, and clypeus yellow; the ocellar region and the front broadly in the middle black; the vertex closely punctured; the depressed front closely transversely striated. Mandibles yellow, the teeth black. Palpi dark-yellow. Thorax, the edge of the pronotum, the tegulæ, tubercles, the lower half of the pleuræ, and the sternum lemon-yellow; the lower part of the propleuræ and of the metapleuræ, the mesopleuræ under the wings, the base and the lower part of the metapleuræ broadly, and the part at the sides of the scutellums black. Mesonotum closely and distinctly punctured. Scutellum sparsely punctured, and with a yellowish tint. Post-scutellum smooth. Median segment shagreened; the depressed base black; supramedian area distant from the base, large, twice longer than broad, rounded at the top. Petiole smooth, shining, slightly tinted with yellow. The four anterior coxæ and trochanters yellow; the hinder coxæ broadly marked with black. Gastracœli shallow, depressed at the apex.

This species may form the type of a new genus; but, in the absence of a female, I have not ventured to name it. Underneath I give its generic characters.

Areolet large, broad, five-angled. Abdomen with seven dorsal segments, the apical one bluntly rounded; ventral keel only extending to the middle of the third segment. Median segment areolated completely; spiracles small, oval. Petiole slender, not much dilated at the apex. Scutellum large, not much raised; keeled at the base only; the basal depression semicircular.

The apex of the clypeus is bluntly rounded; the foveæ large. Mandibles with unequal teeth; the tarsi without, or almost without, spines, of normal length and thickness; claws short, simple. Radial cellule wide; the apical obscissa of the radius straight; transverse median nervure received in front of the transverse basal; the furrows on the base of the mesonotum distinct, the sides of the post-scutellum deeply foveate at the base.

Colobacis, gen. nov.

Antennæ short and thick, tapering towards the apex; the joints of the flagellum short; the basal about twice longer than broad; the apical and middle broader than long. Occiput margined. The eyes surrounded by a distinct furrow. Clypeal foveæ large. Mandibles with a large upper and a smaller lower tooth; the upper tooth elongate, narrowed and rounded at the apex. Scutellum flat, large, its sides not margined. Post-scutellum depressed laterally at the base, the sides bordered with a keel. The areæ on the median segment all distinctly defined; the lateral tooth large. Spiracles elongate, linear. Areolet five-angled, narrowed above; the base of the cubital and the recurrent nervure with a short nervure; the transverse median nervure received distinctly beyond the basal. Abdomen with seven dorsal segments; the ventral keel extending to the apex of the fourth segment; the apical segments bluntly rounded, more broadly and bluntly than in *Amblyteles*. Post-petiole broadly dilated; its apex with three shallow depressions; the apical ventral segment largely triangularly incised. Ovipositor short.

The obtusely pointed abdomen places this genus in the *Amblypygi*. From *Amblyteles* it may be separated by the much wider post-petiole, by the broader-pointed more ovate abdomen; the antennæ are shorter and thicker; the basal obscissa of the cubitus is more sharply angled. The post-petiole is even broader than in the other section of the group (*Platylabrus* and *Eurylabrus*), from which it differs further in the shorter and thicker antennæ, with the joints shorter compared to their width.

Colobacis forticornis, sp. nov.

Niger, pedibus abdominis segmento secundo rufis; pedibus rufis; coxis, trochanteribusque posticis, nigris; alis fulvo-hyalinis, stigmate costâque fulvis, nervis nigris. ♀.

Long., 14 mm.

Antennæ brownish in the middle beneath; the scape punctured, covered with white hair. Head shining; the raised part of the face closely and strongly, the sides more sparsely, punctured; the clypeus with scattered punctures; both parts are rather thickly covered with brownish-fuscous hair. Mandibles black, broadly reddish in the middle. Palpi dark-testaceous; the basal joints blackish. Thorax black; pro- and meso-notum closely and distinctly punctured; the latter, especially at the base, thickly covered with brownish pubescence. Scutellum with scattered punctures above; the lower half of the sides closely and distinctly punctured. Post-scutellum more closely punctured and more thickly haired; its sides stoutly keeled. The basal areæ on the median segment striated strongly, at the apex irregularly punctured; the striæ on the middle area transverse, on the lateral more oblique; the supramedian area slightly broader than long, of equal width throughout; the posterior median area is closely transversely striated, the striæ running into irregular reticulations; the outer areæ are more coarsely reticulated. Propleuræ closely punctured, more sparsely at the apex than at the base. Mesopleuræ closely punctured, but not so closely as the propleuræ, and more strongly; the apex depressed; the depression with stout keels. Metapleuræ closely and rather strongly punctured; the middle with fine longitudinal striations. Sternum closely punctured. Legs red; the coxæ, trochanters, and the apex of the hinder femora black. Wings hyaline, with a slight fulvous tinge; the costa and stigma fulvous; the nervures darker. Abdomen shining, black; the second segment entirely rufous; the first petiole finely longitudinally striated; the second segment finely and closely punctured; gastracœli large, shallow, at the base indistinctly striated; the apical segments are thickly covered with black hairs.

DEGITHINA, gen. nov.

♀. Abdomen with eight dorsal segments, the ápex rather bluntly pointed. Antennæ longish, not distinctly involute; the joints of the flagellum twice longer than broad; the apical slightly compressed and dilated. Upper tooth of mandibles much larger than lower. Clypeus separated from the face. Head largely developed and obliquely narrowed behind the eyes; the occiput sharply margined. Labrum projecting. Scutellum large, flat or slightly prominent. Post-scutellum depressed laterally at the base. Median segment distinctly areolated; the apex with an oblique, straight slope, clearly separated at the top from the basal part; the supramedian area large, widely separated from the base of the segment, and reaching to the apex of the slope. Spiracles large, linear.

Ventral keel reaching to the fourth segment; the eighth ventral segment distinct. Areolet five-angled. In the male the ventral keel extends to the apex of the fourth segment; the apical segments bluntly pointed.

The areolet is narrowed at the top; the transverse basal nervure is interstitial; the gastracœli are indistinct; the post-petiole is obliquely raised from the base and apex. The longish antennæ, the obliquely sloped apex of median segment, which is not hollowed in the middle, and the abdomen with eight segments in the female, and with the apex rather bluntly pointed, as in *Amblyteles*, serve to distinguish this genus from *Ichneumon.*

Degithina buchanani, sp. nov.

Ferruginea; capite thoraceque nigro- et flavo-maculatis pedibus ferrugineis, coxis posticis supra late flavo-maculatis; alis hyalinis; nervis stigmateque nigris. ♀.

Long., 16 mm.

Antennæ black, brownish beneath towards the apex; the scape for the greater part rufous. Head rufous, the front and the lower part of the vertex black; yellow arc, an irregular spot, widened at the top and bottom, on the upper inner orbits, the lower outer orbits to the base of the mandibles, an oblique somewhat conical mark on the top behind the ocelli and touching the eyes, and a broad irregular mark on the sides above the clypeus, yellow. The front at the ocelli is irregularly punctured and striated, and with a shallow furrow, broad at the top; there is an elongated fovea above the lower ocellus. The raised central part of the face is punctured; striated laterally; the clypeus is sparsely punctured; mandibles rufous, yellowish beyond the middle. Thorax mahogany-colour, darker on the sides of the mesonotum, the base of the metanotum, and on the sternum. The following parts are yellow, tinged with orange: The edge of the pronotum, its base, a mark, longer than broad and rounded at the apex, on the middle of the mesonotum near the apex, the scutellum, post-scutellum, the greater part of the posterior median area of the metanotum, an irregular mark on the base of the mesopleuræ, rounded above and incised at the apex, a larger one at the apex lower down, and an oblique one slightly incised at the apex on the metapleuræ. The pleuræ smooth, shining; there are some stout, oblique keels under the fore wings; on the lower part of the mesopleuræ are some distinct, elongated, deep foveæ; the apical furrow is crenulated; the metapleuræ sparsely punctured in the middle. The base of the median segment is obliquely depressed in the middle; the posterior median area is longer than broad, slightly and gradually narrowed towards the apex and rounded at the base; the apex has an oblique slope, is sharply keeled above, but has no central keels. Legs lighter and brighter in tint than the thorax; the four front coxæ below and at the base above, and the hinder part broadly at the base above, yellow. Wings iridescent, hyaline, with a slight, but distinct, fulvous tint; the stigma and nervures black; the former fuscous below; the areolet is much narrowed above; the recurrent nervure is received in the middle. Abdomen deep mahogany-colour throughout, shining, smooth; gastracœli almost obsolete; the sheaths of the ovipositor dark-ferruginous.

Degithina caroli, sp. nov.

Nigra, capite thoraceque flavo-maculatis; abdomine rufo; pedibus rufis, coxis flavo-maculatis; trochanteribus posticis nigris; alis hyalinis; stigmate nervisque nigris. ♂.

Long., 18 mm.

Antennæ black, the scape yellow beneath. Head black; below the antennæ entirely, a line, dilated in the middle, on the inner orbits above, the lower half of the outer orbits, the mandibles, except the teeth, and the palpi, yellow. Front smooth, shining, impunctate, and with a shallow furrow down the middle; the ocellar region at the sides and in front marked with stout, curved keels. Face rather closely, the clypeus more sparsely, punctured. Thorax shining, smooth, black; two lines on the mesonotum leading into the yellow mark, and the two lateral apical areæ of the mesonotum, rufous; the edge of the pronotum broadly, a mark rounded at the base and gradually narrowed to the apex on the apex of the mesonotum in the middle, the scutellum, post-scutellum, the posterior median area of the metanotum, the tubercles, a large irregular mark on the base of the mesopleura, a smaller one, triangularly narrowed above, and a large mark following the curve of the keel on the metapleuræ, yellow. Mesonotum sparsely punctured. Scutellum roundly convex, sparsely punctured. Metanotum black; the posterior median area orange-yellow, twice longer than broad, of nearly equal width throughout; there are three apical areæ; the central is wide and of equal width throughout. There is a rufous line below the yellow one on the pronotum; the lower part of the propleuræ rufous, yellow at the base and apex; the lower part of the mesopleuræ and the greater part of the mesosternum and the apex of the metapleuræ rufous. Wings hyaline, with a fulvous tinge; the stigma and nervures black. Legs rufous; the four anterior coxæ and trochanters yellow; the hinder coxæ rufous, broadly yellow at the base above and at the apex below; the trochanters rufous, black at the base. Abdomen ferruginous, smooth, and shining; gastracœli shallow, smooth.

Degithina davidi, sp. nov.

Ferruginea; facie, scutello, post-scutello, metanoti basi, late, mesopleuris, petioloque, flavis; pedibus rufis; alis hyalinis, nervis stigmateque nigris. ♂.

Long., 13 mm.

Head rufous, below the antennæ yellow. Mandibles yellow, their teeth black; palpi rufo-testaceous. The depressed front smooth and shining, the sides and lower part of the ocellar region striated; the upper part of the front with a wide furrow. Face distinctly and closely punctured; the clypeus much more sparsely and indistinctly punctured. Thorax rufous; the lower half of the propleuræ, the upper part and apex of the mesopleuræ, the base and lower part of the metapleuræ more broadly, the space at the sides of the scutellums, the central apical area, and the sides at the apex of the metanotum, black; a spot on the base of the propleuræ, the greater part of the mesopleuræ, of the metapleuræ, the scutellum, post-scutellum, and the base of the metanotum to the top of the apical slope, yellow. Mesonotum and scutellum sparsely punctured; the basal half of the median segment has no areæ; on the apex are three, the central being slightly wider at the top than at the bottom; pleuræ smooth and shining. Legs uniformly rufous. The recurrent nervure is received shortly beyond the middle. Abdomen smooth and shining; gastracœli shallow, smooth.

Degithina hectori, sp. nov.

Capite thoraceque brunneis, flavo-maculatis, abdomine nigro, apice petioli rufo; pedibus rufis, coxis trochanteribusque nigris, coxis posticis flavo-maculatis. ♀.

Long., 13 mm.

Antennæ black, slightly brownish beneath towards the apex; the apex of the scape rufous beneath. On the dark mahogany-coloured head, the clypeus, lower part of the face, the front, the ocellar region, and the occiput are black; the sides of the face broadly, the upper orbits on the inner side broadly—the marks obliquely narrowed from the middle towards the base and apex—and a large mark near the centre of the outer orbits—rounded and slightly narrowed behind—yellow, mixed with chocolate. The face is distinctly, but not very closely, punctured, more closely and distinctly in the middle than at the sides; the clypeus is sparsely punctured; the projecting clypeus is smooth, except for a narrow band of minute punctures on the apex; it is rufous, and fringed with long fulvous hairs. The front and vertex have a few scattered punctures in the middle; the former is deeply furrowed down the middle. There is a deep furrow surrounding the front ocellus. On the dark-chocolate thorax the following parts are yellow, suffused with rufous: A broad band on the upper part of the pronotum, broader behind than before; a moderately large mark, longer than broad, triangularly narrowed behind, on the apex of the mesonotum in the middle; the scutellum, post-scutellum, the greater part of the posterior median area on the median segment; a large oblique mark, rounded at the apex, on the lower part of the mesopleuræ at the base; a slightly smaller one on the apex, placed lower down and obliquely, irregularly narrowed at the base; and an irregular one on the metapleuræ in the middle at the apex orange-yellow; the sides and base of the mesonotum, the sides near the scutellums, the keels on the median segments, the sides and edges of the pleuræ, and the centre and apex of the mesosternum. The areæ are distinct and complete; the posterior median is widely distant from the base, is longer than broad, rounded at the base, and slightly narrowed towards the apex. The greater part of the coxæ and trochanters are black; the posterior coxæ are broadly rufous at the base above and behind, and with a large yellow mark on the base above. Wings hyaline, iridescent; the costa, stigma, and nervures black; the wings have at the base a fulvous tinge. Abdomen black, smooth, and shining; the petiole rufous, black at the base and more narrowly at the apex; gastracœli shallow, smooth.

Ichneumon pyrastis, sp. nov.

Ferrugineo, capite thoracéque flavo-maculatis, mesonoto nigro lineato; alis fulvo-hyalinis, nervis nigris, stigmate fusco. ♂.

Long., 11 mm.

Antennæ as long as the body, the scape yellow, the flagellum brownish beneath, distinctly tapering towards the apex. Head black; the inner orbits, broad above, narrower below, the outer orbits in the middle, the sides of the clypeus broadly and the apex narrowly yellow; the face and clypeus and the head behind—outside the yellow line—rufous. The vertex in front of the ocelli shagreened; the front very smooth and shining, and with a wide shallow furrow in the middle. Face closely punctured, the clypeus with the punctures larger and more widely separated, the apex smooth. Mandibles yellow, the teeth black, and with a rufous band behind them. Palpi testaceous, tinged with yellow. Thorax rufous; the edge of the pronotum, the scutellum, except for a triangular mark on either side at the base, the post-scutellum, and tubercles, yellow; a broad line down the middle of the mesonotum, its sides more narrowly, the scutellar depression, the part between the wings and the scutellums, the propleuræ broadly at the base, the upper part of the mesopleuræ, and the base and apex more narrowly, and the metapleuræ, except for a broad rufous band—narrowest at the base—in the middle, black. Mesonotum closely punctured; the apical half of the scutellum closely punctured. The median segment obscurely punctured and shagreened; the middle at the apex finely transversely and irregularly striated; the supramedian area is elongated, reaches to the middle of the segment, and is narrowed slightly on the basal half; the base is rounded, and reaches to the top of the basal slope. Mesopleuræ closely punctured; the metapleuræ smooth, except for some minute striæ in the middle. Legs rufous; the four anterior coxæ broadly yellow on the outer side at the base. The areolet is moderately large, five-angled, narrowed at the top, being there half the length of the space bounded by the second transverse cubital and the recurrent nervure, which is received shortly beyond the middle. Abdomen shining, impunctate; the apex rather bluntly pointed; gastracœli shallow, smooth; the ventral keel obsolete.

Resembles *I. richardi;* may be easily separated from it by the longer and narrower supramedian area, by the apex of the yellow lines on the mesonotum, and of yellow on the mesopleura, and by the apex of the abdomen being black.

Ichneumon frederici, sp. nov.

Ferrugineo, maculis thoracis abdominisque apice nigris; scutello, post-scutello basique coxarum posticarum flavis; alis hyalinis, nervis stigmateque testaceis. ♀.

Long., 9–10 mm.

Antennæ stout, thickly covered with a white pile, dark-ferruginous, the apex of the flagellum darker. Head dark-ferruginous; the front black, the inner orbits above narrowly yellow; the vertex distinctly and closely punctured; the front smooth and shining; the face less strongly and closely punctured; the clypeus smooth. Mandibles ferruginous, the teeth black. Thorax ferruginous, the metanotum lighter in tint than the mesonotum; the scutellum, except narrowly at the base, and the post-scutellum bright lemon-yellow; the greater part of the pro- and meta-pleuræ and the upper part of the mesopleuræ black. Mesonotum closely and distinctly punctured; the scutellum flat, sparsely punctured; the parts at its sides black; there are no foveæ at the base of the post-scutellum. Median segment sparsely punctured laterally; the supramedian area is widely separated from the base; it is, if anything, wider than long, and is rounded behind; the posterior median area is distinctly and roundly hollowed and closely and minutely punctured; the lateral apical areæ are also minutely and closely punctured. Propleuræ closely punctured; the mesopleuræ sparsely punctured below; the metapleuræ smooth and impunctate. Mesosternum finely and rather sparsely punctured. Wings hyaline, the stigma testaceous, the nervures darker; areolet narrowed at the top, being there as wide as the space bounded by the recurrent and the second transverse cubital nervures; the recurrent nervure is received at the base of the apical third of the areolet; the second transverse cubital nervure is largely bullated. Except for an oblique large oval mark on the hinder coxæ behind, the legs are ferruginous; the tibiæ and tarsi are thickly covered with a pale down. Abdomen smooth and shining; the greater part of the four apical segments black; the gastracœli obsolete.

Ichneumon richardi, sp. nov.

Ferrugineo; orbitis oculorum, linea pronoti, lineis duobus mesonoti, mesopleuris late subtus, scutello, post-scutelloque flavis, maculis mesonoti abdominisque apice nigris; alis hyalinis, nervis stigmateque nigris. ♂.

Long., 9–10 mm.

Antennæ deep-black; the scape yellow beneath. Head dark-ferruginous; the ocellar region darker; the inner orbits, the lower outer ones, the face, and clypeus lemon-yellow; the vertex shagreened. On the thorax, the greater part of the propleuræ, the upper part of the mesopleuræ, the greater part of the metapleuræ, three large marks on the mesonotum, and the parts at the sides of the scutellum and post-scutellum are black; there is a yellow line on the pronotum, two irregular lines on the middle of the mesonotum, the lower half of the mesopleuræ, the scutellum to shortly beyond the middle, and the post-scutellum lemon-yellow. Mesonotum closely and distinctly punctured. Scutellum almost impunctate. Median segment shagreened, punctured at the base; the posterior median area is longer than broad, wider at the base than at the apex, and rounded at the base. Wings hyaline, iridescent; the stigma and nervures black; the areolet narrowed at the top; the nervures almost touching; the recurrent nervure is received shortly beyond the middle. Legs ferruginous; the four anterior coxæ and trochanters yellow. Abdomen shagreened, the apical three segments for the greater part black; the gastracœli shallow, indistinct.

Ichneumon wellingtoni, sp. nov.

Niger, pedibus rufis, coxis trochanteribusque nigris; alis fulvo-hyalinis, stigmate fusco. ♀.

Long., fere 9 mm.

Antennæ black; the flagellum more or less fuscous beneath; the scape with a rufous mark on the apex beneath; closely punctured, and thickly covered with a pale down. Head black; the labrum and a line along the middle of the inner orbits yellow. Front and vertex closely punctured and covered with a pale down; the frontal depression smooth and shining; the face closely, the clypeus more sparsely, punctured. Mandibles broadly dark-rufous in the middle; the palpi testaceous, black at the base. Mesonotum closely, but not strongly, punctured; the basal furrows transversely striated. Scutellum and post-scutellum almost impunctate; the base of the post-scutellum depressed at the sides; the depression at its sides stoutly striated. Median segment strongly transversely shagreened, most strongly on the apical slope; its base obliquely depressed in the middle; the supramedian area elongate; the lateral nervures not continued to the base, the transverse keel being also obsolete, so that the area is open at the base; all the other areæ are complete. Pleuræ shining, closely punctured; the propleuræ stoutly striated at the apex. Wings fulvo-hyaline, the fulvous tinge more distinct at the base; the basal nervures fulvous, the apical darker; the stigma fuscous; the areolet narrowed at the top, being there less in length than the space bounded by the recurrent and the second transverse cubital nervures; the recurrent nervure is received shortly beyond the middle; the transverse median nervure is received shortly behind the transverse basal. Legs reddish-fulvous; all the coxæ and trochanters black. Abdomen black; the gastracœli and a narrow line on the apex of the second segment reddish; the petiole aciculated; the other segments smooth and shining; gastracœli shallow, closely aciculated; the ovipositor black, rufous in the middle.

The antennæ are slightly compressed and thickened towards the apex; the basal joints of the flagellum are twice longer than broad; the labrum projects; the mandibles have the upper tooth much longer and sharper than the lower; the scutellum is very flat; the sheaths of the ovipositor are longer than the apical two joints united, and project largely; the last segment is large; the abdomen very smooth and shining; the scutellum is twice longer than broad, flat, not keeled at the base.

ZESTOCORMUS, gen. nov.

Abdomen with eight dorsal segments; the ventral keel extends to the fifth segment, the second to fifth segments projecting laterally at the apex; the sheaths of the ovipositor projecting, in length nearly as long as the apical three segments united. Antennæ thickened beyond the middle; the basal joints of the flagellum much longer than broad. Clypeus separated from the face; its sides at the base deeply foveate. The upper tooth of the mandible distinctly larger and longer than the lower. Face roundly projecting in the middle. Labrum not projecting. Areolet 5-angled, narrowed towards the top; the base of the cubitus without a branch; the transverse basal nervure interstitial. The depression at the base of the scutellum is wide and deep; sharply keeled; the base of the post-scutellum deeply foveate laterally. Median segment distinctly areolated; the supramedian area widely separated from the base; spiracles elongated, rounded at the base and apex. Legs of normal length; the hinder tibiæ distinctly narrowed and twisted at the base, and not much shorter than the tarsi, which have the joints spinose at the apex; claws large, simple; the inner joint of the fore calcaria is stout, curved, and bluntly pointed.

The petiole is broader and more dilated at the apex than in the *Oxypygi*, approximating more to *Eurylabus*, &c.; it is even broader than in *Eurylabus*, and is differently formed, being distinctly and somewhat triangularly raised in the middle. The antennæ are involute, stout, dilated somewhat, and compressed towards the apex; the joints of the flagellum are not greatly elongated. The insect is very smooth and shining, and is almost devoid of pubescence.

Zestocormus melanopus, sp. nov.

Niger, nitidus, orbitis oculorum flavo-maculatis; alis hyalinis, nervis stigmateque nigris; abdomine rufo, petiolo nigro. ♀.

Long., fere 10 mm.

Antennæ black, the flagellum fuscous beneath beyond the middle. Head black; a yellow line above and below on the inner orbits; the face and clypeus sparsely punctured; the ocellar region aciculated; below the ocelli is a band of curved fine striæ; the front has a shallow narrow furrow in the middle. Shortly behind the ocelli is a small yellow mark touching the eyes. Mandibles broadly rufous in the middle. Palpi black. Thorax entirely smooth and shining; the scutellum has a fuscous tinge in the middle. The supramedian area is widely distant from the base of the segment, is longer than broad, reaches to the base of the apical slope, and is rounded behind. Legs black; the tarsi more or less dark-fuscous; the apices of the joints spinose; the spines rufous. Areolet narrowed at the top, being there as long as the space bounded by the recurrent and the second transverse cubital nervures; the recurrent nervure is received at the base of the apical third of the cellule. Abdomen smooth and shining; dark-rufous; the petiole black; the longish sheaths of the ovipositor black.

POMPILIDÆ.

Salius monachus, Sm.

LARRIDÆ.

Pison morosus, Sm.
Pison pruinosus, Cam.
Tachytes sericops, Sm.

CRABRONIDÆ.

Rhopalum perforatum, Sm.

FORMICIDÆ.

Aphenogaster antarctica, Sm.
Huberia striata, Sm.
Prenolepis longicornis, F. Not hitherto recorded from New Zealand. It is now practically of universal distribution in the warmer parts of the world.
Monomorium nitidum, Sm.
Ponera castanea, Sm., Mayr.

Art. VI.—*On the New Zealand Lancelet.*

By W. B. Benham, D.Sc., M.A., F.Z.S., Professor of Biology in the University of Otago.

[*Read before the Otago Institute, 13th November, 1900.*]

Plate I.

Some years ago a couple of specimens of a lancelet were collected on the east coast of the North Island, and have since been deposited in the Colonial Museum. They were described by Captain Hutton in his "Fishes of New Zealand," published in 1872 by the Colonial Museum and Geological Survey Department, under the title "*Branchiostoma lanceolatum*, Yarrell."

At that period, and for many years subsequent to that date, all lancelets were regarded as belonging to one and the same species, and were known usually as "*Amphioxus*," more properly as "*Branchiostoma.*" But as material has been accumulated from various seas, and examined and compared with care, it has become evident that at least three subgenera must be erected for the ten well-characterized species—viz., *Branchiostoma, Asymmetron* (Andrews, 1893), from the Bahamas, and *Heteropleuron* (Kirkcaldy, 1895*); the last being characterized by the one-sidedness of certain structures—viz., the genital glands exist on the right side only, and the right

* Quart. Journ. Mic. Sci., xxvii., p. 303.

metapleural ridge is directly continuous with the ventral fin, the left ceasing at the atriopore.

The genus *Heteropleuron* is the commonest in the southern seas, and I was anxious to examine our lancelet in order to ascertain to which genus it really belongs. Sir James Hector was good enough to allow me to examine these interesting and hitherto unique specimens, and I owe him my very best thanks for so readily and generously sending the specimens to Dunedin in accordance with my request; and still further do I thank him for permitting me to retain—as the type of the new species—one of the two specimens, that which I had more particularly and carefully examined and drawn. The other specimen, now in the Colonial Museum, is thus a cotype. The New Zealand lancelet is a very distinct species, and I have named it *Heteropleuron hectori*.

Heteropleuron hectori, n. sp.

Length, just under 2 in. in the preserved condition, and height $\frac{1}{5}$ in. over greater part of body, tapering to each end. Total number of muscle-segments, as indicated by the angulated lines at the sides of the body, 84 (or possibly 85, the first and last being very small), of which 53 lie in front of the atriopore, 19 (or perhaps 20) between atriopore and anus, and 12 behind the anus. The "myotome formula," therefore, is $53 + 19$ (or 20) $+ 12 = 84$ (85).

The median fin is low over the greater part of its dorsal extent; it enlarges to form a small rostral fin (in front of the mouth), which, however, is injured in both specimens, so that its true outline is somewhat uncertain.

The caudal fin, or posterior expansion of the median, is relatively large; it commences dorsally at a point about midway between vertical lines through the atriopore and anus—*i.e.*, about the 10th postatrioporal myotome; and ventrally it commences at about the 7th postatrioporal myotome. It soon attains its greatest height at about the 14th myotome—*i.e*, in front of the anus—and thence tapers regularly and gradually to a point a short distance beyond the tip of the notochord. Its margin is rounded, and not angulated as in *B. lanceolatum*. Our species, in the shape and proportions of the caudal fin, is very different from either of the species of *Heteropleuron* occurring in the Australian seas. Thus, in *H. bassanum*, from Bass Strait, the caudal fin commences behind the anus; while in *H. cultellum*, from Torres Strait, the caudal, although commencing before the anus, attains its greatest height at the level of this aperture; but in myotome formula and in size these differ considerably from our species.

The ventral fin—*i.e.*, that part of the median fin lying between atriopore and the origin of the caudal—is scarcely to be regarded as a separate item in this species; it is, indeed, merely the undifferentiated part of the median fin, and is very short. Whereas in *B. lanceolatum* and in *H. bassanum* the ventral fin is provided with paired fin-rays, in the present species there are no ventral fin-rays, though fourteen fin-ray boxes exist. Another peculiarity hitherto unnoticed in the genus is the continuation of the fin-ray boxes, though without fin-rays, along the base of the caudal fin, both dorsally and ventrally, right to the end of the body. In the best-studied form, from the Mediterranean, such structures are absent, or, at any rate, have escaped observation, the fin-rays and their boxes being confined to the dorsal and ventral fins. In the present species, then, there is less differentiation of this median fin than in other cases.

A full and illustrated account of this interesting little marine fish-like form will appear shortly elsewhere; but I append an outline drawing, in order that naturalists having the opportunity may recognise this the lowest member of the vertebrate race of animals. The species may be looked for at low tide in sandy shores, or possibly in fine gravel.*

EXPLANATION OF PLATE I.

Heteropleuron hectori, n. sp. View of the left side; three times natural size.

An., anus.
Atp., atriopore.
c.f., caudal fin.
fl., floor of atrium.
My., Muscle-segments (myotomes), of which only a few at each end and in the middle of the body are indicated.
Mp., Left metapleural ridge.

Art. VII.—*An Account of* Acanthodrilus uliginosus, *Hutton.*

By W. Blaxland Benham, D.Sc., M.A., F.Z.S., Professor of Biology in the University of Otago.

[*Read before the Otago Institute, 13th November, 1900.*]

Plate V.

In my "Re-examination of Hutton's Types of New Zealand Earthworms" (1) I mentioned the fact that I had been unable to find the "type" of "*L. uliginosus*."† Since that date,

* The specimens referred to were collected one at Awanui, near the East Cape, and the other on Mahia Peninsula, Hawke's Bay.—Ed.

† Trans. N.Z. Inst., vol. xxxi., Art. xix.

however, Captain Hutton has been good enough to send me the type specimen from Christchurch, with the note that "it was collected many years ago in the swamp on which the town of Caversham now stands." The specimen, when it came into my hands, was fairly well preserved, but naturally had lost all colour. It measures 6 in. by ⅜ in., and consists of 145 segments. In other respects—and allowing, of course, for misinterpretation of the terms "male genital openings" and "vulvæ"—the worm agrees with Hutton's description(2). A careful examination of its external characters and of its internal anatomy enables me to state that it is identical with the worm to which Beddard(3) in 1885 gave the name *Acanthodrilus novæ-zealandiæ*, a name which henceforth will have to disappear from literature.

A few years ago the genus to which most of our endemic earthworms belong was called "*Acanthodrilus*," but as the number of species has increased, and as these have been submitted to more and more careful scrutiny, it has been deemed necessary to subdivide the genus. Thus, Beddard(4) established the genus *Octochætus* in 1892 for a group of species presenting an assemblage of characters differing from the bulk of our species. The pale or white worms, some of considerable size, of sluggish habits, and secreting an abundance of slimy fluid belong here; they are provided with eight separated chætæ in each segment, and diffuse nephridia.* But in 1899 Michaelsen(5), the foremost German authority on the group, as a result of the examination of material collected by Schauinsland, suggested further subdivisions of the typical Acanthodrilid type, thus: *Maoridrilus* for those species presenting the very peculiar alternation of the nephridiopores, which is practically limited to our New Zealand species; while the rest of the common species he referred to *Notiodrilus*, in which the pores form a single series on each side.

I confess that there is a certain amount of convenience in the subdivision of the genus, but there is no constant character that accompanies this condition of the nephridiopores; nor, indeed, is there any very strict regularity in the alternation in an individual, and when a series is studied it becomes evident that a good deal of variation occurs.

The term "*Maoridrilus*" may, perhaps, be conveniently used as a subgenus, for it is, anyhow, a remarkable fact that this "alternation" of the pores seems limited to New Zealand species, and occurs also in the genera *Plagiochæta* and *Neodrilus*, both confined to these Islands—though it also

* At another time I will present a complete diagnosis of our native species, but at the present I will leave this matter.

occurs in a genus, *Plutellus*, belonging to quite a different family from America.

The group of species included in Michaelsen's *Notiodrilus* is of much wider distribution.

The genus *Acanthodrilus*, according to Michaelsen, is confined to one species—the original type of the genus—from New Caledonia. Consequently, the worm originally called by Hutton "*Lumbricus uliginosus*" is now properly to be termed

Acanthodrilus (Maoridrilus) uliginosus, Hutton (Syn., **Acanthodrilus novæ-zealandiæ,** Beddard).

It may, perhaps, be as well to give a brief account of the external and internal anatomy of this worm, the earliest species of our native earthworm fauna to be named and described (for we may except Baird's "*Megascolex antarcticus*," which has not yet been rediscovered nor sufficiently described to be recognisable). And, in the interests of our students of biology, I will describe it pretty fully, for there is no general account of our native worms accessible to them, so that they have had to be content with an account of the European earthworm, which differs considerably. Moreover, the account will serve in general for any of our large, common, native worms.

Length.—This varies, as in most earthworms, between certain limits. When alive it is pretty extensible, reaching to more than 1 ft. in length; but when preserved the worm measures anything from 5 in. to 11 in. Usually it is 8 in. or 9 in. in length, and pretty constantly $\frac{3}{8}$ in. in breadth posteriorly to the clitellum. The worm retains this breadth for the greater part of the body, tapering rather suddenly to the posterior end, and more gradually to the anterior, which is pointed.

The *number of segments* varies from 130 to 230, for, as in other worms, new segments are added posteriorly as it grows.

The *colour* of living individuals is not unlike that of the European *Lumbricus agricola*, being a reddish-brown, fading slightly posteriorly, and with a paler and browner clitellum; but the back is dark all along the body, while the ventral surface is pale.

The *prostomium*, too, is like that of *Lumbricus*, in being prolonged backwards across the dorsum of the buccal segment as far as its hinder limit.

Each segment of the body, with the exception of the 1st or mouth-bearing segment (hence termed peristomium, or buccal segment), is provided with eight bristles or chætæ (sometimes also termed by the latin equivalent "setæ"), arranged in four couples, one couple on each side being latero-ventral, the other latero-dorsal. These couples are nearly equidistant, and form four lines along the entire length of the body. The body of the worm is quadrangular in section, except in the anterior twenty or so segments, and these couples of chætæ are situated at the angles. Each segment, too, is provided with a pair of small but distinct pores at its anterior margin. These are the *nephridiopores*, the apertures of the excretionary organs. The first pore lies at the anterior boundary of the 3rd segment. A very remarkable arrangement is presented by these pores in many of our New Zealand worms, in that they are situated alternately in front of the upper and in front of the lower couple of chætæ. This alternation is not absolutely regular, and, in fact, up to the 10th or 11th segment they are in line with the upper couple of chætæ.

Further, in the median dorsal line, on each of the intersegmental furrows, behind the clitellum, is a small *dorsal pore*, which is, however, not easily seen in preserved specimens.

The *clitellum*, or saddle-shaped girdle, covers segments 14–19, and may even encroach occasionally upon the 13th or 20th segments. The glandular thickening of the skin covers the back and passes down the sides as far as the level of the ventral chætæ, leaving the ventral surface free. Within this area, in the hinder part of this region, are four noticeable circular papillæ, usually pale in colour; they lie on the 17th and 19th segments in pairs, in line with the ventral chætæ. Each papilla is provided with a pore—hence they are termed "porophores"—which allows the protrusion of a couple of long, fine bristles, known technically as "copulatory or penial chætæ"—the modified ventral chætæ of these segments. These are about three times the length of ordinary chætæ, and of a different shape (see figs. 9 and 10). The two porophores of each side are connected by a distinct longitudinal furrow, with well-marked lips, passing from the pore on the 17th, across the 18th segment, to the pore on the 19th segment. This "spermatic groove" is straight, and passes between the ventral couple of chætæ of the 18th segment. At this point is situated the "male pore," the external aperture of the sperm-duct; a minute pore, only visible with difficulty. On the 14th segment are the paired "female pores," the apertures of the two oviducts, lying just in front of the ventral chætæ. Further forwards, and placed on the intersegmental groove separating segments 7/8 and 8/9, on each side, are the two pairs of spermathecal pores, also in the line of the ventral chætæ.

Internal Anatomy.

As in other earthworms, the cavity of the body is subdivided by a series of transversely disposed muscular septa, inserted into the body-wall at the level of the intersegmental furrows, and attached to the wall of the gut at their inner edges. Of these septa, those forming the posterior boundary of the segments 8 to 12 are much thicker than the others. The dorsal blood-trunk is duplicated, but the two tubes unite as they pass through the septa. In addition to this main blood-trunk there is, below it and closely connected with the wall of the gut, a "supra-enteric" vessel in a few of the anterior segments—about 9 to 14—and it is this supra-enteric vessel that gives off the four pairs of intestinal hearts, or, better, "enteric hearts," which have no connection with the "dorsal" vessel. These "hearts" occur in segments 10–13; each passes round the gut to enter the ventral vessel below the gut. In segments 8 and 9 are two pairs of "lateral hearts," arising from the dorsal vessel and passing to the ventral; these are, however, smaller and less conspicuous than the other hearts. In the 9th segment the dorsal trunk gives origin to a pair of "lateral" vessels, which run forward on each side of the gut, to break up into a plexus on the pharynx.

The *alimentary canal* consists of the usual parts. The following dispositons, however, are to be noted: The gizzard occupies the 6th segment; the œsophagus is a cylindrical tube, extending back to the 17th segment, where it passes into the intestine. In the course of the œsophagus there are marked dilatations in the 14th, 15th, and 16th segments. The walls are highly vascular, and thrown into folds (lamellæ) internally; the "œsophageal glands," however, contain no lime, as do the calciferous glands of many earthworms. The size of these "glands" is somewhat variable. The intestine is much wider than the œsophagus, is thin walled, and possesses a very slight ridge-like typhlosole.

The *nephridia* are fairly typical, and call for no special remark here; be it noted, however, that there are evident differences between the dorsal and ventral series of nephridia.

The *reproductive system* is, however, of importance, as it is characteristic of the family *Acanthodrilidæ*. We have, of course, to distinguish the male organs and the female organs.

(*a.*) The Male Organs: There are two pairs of testes, lying in segments 10 and 11 respectively, and attached to the anterior wall of each of these segments. They are quite free, not enclosed in sacs, as is *Lumbricus*. In the same segments lie the two pairs of funnels of the sperm-ducts, projecting from the posterior wall, or septum, of each of these segments. Two pairs of lobulated sperm-sacs (seminal vesicles) almost fill the segments 11 and 12. Two pairs of conspicuous, yellowish, coiled tubular glands lie in segments 17 and 19. These are the "spermiducal glands" (or "prostates"). Each gland is connected to the body-wall by a shining muscular duct, which opens by the porophore seen externally; the opposite end of the gland is free. Each gland is accompanied by a short muscular sac, containing the copulatory chætæ aforesaid. When these are examined under the microscope the sac is found to contain two or three chætæ, each of which is long, delicate, hair-like, and gently curved, the tip being somewhat spoon-shaped.

[The functions of these parts is not known with certainty, but in all probability the copulatory chætæ are inserted into the spermathecæ, serving to hold the worms together during the process of copulation, and the secretion of the spermiducal gland aids in this cohesion.]

(*b*.) The Female Organs: There is the usual pair of ovaries in segment 13, attached to the anterior wall, and behind each is the funnel of the oviduct, a wide, flattish structure, resting on the anterior face of the septum between the 13th and 14th segments; it leads into the short, narrow oviduct that passes through the body-wall in the latter segment to reach the exterior.

There are two pairs of spermathecæ (or copulatory sacs), lying in segments 8 and 9 respectively; each sac opens to the exterior at the anterior limit of the segment, through the pores already noted. The form of the spermathecæ is of considerable value in identifying the species of our endemic worms. In *A. uliginosus* it consists of an ovoid sac, the true "copulatory sac," reaching across the segment, and free posteriorly; it possesses a muscular duct nearly as long as itself, into which opens a peculiar "diverticulum," or accessory sac, which usually lies in the preceding segment. This diverticulum* of the duct, which alone contains spermatozoa—received from another worm during copulation—is somewhat variable in size, but its wall presents a considerable number of small rounded pustules on its surface, so that it resembles in its entirety a blackberry. Sometimes this diverticulum is flattened out (when empty); at other times (when distended) it is more or less globular, but always presents the blackberry-like form. The diverticulum is "sessile," opening directly into the duct of the spermatheca. [In a closely allied species, *A. rosæ*, it is provided with a distinct stalk.]

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* The form of the diverticulum is one of the most readily recognised specific characters in *Acanthodrilus*.

Bibliography.

(1.) Benham: "A Re-examination of Hutton's Types of New Zealand Earthworms." Trans. N.Z. Inst., vol. xxxi., 1898, p. 156.

(2.) Hutton: "On the New Zealand Earthworms in the Otago Museum." Trans. N.Z. Inst., vol. ix., 1876, p. 351.

(3.) Beddard: "On the Specific Characters of certain New Zealand Earthworms." Proc. Zool. Soc., 1885, p. 813.*

(4.) Beddard: "On some New Species of Earthworms from Various Parts of the World." Proc. Zool. Soc., 1892, p. 668.

(5.) Michaelsen: "Oligochæten v. den Inseln der Pacific." Zool. Jahrbuch, Abth. f. System, &c., vol. 12, 1899, p. 234.

EXPLANATION OF PLATE V.

Acanthodrilus uliginosus.

Fig. 1. Dorsal view of anterior end of the body; twice natural size.

Fig. 2. Ventral view of the segments 11 to 22, showing the extent of the clitellum, the arrangement of the chætæ (as short lines) and nephridiopores (as small circles), and of the genital pores; × 2.

Fig. 3. Diagrammatic transverse section, showing arrangement of chætæ, intestine, and the difference between the "dorsal" and "ventral" nephridia.

Fig. 4. Diagrammatic view of the first twenty-one segments, showing the alimentary system and part of the vascular system, as seen when the body is cut through along the dorsal mid-line and the wall pinned aside; about natural size.

Fig. 5. Part of the vascular system: the dorsal vessel has been removed in five segments to show the "supra-enteric vessel," with which the large "enteric hearts" are connected. The "lateral hearts" in segments 8 and 9 arise from the dorsal vessel, as do also the two "lateral vessels" in the 9th segment. The supra-enteric vessel is formed by the union of capillaries issuing from the "œsophageal glands."

Fig. 6. Diagram of one of the ventral nephridia: *t*, the coiled tubule; *f*, funnel opening through the septum; *bl*, the muscular bladder; *o*, its external aperture.

Fig. 7. Diagrammatic view of the reproductive organs; about natural size.

Fig. 8. A spermatheca, seen from the side: *s*, main copulatory sac; *d*, muscular duct; *div*, diverticulum.

Fig. 9. Normal chæta.

Fig. 10. Copulatory chæta, magnified to exactly the same size as fig. 9.

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* Contains a somewhat detailed account of the anatomy of our worm.

LIST OF REFERENCE-LETTERS.

bl. Muscular bladder of nephridium.
buc. Buccal region of gut.
cl. Clitellum.
cop. Sac with the copulatory chætæ.
d. Muscular duct of spermatheca.
div. Diverticulum of spermatheca.
d.ne. Dorsal nephridium.
d.v. Dorsal blood-trunk.
f. Funnel, of nephridium (fig. 6), of sperm-duct (fig. 7).
g. Gizzard.
gl. Œsophageal gland.
h. Heart.
i. Intestine.
i.h. Enteric heart, arising from supra-enteric vessel.
L. Lateral couple of chætæ.
l.h. Lateral heart, arising from dorsal blood-trunk.
l.v. Longitudinal lateral vessel.
m. Pore of sperm-duct.
N. Ventral nerve-cord.
ne. Nephridiopore.
o. Ovary.
od. Oviduct.
oe. Œsophagus.
p. Opening of spermiducal gland on porophore.
ph. Pharynx.
pro. Prostomium.
s. Copulatory sac of spermatheca.
s i.v. Supra-enteric blood-vessel.
sp.d. Sperm-duct.
sp.gl. Spermiducal gland.
sp.s. Sperm-sacs, or seminal vesicles.
spth. Spermatheca.
t. Coil of nephridial tubules (fig. 6), testis (fig. 7).
V. Ventral couple of chætæ.
v.ne. Ventral nephridium.
v.v. Ventral blood-trunk.

ART. VIII.—*On some Earthworms from the Islands around New Zealand.*

By W. BLAXLAND BENHAM, D.Sc., M.A., F.Z.S., Professor of Biology in the University of Otago.

[*Read before the Otago Institute, 13th November, 1900.*]

Plates II.–IV.

OUR knowledge of the earthworms of the South Island of New Zealand is now fairly extensive, thanks to the work of Mr. F. E. Beddard, to whom material was sent from time to time by the late Professor Parker and Mr. W. W. Smith; but we know very little as yet of the worms of the North Island and of the outlying islands. I have been fortunate in obtaining material from various friends, and am working upon this material. In the present communication I will concern myself with worms from the Snares (lying south of New Zealand), the Macquaries (still further south), and the Chatham Islands (on the east of the southern portion of New Zealand).

During a recent trip to the Macquarie Islands Dr. D. Colquhoun thoughtfully collected, on the Snares and Macquaries, some earthworms and preserved them in formol, and most kindly handed them over to me. To him my thanks are due. The material from the Chathams was given to me by Captain Hutton, who received a quantity of material collected by Mr. J. J. Fougére. Captain Hutton, with that liberality that is characteristic of him, has handed over to me all the earthworms contained in his collection at the Canterbury Museum. Further, Mr. H. B. Kirk and Mr. L. Cockayne have provided me with specimens from the same islands.

As a result of my examination, I have to form four new species, one of which had, however, been previously partially described as a "variety" by Michaelsen. The new species are: *Acanthodrilus haplocystis*, from the Snares, and *Microscolex huttoni*, *Diporochæta chathamensis*, and *Pontodrilus chathamensis*, Mich., from the Chathams. In addition, I can add several details to Beddard's account of the very interesting species from Macquarie Island, *Acanthodrilus macquariensis*, F.E.B., and record the existence of the world-wide *Allolobophora caliginosa* and *Allol. rosea*, Sav., from the Chathams, introduced by the direct agency of man.

For the present I shall give the characters of the species in a very brief form, as I hope to deal with the whole earthworm fauna in an extended manner elsewhere.

1. **Acanthodrilus haplocystis**, n. sp.

Two specimens, preserved in formol, collected by Dr. Colquhoun at the Snares Island.

Colour.—Light-brown, with a darker ring round the hinder half of each segment in the postclitellian region, giving a coloration not unlike that of *A. annectens.*

Dimensions.—Length, about $11\frac{1}{2}$ in. by $\frac{1}{4}$ in. (= 290 mm. by 6 mm.); cylindrical; with two hundred segments, which, in the preclitellian region, are much annulated.

Prostomium with prolongation over half the buccal segment.

Chætæ.—In couples; a ventrally placed couple and a laterally placed couple. The separation of the individuals of a couple is equal—*i.e.*, $ab = cd$; V (ventral gap) $= 2\ ab$; D (dorsal gap) $= 5\ ab$; L (lateral gap) $= 1\frac{1}{2}\ ab$.

Clitellum.—Ill-defined, except by its coloration; covers segments 13 to 19 inclusive. The "spermatic groove" connecting the porophores of 17 and 19 is curved, concave ventrally, passing outside the ventral couple of chætæ. The latter (*ab*) are present on each* of the segments 17, 18, 19, for there are no specialised penial chætæ.

Genital Pores.—Male pores on segment 18 as usual; spermathecal pores between 7/8 and 8/9 in line with chæta *b*. Each pore is surrounded by a distinct glandular area, above

* In the immature specimen; in the mature one, however, *a* alone is present in 17, 19.

which is an oval glandular patch, extending up to the level of chæta *c*. Each oval patch really consists of a crescentic patch on the hinder edge of 7, and another on the anterior edge of 8 (and so with segments 8 and 9). In addition to these there is a similar oval "tuberculum pubertatis," or "genital papilla," on the intersegmental grooves 9/10, in a line with chæta *a*. Thus there are three pairs of preclitellian "tubercula pubertatis."

Nephridiopores in a single series in line with chætæ *b*. They are invisible externally in the preserved worm, but can be traced from within.

Internal Anatomy.

Septa forming the posterior boundaries of segments 7 to 14 inclusive are more or less thickened.

Vascular System.—The dorsal vessel is completely duplicated, not uniting to pass through the septa. There are four pairs of "intestinal hearts" in segments 10 to 13, and a smaller "lateral heart" in the 9th segment.

Alimentary Tract.—The gizzard is in segment 6; the œsophagus is dilated in segments 15 and 16: it has here highly vascular and lamellate walls, but is without any lime-particles. The œsophagus thence narrows to the 19th segment. The intestine commences in segment 20, and is without a typhlosole.

Nephridia.—The worm is meganephric, the organs being in a single series. One peculiarity is to be noted—viz., the absence of a muscular duct. The nephridia of the segments 3, 4, 5 are large and pink. I traced their ducts to the body-wall, and saw none entering the buccal region of the gut. No doubt they junction as "peptonephridia."

Reproductive Organs.—The two pairs of testes lie in segments 10 and 11, free in the cœlom, attached to the anterior wall. The sperm-sacs are in three pairs, those in segments 9 and 10 attached to hinder septum, and a larger pair attached to the front septum of the 12th segment. The spermiducal glands are thick, much convoluted tubes, compressed and compacted to form, apparently, a lobed mass. Each is confined to its own segment. The duct is short and narrow. Penial chætæ are absent. Spermathecæ: Two pairs in the usual segments; each is a simple ovoid sac, with a rather prominent equatorial region, the proximal portion being rather more muscular than the distal. There is no definite duct. There is no diverticulum; and sections demonstrate that none exists embedded in the body-wall. The simple character of this organ suggests its specific name, for, without exception, I believe, members of the genus *Acanthodrilus* (s.l.) have a diverticulum.

Affinities.—There is undoubtedly a very close affinity with the species *A. annectens* and *A. paludosus*, which, as Beddard has shown, differ in many respects from other members of *Acanthodrilus*, and approach in some respects to *Octochætus*. The present species is larger than either of these. In coloration and in certain details—in absence of muscular duct to the nephridium, absence of penial chætæ—it resembles *A. annectens*, from which it differs, however, in the position of the gonads, in the form of the spermatheca, and some other details: while from *A. paludosus* its size marks it off, as well as such details as the position of sperm-sacs and the form of spermatheca.

In a previous note (see page 123) I have referred to the fact that Michaelsen (*loc. cit.*, page 233) has proposed a subdivision of the genus *Acanthodrilus* into a number of genera. With some of his reasons I agree, but I do not as yet feel convinced of the possibility of erecting the genera *Maoridrilus* and *Notiodrilus* for such species respectively as have nephridiopores alternately in line with dorsal and ventral chætæ, and for those in which all the pores are in line. As subgenera the names are certainly convenient, and the present species belongs to the subgenus *Notiodrilus*.

2. **Acanthodrilus macquariensis,** Beddard.

Two specimens were collected by Dr. Colquhoun. The species was originally described by Beddard(7) from two sexually mature and several immature specimens. Its great interest lies in the fact that it has closer affinities with the species occurring in Patagonia, the Island of South Georgia, and the Falkland Islands than with those of New Zealand.

Colour.—Light greenish-brown (in formol). The pigment confined to the dorsum of the anterior 30 segments, while posteriorly the pigment is absent.

Dimensions.—A small cylindrical worm, measuring about $1\frac{1}{2}$ in. by $\frac{3}{16}$ in. (*i.e.*, 40 mm. by 4·6 mm.) in diameter. The body consists of 83 and 85 segments respectively. (Beddard finds 100 segments.)

The *prostomium* is prolonged backwards through half the length of the buccal segment. (Beddard states that it does not divide this segment.)

The *chætæ* are very nearly equidistant, though the dorsal couple (*cd*) are slightly further apart than the ventral. The relative distances, as measured on the skin spread out on a slide, are: $ab = 4$, $L = 5$, $cd = 5$, $V = 7$, $D = 10$.

The *clitellum* covers segments 13 to 16 and 13 to 17 in the two individuals; the intersegmental grooves, however, remain distinct, and the colour is scarcely different from that of preclitellian region. (Beddard found it only extending as far as the 16th segment.)

Genital Pores.—The usual "porophores" exist on segments 17 and 19, and are very distinct papillæ. The ordinary ventral chætæ are here absent; but both are present on the 18th segment, and the "spermatic groove" passes outside them. The two pairs of spermathecal pores have the usual position. The ventral surface of the body on segments 7 to 10 is much swollen, and paler than the rest. On the 10th segment is a pair of large "tubercula pubertatis," or papillæ, surrounding the ventral chætæ (*ab*) of each side; each is slightly cupped, and the two nearly meet one another. These were present on each of the two individuals. (Beddard's specimens appear to have been somewhat abnormal.)

Nephridiopores in line with chæta *c*.

Internal Anatomy.

Vascular System.—The dorsal vessel is duplicated up to the 11th segment at least, and the last heart is in the 13th segment.

Alimentary Tract.—The gizzard is absent. The œsophagus is suddenly dilated in the 16th segment, and both in this and the next has whitish walls, with a few longitudinal ridges within; these lamellæ can be traced forwards, becoming more numerous in 15 and 14, where they become irregular, and take an oblique direction; they increase in size and irregularity in segments 13, 12, and 11, till they considerably reduce the lumen. From the 17th segment the œsophagus continues backwards, unconstricted, through the 18th and 19th segments, to pass into the intestine in the 20th segment, where the gut has now thin walls without any folds. Beddard states that "the intestine appears to begin in the 17th segment." In this I believe he is mistaken: the structure of the œsophagus and the intestine is sufficiently distinct in sections to allow me to state that the intestine commences in the 20th segment, after which it is sacculated.

Reproductive System.—The two pairs of testes have the normal position; they and the funnels are "free." There are two pairs of lobulated sperm-sacs in segments 11 and 12. The spermiducal glands I find to be large, with a narrow duct. The penial chætæ are very delicate, ornamented, as Beddard states, with "scattered triangular tubercles, rounded at the tip"; but he overlooked the fact that the chætæ are hooked at the end. I find three, or even four, couples of penial chætæ in each sac. The spermathecæ are pyriform sacs, each with a long, thick, muscular duct about equal to the length of the sac. The sac and its duct are bent at an angle, and at this point there enter a couple of small oval diverticula, one on each side of the duct.

The following earthworms were collected at the Chatham Isles:—

1. *Allolobophora caliginosa*, Sav. Several; from a peat swamp; collected by J. J. Fougère.

2. *Allolobophora rosea*, Sav. Collected by Mr. L. Cockayne, and presented to me by Dr. Dendy.

3. *Lumbricus*, sp. Small and immature.

The above are introduced, being more or less world-wide, though their home is Europe.

4. *Diporochæta chathamensis*, n. sp. From a peat swamp; collected by J. J. Fougère.

5. *Pontodrilus chathamensis*, Michaelsen. Collected on the sea-beach, in Shelly Land, by Mr. J. J. Fougère; and other specimens by Mr. H. B. Kirk "from near the mouth of the Waitangi Stream. They live," he says, "in what appears to be pure sea-sand, and at high tide are covered by brackish water. They probably feed on decaying seaweed."

6. *Microscolex huttoni*, n. sp. Collected in the bush by J. J. Fougère.

3. **Diporochæta chathamensis**, n. sp.

Seven specimens were collected from a peat swamp; preserved in formol.

Colour.—Pale-pink; no pigment.

Dimensions.—2 in. long by $\frac{1}{16}$ in. in diameter (*i.e.*, 50 mm. by 1·5 mm.). The worm is thus very slender; the segments relatively long and well marked. Usually about 100 segments, though one specimen of the usual size consists of only 57 segments.

The *prostomium* is partially embedded in the buccal segment for about one-third the length of the latter, but it has no posterior bounding furrow.

The *chætæ* are sixteen in each segment throughout the worm, eight on each side, at nearly equal distances apart. The dorsal gap is only about one and a half times the normal gap, the ventral gap rather greater. The chætæ are more distinctly hooked than in most worms.

The *clitellum* is yellowish, and complete. It covers segments 14, 15, and 16. The intersegmental grooves and the chætæ are still evident.

Genital Pores.—The male pores are on the 18th segment, each on a large, depressed, oval, white papilla; the two "porophores" meet one another medially, forming a dumb-bell-shaped glandular band extending right across the segment. The actual pore (though invisible under a lens) is in line with the most ventral chæta. Two transverse "tubercula pubertatis," on the intersegmental grooves 17/18 and 18/19 respectively, meet the dumb-bell, and the whole glandular structure forms a conspicuous octagonal area on this 18th segment. The oviducal pores are separate, and lie within a pale area, contrasting well with the yellow glandular substance of the clitellum. Spermathecal pores are invisible, but sections show that there are three pairs on the furrows 5/6, 6/7, and 7/8.

Nephridiopores in line with the fourth chæta from below.

Dorsal pores commence behind the 7th segment, and are evident along the entire length of the body.

Internal Anatomy.

Alimentary Tract.—The small gizzard is quite definite in segment 5; it has very thick walls, and a narrow lumen; its external diameter, however, is not greater than that of the œsophagus. The latter is provided with four pairs of lamellate sacs (œsophageal glands) in segments 12, 13, 14, and 15. The intestine commences in segment 17, and is without a typhlosole.

Reproductive System.—There is but a single pair of testes in segment 11, and a single pair of sperm-sacs in the 12th, but the preceding segment is filled with loose sperms. The sperm-duct passes straight backwards along the body-wall at the level of the nephridiopores as far as the 18th segment, where it bends to traverse this segment at right angles to its former course. The spermiducal gland is elongated and tubular, passing backwards into the 21st segment, where its free end is slightly coiled. It joins the sperm-duct at the above-mentioned bend. There are no special penial chætæ. The ovaries and ducts are normal. The spermathecæ are three pairs, in segments 6, 7, and 8; each is an ovoid sac, without a distinct duct and without a diverticulum.

Affinities, &c.—The genus *Diporochæta* is Australian. Of the twenty-six species hitherto known, all but one (*D. intermedia*, Beddard,* which is a native of New Zealand) occur in Victoria, New South Wales, and Queensland. The occurrence of a second species in New Zealand is thus of some interest. The present species differs from *D. intermedia* in several points, chief amongst them being the single pair of testes and of sperm-sacs, the possession of three pairs (instead of four) of spermathecæ, and the 16 instead of 75 chætæ per segment. In fact, only one other species possesses a single pair of male organs—viz., *D. maplestoni*, Spencer,† from Victoria. This has, however, two pairs of spermathecæ and fewer chætæ—viz., 8 to 14 per segment—and fewer anteriorly than posteriorly. *D. walhallæ*, Spencer,‡ has one pair of sperm-sacs in segment 12, but

* (1), p. 380, and (3).
† (2), p. 64.
‡ (1), p. 15.

Beddard, in his "Monograph," does not say that there is a single pair of testes, and I have not Spencer's paper at hand to refer to; anyhow, *D. walhallæ* differs in having five pairs of spermathecæ and 20–24 chætæ per segment. *D. maplestoni* has, moreover, spermiducal glands and spermathecæ of quite a different form (though there is no diverticulum); it differs also in the arrangement of the genital papillæ. In the latter matter *D. lindti*, Spencer,* and *D. dicksonia*, Spencer,† bear a closer resemblance to our own species than do any of the others, but in all other features are very different. It is possible, of course, that *D. chathamensis* has been introduced into the Chathams from Australia by man, though it is noteworthy that it differs from all those twenty-six other species carefully examined by Spencer and by Fletcher.

4. **Pontodrilus chathamensis,** Michaelsen = **P. matsushimensis,** var. **chathamensis,** Mich.

Of this worm I have a good supply of material, partly collected, as I have said, by Mr. J. J. Fougère, to whom I am indebted for fourteen individuals preserved in formol, and partly by Mr. H. B. Kirk, who handed me ten individuals preserved in alcohol.

The genus *Pontodrilus* is the only earthworm that lives actually within reach of the sea—in fact, between tide-marks. For reasons discussed below I believe this Chatham Islands form is worthy of being considered a distinct species, while Michaelsen, who, it is true, had very poor material, regards it as a local variety of a Japanese species.

Colour.—The formol specimens are pale-buff, distinctly pink anteriorly, with a brown clitellum.

Dimensions.—The length of the formol specimens is about $4\frac{1}{2}$ in.; some attain a length of 5 in. The alcoholic individuals, however, average only 3 in., though both sets are mature. The postclitellian diameter is $\frac{3}{16}$ in. in both lots. The worm contains about 80 to 130 segments, long and triannulate in posterior region, while the anterior segments are even quinquiannulate. The animal is cylindrical.

The *prostomium* is prolonged into the dorsum of the buccal segment for fully a quarter the length of the latter. All my specimens show the prolongation quite distinctly, but the lateral furrows do not reach the posterior groove of the buccal segment, as in the figure given by Jizuka.

The *chætæ* have the usual arrangement in four couples, the individuals of which are rather far apart: $ab = cd = 3$, $L = 5$, $V = 6$, $D = 8$.

* (2), p. 54.
† (1), p. 16.

The *clitellum* is saddle-shaped, covering segments 14 to 17 usually, though in some individuals it encroaches on the 13th and 18th segments. Its ventral margin is a fairly distinct ridge, in line with the ventral chætæ. It is true that sections show (as in many other "incomplete" clitella) a glandular thickening of the epidermis on the ventral surface, but this is only very slightly thicker than the normal epidermis. The intersegmental grooves and the ventral chætæ are perfectly evident.

Genital Pores.—The male pores are not evident externally, but their position is indicated on the 18th segment by the characteristic specialisation of the lower surface of this segment, resulting in a prominent and thickened ridge on each side, limiting and overhanging a depression, which is deeper laterally below the ridge than in the middle of the segment. The anterior and posterior boundaries of this transverse depression are more or less prominent, so that a somewhat rectangular pit is formed; in this lie the microscopic male pores, in the lateral deeper regions, in line with chæta *b*. The two oviducal pores occupy the usual position, in front of and mediad of chæta *a*. There are two pairs of spermathecal pores, between segments 7/8 and 8/9; each is on a small papilla—very distinct in the formol specimens—which in reality belongs to the anterior margin of the 8th and 9th segments respectively, but as the papillæ overlap the furrow they appear to be intersegmental (as is the truth with regard to the "intersegmentally" situated spermathecal pores in other worms). "Tubercula pubertatis" are very characteristically developed—as oval intersegmentally placed glandular areas, with well-defined margins, slightly depressed centrally, and probably acting as suckers. There are two preclitellian and one postclitellian in position, situated at 11/12, 12/13, and 19/20. In the eighteen mature specimens at my disposal these three are universally present; in three instances the postclitellian is rather small, and in one case an additional tubercle exists at 20/21. In another individual an additional preclitellian tubercle is present at 13/14. I shall return to these papillæ in discussing the specific value of the worm.

Nephridial pores commence only at the 13th segment, and in line with chæta *b*.

Internal Anatomy.

The *septa* behind the segments 7 to 11 are much thickened and infundibuliform, those at 6/7 and 11/12 less so, though stouter than the following; the normal posterior septa are thinner than in most earthworms of this size.

Alimentary Tract.—The gizzard is small, but highly muscular, with thick walls; it occupies segment 5. (I find the best way of locating the position of this organ is by slicing the worm in two by a horizontal cut, for by the ordinary method of dissection the septa are torn, especially when they are infundibuliform.) The œsophagus is narrow; it is slightly dilated in 13, 14, and 15 to form rather globular diverticula, with feeble lamellæ internally; in segments 16 and 17 it widens out, but retains the lamellate structure of its wall. These gradually die out and the intestine commences in segment 20; it is wide, unconstricted, and differs structurally from the œsophagus.

Reproductive Organs.—There are the usual two pairs of testes in 10 and 11, and two pairs of lobulate sperm-sacs in the 11th and 12th segments. The spermiducal gland is a thick irregularly cylindrical tube of some length, coiled somewhat, though not to so great an extent as in the Japanese species. The coils lie in a plane, are compressed and compacted to form what looks like a flattish lobed mass, till carefully unravelled. The gland occupies only segments 18 and 19 in the specimens examined. The muscular duct is very short and narrow, hidden below the glandular mass, which has to be lifted and turned aside; but then it is quite distinct. This duct is not bent upon itself as in the Japanese species, but is transversely disposed, and passes almost straight to the pore. Sections demonstrate that the sperm-duct opens into the duct of the gland *at the junction of the gland with the muscular duct*, not at the free end, as in the Japanese species. Serial transverse sections are quite clear on the point. The sperm-duct leaves the body-wall, crosses the lower end of the gland immediately above its duct, bends down towards the latter, and opens into it just at the junction of the two. This can be followed out in the course of ten sections. The spermathecæ are in two pairs, lying in segments 8 and 9. Each consists of a globular sac, opening to the exterior by a narrow duct, which is longer than the sac itself. Each has a diverticulum (opening into the duct close to the body-wall), which is only about half as long as the duct and sac together. The ovaries are of considerable size, extending across the 13th segment.

Affinities, &c.—In a recent article Michaelsen (p. 220) has discussed the relations of the species of *Pontodrilus* occurring on the shores of the Pacific, viz.: *P. michaelseni*, Eisen, California; *P. ephippiger*, Rosa (p.281), from Christmas Island; and *P. matsushimensis*, Jizuka, Japan. He recognises the affinity of the two last, both presenting a distinct "tuberculum pubertatis" on the intersegmental groove 19/20, while differing in details. He further describes, briefly, a single somewhat damaged individual from Te One, in the Chatham Islands, and concludes that it is a variety of the Japanese species. I cannot but think that his decision would have been different had he had a greater number of and better-preserved specimens at his disposal. Nevertheless, he recognises certain differences; chief amongst them being the presence in the Chatham Islands worm of preclitellian tubercles, in addition to the postclitellian tubercle (on 19/20). These he places at 11/12, 12/13, and 14/15, but remarks that they are "*undeutlicher umwandete.*" In all the nineteen mature specimens in my possession, collected by two different persons at different times and probably at different spots, the tubercles are extremely well defined, having an oval margin well raised up from the surrounding skin; and, while presenting the first two tubercles (on 11/12 and 12/13), not one of them shows a trace of any similar structure at 14/15. Michaelsen is so experienced and so careful an observer that this discrepancy can only be due to the imperfect condition of his specimen; he has, I fancy, mistaken for an incipient intersegmental tubercle a transverse glandular ridge, which in most of my specimens exists on segment 14 between the ventral chætæ of the two sides. A similar more or less swollen ridge occurs, in several of my specimens, also on segments 15 and 16. But these are quite different in structure and in position from the intersegmental tubercles. Another point upon which my specimens disagree with his is in reference to the prostomium, for he states, "*Der Kopflappen ist quer oval, vom Kopfring scharf abgesetzt, und lässt keine Spur eines dorsalen Fortsatzes erkennen.*" This is the more curious in that the Japanese species has this process, where, however, it reaches back to the hinder edge of the buccal segment.

A comparison of the Chatham Islands worm, as represented by my collection, with the Japanese species shows the following more or less important differences:—

Dimensions.	Segments.	Clitellum.	Papillæ.	Spermathecæ.	Spermiducal Gland.
			P. matsushimensis.		
90–110 mm. by 3–3·5 mm.	100–105	12–17 (complete)	19/20	Diverticulum rather shorter than sac, which has no distinct duct	Much coiled; extending through segments 17 to 19, with long duct in 17 and 18.
			P. chathamensis.		
100–125 mm. by 4·6 mm.	80	14–17 (saddle-shaped)	11/12, 12/13, 19/20	Diverticulum much shorter than sac, which has a long distinct duct	Little coiled; confined to 18th; short, fine, transverse duct.

It seems to me that the differences enumerated in the table are sufficient to raise our Chatham Islands form to the rank of a distinct species, for there are other details in which the two disagree. The thickened septa in the Japanese species are behind segments 5 to 13, whereas in ours only those behind 6 to 12; and even the first and last of these are not so thick as the rest of the group. The chætæ of the dorsal and ventral couples are equally spaced. The intestine in the Japanese form is said to commence in the 14th, while I find it beginning in the 20th. But most striking of these details is the point of entry of the sperm-duct into the duct of the spermiducal gland. Further, the geographical relations must, in the case of earthworms, have considerable weight in determining the question: for there is little, if any, communication between Japan and Chatham Islands.

5. **Microscolex huttoni**, n. sp.

Seventeen specimens collected in the "bush," Chatham Islands; preserved in formol.

Colour.—Pinkish—*i.e.*, unpigmented—with light-brownish clitellum.

Dimensions.—The usual length is $3\frac{1}{2}$ in., though one reaches 5 in. The diameter is $\frac{3}{32}$ in. (*i.e.*, 90–125 mm. by 3·3 mm.). It is thus a slender worm, and contains 130 segments. Even the longest has only 136.

The *prostomium* is prolonged over a quarter of the length of the buccal segment.

The *chætæ* are arranged in four rather distant couples: $ab = cd < \mathrm{V}$, $\mathrm{D} = 3\frac{1}{2}\,cd$, $\mathrm{L} = 2\,ab$; or, put into proportionate numbers, measured on the flattened skin, $ab = cd = 3$, $\mathrm{V} = 4$, $\mathrm{L} = 5$, $\mathrm{D} = 8$.

The *clitellum* is saddle-shaped, extending over segments 14 to 17; but the glandular thickening ceases ventrally at the level of chæta *b*.

Genital Pores.—Each male pore is situated on a papilla on segment 17; from each pore there protrudes a long delicate penial chæta, which, when magnified, is seen to curve rather abruptly at the free end, while the extreme tip is recurved to form a hook; it is without ornamentation. The spermathecal pores (two pairs) are invisible with a lens only; they lie, however, in the grooves 7/8 and 8/9, at the level of chæta *b*.

In addition to these structures, there is a series of paired "tubercula pubertatis," or genital suckers. Each "sucker" is a circular glandular pad with a central depression; they are all situated in line with, and behind, chæta *a*, close to the hinder margin of the segments, so as to appear at first sight intersegmental. The usual number, so far as can be judged from seventeen individuals, is three pairs, which are on segments 11, 20, and 21, or 11, 21, and 22; in a few cases an additional pair may exist.*

I was unable to find any dorsal pores, even when the body-wall was mounted.

Internal Anatomy.

The dorsal vessel is single; the last heart is very large, lying in 12th segment, those in 10 and 11 being smaller. The worm is meganephric.

Alimentary Tract.—The gizzard, rather long, occupies the 6th segment; the œsophagus, with vascular walls, bears a single pair of "œsophageal glands" in the 13th segment. Intestine commences in the 18th, and is without a typhlosole.

Reproductive Organs.—The two pairs of testes lie in the normal segments. There are two pairs of lobulated sperm-sacs in segments 11 and 12 attached to the anterior wall, while the two segments 10 and 11 are filled with loose spermatozoa. The sperm-duct is slightly muscular at its hinder end as it enters the body-wall, passes behind the duct of the gland, and opens through the porophore by an independent aperture. The spermiducal gland is relatively large, extending backwards as far as the 25th segment, accompanied by the long sac with penial chætæ. The gland is somewhat tongue-shaped, and slightly curled at the posterior end; its muscular duct is short, limited to the 17th segment, and opens to the exterior in front of the sperm-duct and independently of it. The sac of penial chætæ opens by the same pore, though practically it is independent of the duct. The two pairs of spermathecæ lie in segments 8 and 9 respectively; each is a pyriform sac, with a thick muscular duct of its own length, with a diameter rather less than half that of the sac. There is a single tubular diverticulum opening near the end of the duct; it is relatively wide, slightly undulating, and not distended distally. Its diameter is greater than the duct, and its length about twice that of the sac and duct together.

Affinities, &c.—The present addition to our fauna makes the fourth species of *Microscolex* known to inhabit the Islands of New Zealand, for Mr. F. E. Beddard has already described three species. Though the descriptions are somewhat

* The facts of the variation may be summarised thus: In six specimens suckers are on segments 11, 20, and 21; in six, on 11, 21, and 22—in four of these additional suckers, small or unpaired, are present on 23; in one case, on 11, 19, 20, and 21; in one case, on 10, 11, and 21; in one case, on 11, 22, and unpaired on 23; and in one case, on 11 and 20. The 17th specimen is immature. There is thus a tendency to add suckers posteriorly.

meagre, yet they are quite sufficient to indicate the differences between them, as will be seen in the following table :—

Dimensions.	Segments.	Clitellum.	Spermathecæ.	Spermiducal Gland.	Dorsal Pore.
		M. minutus.			
2 in.–3 in.	100	14–17	Four pairs, in 6–9th segments.	Extends through seven segments	Post-clitellian.
		M. monticola.			
1 1-5th in.	79	(?)	One pair in 9th	Long and coiled	Present.
		M. novæ-zealandiæ.			
1 3-5th in.	76	13–17 (complete)	One pair in 9th	(?)	(?).
		M. huttoni.			
3 in.–5 in.	100	14–17 (saddle-shaped)	Two pairs, 8th and 9th.	Extends through nine segments	None.

There are several other differences, such as the details as to the relative distances separating the chætæ, the form of penial chætæ, the shape of the diverticulum of the spermathecæ, the arrangement of "tubercula pubertatis," but these are not known for all the four species,* and many are not capable of being tabulated. Sufficient, however, is known to characterize as distinct at least three of the species, for *M. novæ-zealandiæ*† and *M. monticola*‡ appear, from the brief summary given in Beddard's monograph, to be very closely allied. The latter species is one of the very few worms recorded from the North Island; it was collected at Mount Pirongia by Captain Broun.

This genus *Microscolex* is a very puzzling one, for, of the sixteen species known outside New Zealand, all but two (one of which is Algerian, the other Madeiran) inhabit the American Continent. Of these, eleven belong to South America and three inhabit California. There is a species (*M. dubius*) recorded from Australia and (*M. modestus*) from Italy, but each of these has been, almost beyond any doubt, conveyed to these localities by man from its home in the Argentine, where each occurs in abundance. Of the South American forms, nine possess only one pair of testes and of sperm-sacs, the remaining eleven species having these organs

* Beddard does not note them in *M. minutus*, but I find that in segment 18 a pair of large circular discs exist, just behind the male pore on segment 17.

† (5), p. 33.

‡ (6), p. 467.

repeated. But except for two of our New Zealand species—viz., *M. minutus** and *M. huttoni*—the entire genus is characterized by possessing a single pair of spermathecæ. On this account Michaelsen has recently, in a revision of the New Zealand worms, suggested the resuscitation of Beddard's genus *Rhododrilus* for these species with more than one pair of spermathecæ. Though this might be convenient, it seems to me at present inadvisable to follow him, for in all other anatomical features our two species are in thorough agreement with the genus *Microscolex*. And, even if we referred two of our species to *Rhododrilus*, we should still have to face the fact that we have two species of *Microscolex* in these Islands.

The existence of this genus here in New Zealand, with four distinct species, goes very far towards supporting the land connection with South America, and points, perhaps, rather to a connection with the northern part of the southern continent than with the extreme south. However, *Acanthodrilus macquariensis* must be regarded as lending a support to an antarctic continent.

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EXPLANATION OF PLATES II.–IV.

The illustrations of the anatomy of the five earthworms described in this paper are purely diagrammatic, indicating only the segmental position of the various organs, the worm being supposed to be slit up along the dorsal line and the body-wall pinned aside.

A group of three diagrams refer to each worm herein described. The left-hand diagram in each of the groups referring to a species represents the external features. The location of the various genital pores is represented as round black dots (if on a papilla this is left white), the clitellum is obliquely shaded, the tubercula pubertatis are vertically shaded.

In addition, the arrangement of the chætæ—labelled *a*, *b*, *c*, *d*—is indicated in two segments in each case, usually in the 4th and the 21st; they are omitted in the remaining segments for clearness' sake. The true relative spacing of the chætæ is shown.

The position of the nephridiopores is given for one segment, except in the species of *Acanthodrilus*, in which it is necessary to note whether there is a linear or an alternate (zigzag) arrangement.

The middle figure represents the alimentary canal and so much of the vascular system as is diagnostic. The latter is black. The gizzard is indicated by vertical shading, the œsophageal glands by more or less horizontal lines. The intestine is not represented as being constricted, which is, however, the case in most worms.

The right-hand figure shows the reproductive system. The gonads are in black. The sperm-sacs are dotted. The sac with penial chætæ (cop.) when present is indicated, and the muscular duct of the spermiducal gland is transversely striped.

No attempt is made to give the relative sizes of the worms or of the various organs. Nor has it been considered necessary to label the various organs, since to any one who is familiar with the anatomy of any earthworm the structures here indicated will be sufficiently intelligible.

ART. IX.—*Life-history of* Plutella cruciferarum, *Zeller.*

By F. W. HILGENDORF, M.A., B.Sc., Canterbury Agricultural College.

[*Read before the Philosophical Institute of Canterbury, 3rd October, 1900.*]

THE diamond-back moth is referred to in every work on agricultural entomology, but the best notices occur in "Farm Insects" (Curtis, p. 85), and in a "Special Report to the Board of Agriculture, London," by Charles Whitehead, 1891. In neither of these, however, is the life-history given with any degree of completeness, and to supply this omission is the object of this paper.

The diamond-back moth and the ravages of its larva on cruciferous crops are well known. I found larvæ, pupæ, and adults on cabbage-plants all the year round. In winter their numbers are small, and do not increase rapidly till December and January, when the turnip-crops become available as food. Rape is hardly touched, but in February and March of this year clouds of the moths infested the turnip-fields on the College farm. The larvæ destroyed all the foliage, so that the turnips put forth new leaves, and this checked the root-growth so seriously as to diminish the crop by nearly 75 per cent.

In the adult the male and female can be distinguished, with the aid of a pocket-lens, by the fact that the male has the antennæ more setose, and therefore less distinctly notched, than the female. Of the specimens I employed for breeding, gathered in late autumn, the females were about twice as numerous as males. The adults lived, on an average, fourteen days when confined in a glass box 4 ft. by 3 ft. by 2 ft. in which turnip-plants were growing. For purposes of closer observation the specimens were kept in bell-jars about 1 ft. high, and here their average life was ten days, the longest life being that of a female who lived for thirteen days, in company, most of the time, with another female.

When a male and a female were placed under a bell-jar, with a piece of cabbage-leaf to encourage laying, the following was found to be the normal course of events: Copulation took place on the second day of adult life; eggs (about seven in number) were laid on the third day; copulation again on the fourth day; eggs (averaging six in number) laid on the fifth day; copulation again on the sixth day; eggs (about four in number) laid on the seventh day. One or two more eggs may be laid, but the death of both male and female occurred usually on the ninth and tenth days of life. Thus about eighteen eggs were laid, and oviposition was continued for five or six days. The eggs are small, white, iridescent, crinkled; and when the caterpillar emerges it does so by a small, regular opening at one end. Before I clearly distinguished males and females two females were occasionally put together. In this case nothing happened till about the eighth day of adult life, when one or both of the moths laid all her eggs (eighteen to twenty in number) in a few hours, and shortly afterwards died. These unimpregnated eggs were yellowish in colour, and never developed. The eggs are scattered about the leaf on which they are laid; the female has great difficulty in extruding them, as they cling to the genital aperture, and have to be rubbed off against the leaf. It frequently takes over fifteen minutes to lay a single egg.

The eggs hatched in from eight to ten days in a uniform temperature of 60° Fahr.

The appearance of the caterpillar is well known. In an equable temperature and with an abundant food-supply its active life lasted for twenty-two days; by this time it is full-fed, and spins its delicate white network cocoon.

The time of pupation averaged seventeen days in a room rather cooler than that used for hatching and feeding.

Summary.

Length of life of adult (average of thirty-five), ten to fifteen days; eggs laid (average of nine pairs), on third to seventh day of life; number of eggs (average of nine pairs), eighteen; eggs hatched (average of about forty), on the ninth day; life of caterpillar (average of nineteen), twenty-two days; pupation period (average of twenty five), seventeen days: duration of cycle, fifty-three days.

The proportion of larvæ that reached adult life was very large—fully 80 per cent. Only one specimen of the common parasitic *Hymenoptera* was obtained from thirty pupæ, though in England about 70 per cent. of the pupæ have been found to produce parasites.

Art. X.—*Description of the Caterpillar of* Epirranthis alectoraria.

By George R. Marriner.

Communicated by Professor Dendy.

[*Read before the Philosophical Institute of Canterbury, 3rd October, 1900.*]

Plate VI.

This caterpillar was found on the matipo hedges (*Pittosporum tenuifolium*) around Christchurch in large numbers about April, 1900. The full-grown larva is about 1 in. in length, with the body narrowest at segments 4 and 5, and thickest at segments 7 and 8. It consists of the head and 13 segments.

The colour is of a bright-green, dotted all over with pale-yellow spots, larger and more numerous on the dorsal surface, but smaller and fewer as they approach the ventral surface. Along the middle of the dorsal surface there is a fairly thick and very conspicuous bluish-red line, sometimes continuous from end to end or more or less broken, while at the joints between the segments the line is thickened. More conspicuous in the middle segments, but less so in the anterior and posterior segments, are thin but well-marked pale-yellow diagonal lines, thickest near the middle dorsal line, but become fainter as they approach the ventral surface, where a pale-yellow line runs from the 4th segment backwards.

The head is small, and narrower than the 1st segment, with five or six pairs of ocelli, arranged in a group on each side of the head.

Segments 1, 2, and 3 have each a pair of well-developed legs. Segments 1 and 4 to 11 have each a pair of spiracles. Neither of the segments 9 or 10 has a pair of fleshy pads, termed "prolegs" or "abdominal legs," but one pair situated at the junction of the two segments, and supplied with a half-circle of hooks on their inner surfaces. Segment 13 has a pair of abdominal legs, but they are modified to form flap-like claspers, being flattened along the line of the body, with the hooks on the anterior end of the claspers; there is also a tail-like projection at the extremity of the segment. The legs, claspers, and the tail-like projection are more or less coloured a bluish-red, corresponding to the dark colour of the matipo-branch.

The young larvæ are not so thick in proportion to their length, nor are the spots and diagonal lines so well marked as in the full-grown larva. The larvæ, after feeding voraciously for some time, formed cocoons about the 8th May. These they constructed in several ways; some simply bound two or three leaves together with silk, others rolled up a leaf like a roll of carpet, either closing both ends or leaving them open.

The pupa averages from $\frac{1}{2}$ in. to $\frac{5}{8}$ in. in length, and the specimens in my possession are of a dull-brown colour, with the posterior end of a darker brown. Mr. Hudson, in his book, "New Zealand Moths and Butterflies," page 81, describes the specimens under his observation as being of a greenish-brown colour; but this variation may be accounted for by the fact that pupæ often take the same colour with which they are surrounded.

After remaining in the pupa stage for three weeks or a month, the pupæ reared by me emerged as perfect insects between the 10th and the 15th June,* though the room in which they were kept was often lower in temperature than the air outside.

The larvæ no doubt do much harm to the matipo fences, as they devour the leaves with great voracity, often leaving only the petioles on the branch, thus giving the hedge a thin or dead appearance on the top.

Owing to its peculiar colouring the larva has a striking resemblance (no doubt a protective one) to a leaf of the matipo folded inwards towards the midrib. It holds on to the branch by the two abdominal legs, claspers, and the tail-like flap. These enable the larva to grip very tightly, and, as the abdominal legs and claspers are more or less of the same colour as the stem of the matipo, at a distance the caterpillar appears to be an outgrowth of the tree. Then, with the mid-dorsal line acting as a midrib and the diagonal lines as veins, its likeness to a leaf is almost complete. The effect is heightened by the larva often standing out from the branch at the same angle as a leaf. In this position it will remain for some minutes, so that it is almost unrecognisable in the green foliage from a folded leaf.

EXPLANATION OF PLATE VI.

Fig. I. Full-grown larva (enlarged): *a*, clasper; *b*, tail-like projection (the peculiar markings of the body are not shown).
Fig. II. Position of the clasping organs when clasping a branch.
Fig. III. Pupa (enlarged).
Fig. IV. Larvæ on a matipo-branch; natural size.

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* This shows that there is an irregularity in the time which they emerge. Mr. Hudson says, "The moth first appears about the end of October, and is met with until the middle of March" ("New Zealand Moths and Butterflies," p. 81).

Art. XI.—*Notes on New Zealand* Ephemeridæ.

By C. O. Lillie, M.A., B.Sc.

[*Read before the Otago Institute, 9th October, 1900.*]

Plate VII.

Nymph unknown.

The accompanying plate shows drawings of an Ephemerid nymph which is to be found in a few streams about Dunedin. The colour is from reddish-brown in the younger stages to brownish-black in the full-grown nymph. The surface is thickly beset with stiff bristles and spines. The legs are markedly flexed, but are shown straightened in the figure. The wing-cases are very prominent, and project from the body.

The nymph is found on stones in swiftly-running water. It swims clumsily by flexing and extending the body, and seems of sluggish habit.

All my attempts to rear it have been unsuccessful.

Note to Art. XX., Vol. XXXI., Trans. N.Z. Inst.

Specimens of the nymph, subimago, and imago of the insect identified as *Atalophlebia scita* were forwarded to the Rev. A. E. Eaton, author of the monograph on the *Ephemeridæ.* Mr. Eaton places it in a new genus, *Deleatidium*, and names the species *Deleatidium lillii*, and gives the following description in his " Annotated List of the New Zealand *Ephemeridæ*" (Art. xi., Trans. Ent. Soc. London, 1899, part iii.) :—

" Deleatidium. Eaton.

" Distinguished as a genus from *Leptophlebia* by the ♂ imago having genitalia conformable in pattern to those of an *Atalophlebia*, and by the nymph having tracheal branchiæ in the form of single, ovate, acute, penniveined foliaceous lamellæ. The tracheal branchiæ of the first abdominal segment are reniform, unlike those of the other segments. The cross-veinlets of the fore wing in the typical species are in two of the specimens widely spaced in places, after the manner of those of the species of *Atalophlebia* here illustrated, but in the other specimens of the same and of the other sex the blanks are less noticeable or are filled up. The name in Greek signifies ' a little bait.'

"**Deleatidium lillii** (Eaton).

"*Subimago (in fluid).*—Wings uniformly light-grey, with opaque neuration. Setæ grey, their joinings towards their tips evenly defined.

"*Imago (dried).*—♂. Body pitch-brown, the thorax polished above. Femora and fore tibiæ raw umber-brown, fore tarsus and hinder tibiæ lighter in tint, hinder tarsi somewhat of a sepia-grey throughout. Wings vitreous, with pitch-black neuration, except in the fore wing, the finer cross-veinlets of the marginal and submarginal areas that precede the pterostigmatic region (which are deficient in colouring), and the roots of the stronger nervures interior to the humeral cross-vein, which are raw umber-brown; the membrane at the extreme roots is almost imperceptibly tinted raw-umber or greenish. In the marginal area of the fore wing, before the bulla, are usually about 6 faint cross-veinlets, and beyond that 2–4 faint and 8–11 stronger veinlets, all simple. Setæ light sepia-grey with blackish joinings, of which some in the basal quarter are alternately distinct and faint. In the abdomen, segments 3–6 are sometimes transparent and whitish to a variable extent at the base.

"♀. Very like the ♂, but the colouring at the fore-wing roots, interior to the humeral cross-vein, is rather darker in tint. The marginal area of the fore wing contains about 3–5 faint cross-veinlets before the bulla, and 2 faint and 13 stronger beyond that, all simple. Ventral lobe of the 9th abdominal segment slightly (not deeply) emarginate, with acute points.

"Length of body, 8–9 mm.; wing, 12 mm.; setæ, ♂ im., 51 mm."

DESCRIPTION OF PLATE VII.

EPHEMERID NYMPH (UNKNOWN).

a. Dorsal view.
b. Ventral view.
c, d, e. First, second, and third legs.
f. Second maxillæ and labium.
g. Right mandible.
h. First maxilla, right.
k. Labrum.
t b., 1–7. Tracheal branchiæ.

Art. XII.—*Further Contributions to the Geographical Distribution of the New Zealand Non-marine Mollusca.*

By Henry Suter.

[*Read before the Auckland Institute, 15th October, 1900.*]

No. I. Shells collected near Birch Hill Station, Wairau, Province of Nelson, by Mr. Edward Suter.

No. II. Shells from Happy Valley, near Motanau, Canterbury, by Mr. Fritz Suter. Of special interest is the occurrence of *Flammulina virescens, Endodonta tau, wairarapa, mutabilis,* and *novoscelandica*, the latter having been known from the North Island only.

No. III. Mr. A. Hamilton, of Dunedin, collected some shells near Ngaputahi, Urewera country. Most of the shells were in a bad condition, and their identification not easy. *Endodonta varicosa* I had hitherto only seen from Taranaki and the South Island, and amongst the lot I found a new species, *Endodonta (Ptychodon) ureweraensis* (Suter, Journal of Malacology, 1899, vol. vii., p. 53, pl. iii., figs. 7–10).

No. IV. A few land-shells collected near Otarama, Canterbury, by Mr. Alf. Suter.

No. V. Shells collected by Mr. Charles Cooper, of Auckland, on Chicken Island.

The localities Nos. III. and V. were up to the present a *terra incognita* conchologically, and I am much indebted to my two friends for presenting to me the whole of their harvest.

—	I.	II.	III.	IV.	V.
Fam. *Limnæidæ.*					
Isidora variabilis, *Gray*	x	...	...	...	...
Fam. *Rhytididæ.*					
Rhytida meesoni, *Suter*	x	...	...	...	...
Rhenea coresia, *Gray*	...	...	...	...	x
Fam. *Phenacohelicidæ.*					
Genus *Flammulina.*					
Phacussa hypopolia, *Pfeiffer* ...	x	...	...	...	...
Thalassohelix zelandiæ, *Gray* ...	...	...	x	...	...
" ziczac, *Gould* ...	...	...	x	...	...
" igniflua, *Reeve* ...	...	x	...	...	...
Allodiscus dimorpha, *Pfeiffer* ...	...	...	...	...	x
" tullia, *Gray*	...	...	x	...	...
" granum, *Pfeiffer* . .	...	...	...	x	...
" planulata, *Hutton* ...	...	...	...	x	...

—	I.	II.	III.	IV.	V.
Pyrrha virescens, *Suter*	...	x	...	...	...
Therasia celinde, *Gray*	...	...	x	...	...
" decidua, *Pfeiffer* ...	...	x	...	...	x
" traversi, *E. A. Smith* ...	...	...	x	...	...
Phenacohelix lucetta, *Hutton* ...	x	...	...	...	...
Suteria ide, *Gray*	x	...	x	...	...
Flammulina zebra, *Le Guillou* ...	...	x	...	...	...
" crebriflammis, *Pfeiffer*	x	x	...	...	...
" perdita, *Hutton* ...	...	...	x	...	...
" pilsbryi, *Suter* ...	...	x	x	...	...
Fam. *Laomidæ.*					
Genus *Laoma.*					
Phrixgnathus mariæ, *Gray* ...	...	...	x	...	...
" ariel, *Hutton* ...	...	...	x	...	...
" phrynia, *Hutton* ...	...	x	...	...	x
" allochroida, *var.* lateumbilicata, *Suter*	...	...	...	...	x
Fam. *Patulidæ.*					
Genus *Endodonta.*					
Thaumatodon varicosa, *Pfeiffer* ...	...	...	x	...	...
" tau, *Pfeiffer* ...	...	x	...	...	...
Ptychodon wairarapa, *Suter* ...	...	x	...	...	...
" ureweraensis, *Suter* ...	...	...	x	...	...
Phenacharopa novoseelandica, *Pf.*...	...	x	...	...	...
Charopa coma, *Gray*	x	x	...	x	...
" " " *var.* globosa, *Suter*	...	...	x	...	...
" buccinella, *Reeve* ...	...	...	x	...	...
" anguiculus, *Reeve* ...	...	x	...	x	...
" " " *var.* montivaga, *Suter*	...	x	x	x	...
" corniculum, *Reeve* ...	...	...	x	...	...
" infecta, *Reeve*	x	...	...	...	...
" caput spinulæ, *Reeve* ...	...	x	x	...	...
" bianca, *Hutton*	...	...	x	...	...
" tapirina, *Hutton* ...	...	...	x	...	...
" sterkiana, *Suter, var.* ...	x	...	...	...	...
" mutabilis, *Suter*... ...	...	x	...	...	...
" subinfecta, *Suter* ...	...	x	...	...	...
Fam. *Bulimulidæ.*					
Placostylus hongii, *Lesson, em.* (shongii)	...	...	...	...	x
Fam. *Unionidæ.*					
Unio menziesi, *Gray, var.* rugata, *Hutton*	x	...	...	...	...

ART. XIII.—*Hymenopterous Parasite of Ovum of* Vanessa gonerilla.

By AMBROSE QUAIL, F.E.S.

[Read before the Wellington Philosophical Society, 15th January, 1901.]

Plate VIII. (in Part).

Vanessa gonerilla deposits ova singly on the upper surface of leaves of *Urtica ferox*, &c. Nine ova were collected on the 9th November, 1900. At the same time I noted in close proximity, if not actually on one of these ova, a small black fly, which was so inconspicuous that only its movement attracted my attention, and it escaped capture. One larva of *V. gonerilla* hatched out within a fortnight, and on the 1st December I bred also from another ovum a small hymenopterous parasite. Some three weeks later each of the remaining ova produced a parasite. Meanwhile I frequently examined the ova under the microscope, and each contained something black (*V. gonerilla* larva appears pale-brown within the egg-shell). I confidently believe the entire metamorphosis of this insect takes place within the ovum of *Vanessa gonerilla*. At the time of emergence of this parasite in its fully matured state *V. gonerilla* have hatched, and are then mostly in the larval stage. I doubt whether the parasite attacks the larvæ. It is also unlikely that it lives in the imago stage until the next deposition of ova by *V. gonerilla* twelve months later. It is probably parasitic on the ova of other insects.

DESCRIPTION.

Head, thorax, and abdomen are very dark-brown, black to the naked eye; antennæ dark-brown; legs dark-brown except near the joints and the tarsal segments, which are semitransparent yellowish-brown. Head flat in front and behind; antennæ are almost exact length of fore wings, and placed low on front of head near the mouth; antennæ have ten joints (one specimen has eleven); the scape is long; clavola basal segments elongate; terminal segments short and broader; antennæ elbowed at scape and middle. Thorax broad dorsally and laterally. Abdomen dorsally broad elongate-oval, laterally slender. Legs comparatively uniform, with five tarsal joints and terminal claw. The wings are especially interesting: at rest they overlap flat on dorsum of abdomen; fore wings are battledore-shape, with inner marginal curve near base; hind wings are elongate to a blunt tip, and have a sharp upper marginal curve near base. All the wings have a serrated edge near base of upper margin, and appear to have no nervures. The striking feature, however, is an innumerable number of minute sharp bristles pointing in all directions on the surface of each wing. The upper margin and tip of fore wings and lower margin and tip of hind wings have long bristles, proportionally more hair-like than the small surface bristles. Expands about $\frac{1}{16}$ in.

PROCTOTRYPIDÆ.

Mymar ("Curt.") *crinisacri*, sp. nov.

I am unable to ascertain whether the hymenopterous parasite of the ovum of *Vanessa gonerilla* has been previously described. It is extremely probable, however, that this minute species has hitherto been unnamed, and in this belief I have named as above.

EXPLANATION OF PLATE VIII. (IN PART).

Fig. I. Antennæ
Fig. II. Fore wing } × 200.
Fig. III. Hind wing

ART. XIV.—*On* Lysiphragma howesii, *sp. nov.*

By AMBROSE QUAIL, F.E.S.

Communicated by F. W. Hutton.

[*Read before the Philosophical Institute of Canterbury, 4th July, 1900.*]

Plate VIII. (in Part).

Larva. (Fig. A.)

THREE larvæ received from Mr. G. Howes, of Invercargill, were found by him with others in rotten wood of *Plagianthus betulinus*, and were contained in rather tough cocoons. The length was respectively $\frac{5}{8}$ in., $\frac{3}{4}$ in., and $\frac{7}{8}$ in., and there was no apparent difference in structure, but in the smallest specimen the colour was very pale compared with the larger specimens, especially in respect to the darker structures. My description was made from one of the largest specimens.

Colour: Head dark-brown. Thoracic dorsal plates brown, that of the prothorax paler on anterior edge. Segmental oily white. All tubercles are brown. Legs pale-brown, semi-transparent, not glassy. Hairs pale-brown. Spiracles pale yellowish-brown.

Shape, dorsally: Head broad, smaller than prothorax, sloping from base to front, which is produced, and, viewed laterally, snout-like. Thoracic segments are larger than the abdominal, which latter taper gradually to anus. Comparative size of segments twice the width of length; viewed laterally, about the same width as length.

Structure, lateral (under 1 in. objective): Head roughly striated; several dorsal and lateral hairs on lobes; the latter are not hemispherical, but rather square at sides and front. Antennæ have broad basal joints, with a longer joint terminated by a long bristle. The outer maxillary palpus resembles the antennæ, except having no bristle. Spinneret long and slender.

Prothorax: Dorsal plate covers about one-third of lateral area of segment and has one anterior dorsal, one anterior lateral hair, and two hairs, one above other, on posterior area of plate. Below the posterior area of the plate is the spiracle; anterior to the spiracle is a large tubercle with two (? three) hairs; below is a tubercle without hairs, and a large subventral tubercle with two hairs above the legs (in my figure there are three hairs on this tubercle).

Mesothorax: Dorsal plate small at anterior area, produced laterally at posterior; on dorso-anterior area two hairs (one above other). Below the plate is a curious curved tubercle with two hairs (one above other), a large posterior tubercle with one hair, and a small tubercle with one hair, a small tubercle (posterior) without hairs, and a large subventral anterior tubercle with one hair (in my figure there are two hairs on the tubercle); a small anterior subventral tubercle with one hair is sometimes present.

Post-thorax as mesothorax, except the small anterior subventral tubercle is not present. On each pro-, meso-, post-thoracic intersegmental membrane is a single dorso-lateral tubercle, apparently without hairs. The three thoracic segments have legs, each of which has hairs above the joints. The meso- and post-thoracic segments have no spiracles. 1st abdominal segment without feet; anterior trapezoidal dorsal and large, with one hair; posterior trapezoidal tubercle elongate laterally, with one hair situate at the lateral extremity. Below the anterior trapezoidal is a large inverted heart-shaped tubercle with one hair in centre (supraspiracular tubercle); within the curve of the supraspiracular is a minute pale (apparently functionless) spiracle; below are two anterior, two posterior tubercles, each with one hair, and a large subventral tubercle with two hairs. 2 corresponds. 3, 4, 5, 6 have abdominal feet, and correspond as to position of the tubercles, the subventral tubercle, with two hairs, being at base of the abdominal feet. 7, the subventral tubercle has only one hair. 8, the posterior trapezoidals are less remote; supraspiracular is horse-shoe shaped (with one hair in centre), and encloses a large spiracle (as on prothorax); subventral tubercle becomes ventral. 9, no spiracle; below the trapezoidals is a large elongate tubercle bearing three hairs, below is a small subventral tubercle with one hair. 10, above the anal flap are three hairs, below is a large tubercle with four hairs, and one hair at base of claspers.

Structure, ventral (under 1 in. objective): At the base of each thoracic leg, on the segmental area, is a single hair; on 1 and 2 abdominal are hairs which correspond; 3, 4, 5, 6 have a single hair at the inner side of each of the abdominal feet; 7–10 have hairs which correspond.

Under $\frac{1}{4}$ in. objective: The hooks of abdominal feet turn outwards, forming a complete margin. The skin of the segments is prickly—*i.e.*, densely covered with minute hairs. The setæ, or hairs, of the tubercles are smooth, apparently finely striated.

All the larvæ expired from ill-usage during microscopical examination. My figure was drawn from one specimen, and description taken from another. Subsequently I received another larva from Mr. Howes, which pupated in a frail cocoon amongst moss.

Pupa. (Fig. B.)

Colour: Pale-mahogany.

Length: Exactly $\frac{1}{2}$ in.

Shape and structure (under 1 in. objective): In front of head, above the eyes, is a pointed protuberance; there are two hairs between the eyes; the latter are large, dark, and conspicuous. I am not sure whether there are one or two hairs at base of antennæ. The antennæ and wing-cases extend to the posterior edge of 5th abdominal segment, and are quite separate from and unattached to either 4 or 5 abdominal segments. 4, 5, 6 abdominal segments are free, the remaining segments fused. Pupa tapers rapidly from 7–10, the posterior extremity being terminated by two dorsal and two ventral angular processes, with no trace of hooks or spines.

On all the abdominal segments except 1 and the last two there is an anterior transverse dorsal series of short blunt spines, varying from three rows in middle to one row at extremities of series. These spines extend from spiracle to spiracle, and are terminated at or by a single hair (homologous of the supraspiracular hair). The spiracles are very like those of the larva—small, round, and elevated. Below the spiracle is a minute hair, and posterior to it is another. Abdominal segments 3 to 6 have a second series of spines—a single posterior row, and not so numerous as the anterior series. Among the spines of the anterior series are hairs possibly analogous to the anterior trapezoidals of the larval stage, but I cannot find traces of the posterior hairs. The ventral area of pupal segments is smooth (no spines), with some hairs possibly homologous of the subventral and ventral larval hairs.

This pupa met with an accident during examination and succumbed. However, I had the satisfaction of receiving a note from Mr. Howes, saying he had bred a specimen of the imago. Upon this I wrote, asking him to forward empty pupa-case, so that I could examine the manner of dehiscence, and I subsequently received same. The dorsum of metathorax is split centrally. Prothorax, head parts—antennæ, proboscis—and leg-cases separate from each other and from the wing-cases throughout their length; the latter remain connected with the thoracic segments, but are quite severed from the abdominal segments.

Mr. G. Howes was also kind enough to forward specimens of the imago to me, same having been bred on and after the 21st December, 1899.

Imago.

Expands $\frac{13}{16}$ in. The markings of wings are not very distinct. Ground-colour of fore wings is greenish, intermixed with paler scales; near the base is a suffused blackish line. At 1/3 on the inner margin is a black spot, at 1/2 a similar spot; both extend upwards by a thin wavy line to about the middle of wing. On the costal margin at 2/3 is a light patch edged with black; at the apex there is also a light patch. The costa is marked with black dots. Hind wings are grey on basal area, darker at margin. Thorax silvery, with green scales intermixed. Abdomen silvery-grey.

Structure: Antennæ comparatively long; clavola segments elongate, with a broad margin of basal scales, directed anteriorly. The labial palpi are large, ascending, each joint covered with scales. Maxillary palpi are long and slender, with several joints covered with scales; there is apparently a short proboscis.

Neuration (Fig. C): Fore—Subcostal, 1; radius, 5; media, 3; cubitus, 2; anal, 2 = 13 nervules. Hind—Subcostal, 1; radius, 1; media, 3; cubitus, 2; anal, 1 = 8 nervules.

The neuration is distinctly specialised—that is to say, very much modified from assumed (*Trichoptera*) lepidopterous primitive type. The loss of the stem (nervure) of the median system is itself a mark of specialisation, although the median of the hind wings remains. The number of radial nervules (hind) is reduced to one only. It would be interesting to compare this neuration with that of *Sesiidæ* (New Zealand representative, *S. tipuliformis*, introduced from Europe), which, so far as my memory serves me, is a further specialisation of a similar type.

Wing-scales: Towards the base of the inner margin of fore wings I observed some hairs and a few scales without teeth (fig. 1). On the wing-surface are three types of scales—broad with blunt dentation, broad with sharp dentation, long narrow scales irregularly dentate; the latter appear to be associated in position with the nervures on the wing (figs. 2, 3, and 4). Towards the outer margin I only observed the broad scale with sharp dentation (fig. 3). The fringe is composed of two patterns of scales: one forms a narrow fringe of scales longer than the surface scales, broad at outer end and more deeply dentate (fig. 6); one pattern forms a broad fringe of longer, attenuated scales, the broad end split into very long teeth (fig. 5). Both these patterns are contained in the fringes of fore and hind wings, and they rise from the edge of the wing-membrane.

The study of scale-structure seems to be usually neglected, yet appears to me worthy of attention. Among *Lepidoptera* of more ancient type—for instance, *Hepialidæ*—the thorax, legs, and abdomen are covered with hair, and the covering of the wings is partly hair, partly — towards the margins —scales. These scales have smooth (rounded somewhat) tips among ancient genera (instance *Porina*), dentate tips among specialised genera (instance *Hectomanes*, of Australia), and, though the majority of *Lepidoptera* appear to have dentate wing-scales, and scales on the thorax, &c., the study of their structure would appear to be of value as an indication of affinity.

Mr. Howes also kindly sent me specimens of *Lysiphragma epyxila*,* imago, the larvæ of which he states have similar habits, and feed on the "soft inner bark of the broadleaf-tree." This species, as regards neuration and wing-scales and antennæ, is also identical with that which forms the subject of my paper. It is, however, a larger insect. The markings are similar, and evidently the two are most closely allied.

EXPLANATION OF PLATE VIII. (in Part).

Imago of *Lysiphragma howesii*, nat. size.

Fig. A. Larva of *Lysiphragma howesii*; enlarged about 4 by 4.
Fig. B. Pupa of *Lysiphragma howesii*; enlarged about 4 by 4.
Fig. C. Neuration of wings; enlarged about 50 diameters.
Fig. 1. Basal wing-scale
Fig. 2. Surface wing-scale
Fig. 3. Surface wing-scale
Fig. 4. Surface wing-scale
Fig. 5. Outer-fringe scale
Fig. 6. Inner-fringe scale
} enlarged about 200 diameters.

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* Meyrick, Trans. N.Z. Inst., vol. xx., p. 105 (1888).

Art. XV.—*Embryological Structure of New Zealand* Lepidoptera: *Part I.*

By Ambrose Quail, F.E.S.

[*Read before the Wellington Philosophical Society, 12th March, 1901.*]

Plate IX.

The subject has of recent years received the attention of capable authors in England and America, and some notes on the embryology of *Lepidoptera* of general interest, if applied to local species, may be of use to New Zealand students in directing attention to its scientific importance.

The number of eggs laid by *Lepidoptera* varies inversely in proportion to specialisation. Assuming primitive productivity to be great, *Hepialidæ*—an ancient group—deposit their ova indiscriminately at random amongst the herbage in great quantity, probably thousands in some genera. The development of ornamentation of the ovum, the degree of development attained within the ovum by the ensuing larva, may cause greater assimilation of egg-producing matter per ovum, hence a reduction in the number of ova laid per species.

It is characteristic of *Arctidæ*, *Noctuæ*, *Geometræ* to attach ova in batches to branch, twig, leaf, or what not, and, generally speaking, in these groups the number of ova is limited, in some species to a hundred or so. Among *Rhopalocera* the position is usually selected and ova deposited singly, and the number deposited is small.

Individual species in any group may be noted to have a greater productivity than is usual, but some female *Lepidoptera* develope a greater capacity for egg-production at the expense of imaginal structures; thus reduction may be counteracted and rate of productivity maintained. Apterous female *Orgyia*, *Hybernia*, &c., are extreme examples of such.

Ova of *Hepialidæ* (*Porina* and *Charagia*) are smooth and of spherical shape. This may not indicate generalisation, since *Psychidæ* (*Œceticus*) ova, though smooth, are longer than broad, and have equal claim to be considered a primitive egg-shape; there is little doubt, however, that the smooth egg is more primitive than the sculptured egg. Eggs of certain groups are laid on the side (lateral); among these a Tineid egg (fig. 3), with obscure sculpture, is a more ancient type than such lateral eggs as have parallel ribs, and are also probably more primitive than Geometrid eggs, with distinct hexagonal sculpture—*Selidosema*, *Asaphodes* (fig. 4). Eggs of certain groups are attached on end (vertical); among these the smooth round eggs of *Rhapsa scotosialis*, flat on attached surface, are more primitive than Arctid (*Nyctemera*) eggs, which are similar in shape but with hexagonal sculpture, or typical *Noctuæ* (*Melanchra insignis*) eggs, more flattened at the base, with parallel corrugations converging to the centre. *Rhopalocera* ova have elaborate sculpture (figs. 1, 2).

The eggs of *Lepidoptera* most frequently have hexagonal figures raised on the surface; more highly specialised forms, with parallel ribs, appear to be derived from the hexagonal by the decadence of the transverse sides of the hexagons and greater development of the longitudinal sides. I have, in fact, examined a Tineid egg which seems to actually illustrate the process. Egg-shells with hexagonal patterns are probably similar in composition to beeswax, recent experiments* having proved the natural formation of "crystalline" hexagons in the pure beeswax upon which bees build up the cells of honeycomb; the size of the hexagons has been varied experimentally, according to the thickness of the wax, "from those of nearly an inch across to others of microscopic dimensions," and a variety of these "crystalline" bodies has been formed by the treatment of certain "waxes with other fats, oils, and waxes." It may be noted that the ovum of *Vanessa gonerilla* (fig. 1) has an ornamentation which is not hexagonal, and the secretion by which the ovum is attached at its base to the leaf upon which it has been deposited is of irregular "crystalline" formation, but nevertheless largely hexagonal. Certain Tortricid ova look like mere splashes of white, green, or brownish matter, due apparently to a secretion which covers them, which is likewise characterized by "crystalline" hexagons.

The larvæ of *Lepidoptera* are composed of fourteen bilaterally symmetrical segments, which comprise the head = 1, thorax (pro-, meso-, post-) = 3, abdomen = 10. The head near the mouth has six ocelli on each side. In their imago stage *Lepidoptera* have compound eyes (except, perhaps, female *Psychidæ*); near the ocelli in front are antennæ, broad and fleshy organs very unlike those of the imago; at either side of the mouth are the jaws, and below are the maxillæ and the labium (lower lip), with its minute palpi and terminal spinneret, from which the larva produces its silken threads. The thoracic segments have legs which ultimately become the imaginal legs, and certain abdominal segments have fleshy ventral extensions terminated by one or more rows of hooks; these are termed prolegs (claspers on 10), but Dr. Sharp† has proposed a more appropriate term, "abdominal feet." These

* C. Dawson, F.G.S., and S. A. Woodhead, in "Natural Science," vol. xv., p. 347.

† "The Cambridge Natural History," vol. vi.; Insects (part ii.).

are not retained in the imago. The spiracles (breathing-organs) are lateral, one each side of the prothorax and first eight abdominal segments; those of the prothorax and 8th abdominal segments are often larger than the spiracles of any other segment. The absence of spiracles from meso- and post-thoracic segments may be associated with the ultimate development of the imaginal wings.

The thoracic and abdominal segments are made up of minor subsegments, and the skin is frequently covered wholly or in part (figs. 12–14) with minute hairs, and in more or less fixed position there are certain pimples (termed "tubercles"), which form the base of longer and stouter hairs (termed "setæ"). The position of the tubercle setæ affords a basis for classification. The arrangement of the tubercles of prothorax is mostly scutellar—*i.e.*, on the dorso-lateral plate or scutellum—and always differs from the arrangement of the tubercles on meso- and post-thorax.

[Since the above was written Dr. G. Harrison Dyar, writing in the "Century" number, vol. xiii., "Entomologists' Record," states: "I now agree with Dr. Hofmann that the thoracic and abdominal setæ are homologous," a conclusion reached by the present writer independently but not stated, as hitherto Dr. Dyar had not formed that opinion. The nomenclature of the thoracic (below the scutellum) and abdominal setæ should correspond.]

I have noted elsewhere* a probable generic distinction among *Hepialidæ* (*Porina* and *Charagia*) in the arrangement of the prothoracic scutellar setæ, and have noticed considerable diversity in the position of the prothoracic tubercles in most groups of *Lepidoptera*. The more fixed position of the abdominal tubercles appears to be of little value in differentiating genera, though of great significance in classifying larger groups.

The arrangement of the meso- and post-thoracic tubercles differs from the abdominal, though more approximate than those of the prothorax; the abdominal segments are practically duplicates—except 9 and 10, which are always modified. Newly hatched larvæ usually have the primitive arrangement of tubercles in the group of which they are representative, and also usually have primitive tubercles with single setæ. Multiplication of tubercles (and reduction) and of setæ takes place after the first moult, though sometimes newly hatched larvæ exhibit specialisation.

Abdominal dorsal tubercles: On the back four tubercles are placed, as it were, at the corners of a trapezoidal figure, those in front being near each other, those behind being more

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* Trans. Ent. Soc. London, 1900, p. 424.

remote. Such is the normal form in most groups of *Lepidoptera*, and in the nomenclature of Dyar* are known as—i. anterior, ii. posterior, trapezoidal tubercles. Newly hatched larvæ of *Rhopalocera* have the primitive position of the tubercles and single setæ (*Vanessa gonerilla*, figs. 9–11). After the first moult *Vanessa* larvæ acquire by coalescence of the anterior trapezoidal tubercles a single mid-dorsal unpaired tubercle (fig. 12), which, with the other abdominal tubercles, has numerous setæ. The trapezoidal tubercles of some *Psychidæ* (*Œceticus*, fig. 17) are reversed in position in newly hatched and adult larvæ. Some European *Psychidæ* (*Taleporia*) exhibit intermediate and normal position of the trapezoidals. Abdominal tubercles (iii.) supraspiracular, a tubercle always above the spiracle usually somewhat anterior, in *Geometræ* (figs. 5, 6) noticeably so. The primitive condition of the supraspiracular tubercle appears to be with a single seta in most groups—*Rhopalocera* (fig. 9), *Psychidæ* (fig. 16), *Noctuæ* (fig. 13). *Hepialidæ* have two supraspiracular setæ in the newly hatched stage, which, however, appear to arise from distinct separate tubercles. From its minute size the anterior seta suggests the original condition of two supraspiracular tubercles and the gradual loss of one (the anterior) amongst primitive *Lepidoptera* from which *Hepialidæ* were derived; and it is of interest to note that the supraspiracular in *Tinea* (*pellionella*, fig. 15) has two setæ, one of which, as in *Hepialidæ* (the anterior), is very minute. *Tinea* is certainly an ancient group of *Lepidoptera*, and its minute supraspiracular seta, with its less independent base, may represent a further stage in the loss of the ancestral second supraspiracular. Such a form as may be observed in *Arctidæ* of supraspiracular tubercle with numerous setæ (fig. 18) is unquestionably evidence of specialisation. A closely allied genus in the same group (*Nyctemera annulata*) has the supraspiracular and the other abdominal tubercles with primitive single setæ. iv. Postsubspiracular tubercle usually below the spiracle in a posterior position; in some groups is moved up level with the spiracle —*Geometræ* (figs. 5, 6), *Noctuæ* (fig. 13), *Arctidæ* (fig. 18). v. Subspiracular in all groups with which I am acquainted is below the spiracle and usually anterior. vi. A tubercle above the abdominal feet is usually not present until after the first moult in *Psychidæ* (fig. 16) and *Arctidæ* (fig. 18). In – x I have observed an area probably representing this tubercle in the newly hatched larvæ, but the seta is not developed until after the first moult. It may be noted that, whereas in *Hepialidæ* and other groups this tubercle (vi.) is anterior above the abdominal feet, in *Noctuæ* (fig. 13) it is posterior in position.

* Classification of Lep. Larvæ, G. H. Dyar, Ph.D.

vii. The basal tubercles on the base of the abdominal feet and in a corresponding position on the footless segments—*Hepialidæ* (*Porina*)—have three basal setæ (four in adult), but most groups have only two in the early stage (figs. 6, 9, 16, 18). The tendency throughout the *Lepidoptera* seems to have been towards a reduction in the number of primitive tubercles. That the ancient stock probably had a greater number of tubercles is suggested by the supraspiracular of *Hepialidæ* and *Tinea* and the basal setæ of *Hepialidæ*. Such modifications as take place after the moult are specialisations of recent acquirement, and when, as in *Metracias*, such is present in the newly hatched stage it is tolerably certain we have a comparatively recently evolved species. viii. is a tubercle on the ventral surface inner to the abdominal feet and on the footless segments, always present in all groups so far as my observations go.

A good deal might be said of the tubercles on the 9th and 10th abdominal segments, but I have been unable to make determinations of their value, which appears to be of rather a specialised character. There is also a great diversity in the structure of the tubercle setæ (figs. 8, 11, 18); probably the smooth hair-like seta is the more primitive form.

The number of abdominal feet is also various; in most groups there is a pair each on segments 3, 4, 5, 6, and 10. The anterior pair (segment 3) in *Rhapsa* and others are greatly reduced in size—are, in fact, little more than enlarged tubercles in the newly hatched stage. Other *Noctuæ*, as *Melanchra insignis*, have two pairs of feet reduced in size (of 3–4 segments), and not functionally operative in the newly hatched stage. Speaking from memory, some *Geometræ* are similar to *Melanchra* (*Rumia*, of Europe, for instance). Typical *Geometræ* (fig. 6) have abdominal feet between 6th and 7th and on 10th segments—two pairs only.

The number of rows of terminal hooks which more or less completely encircle the abdominal feet is various in different groups and genera of the same group—for instance, *Porina* and *Charagia* (*Hepialidæ*).

Pupæ in all groups of *Lepidoptera* differ greatly in structure from larvæ, and, though functionally quiescent as regards consumption of food and comparatively so in movement, it is in the pupal stage that the imaginal organs are largely developed and larval structures obliterated.

The pupa consists of the same number of segments as the larva, of which 8, 9, 10 abdominal are often consolidated and with difficulty identified. Movement, being practically confined to the segments between the posterior edges of the wing-cases and the consolidated anal segments, is often curtailed in the higher groups.

Imaginal organs are developed within well-marked areas of the pupa. The prothorax is small; mesothorax greatly enlarged at the expense of the other thoracic segments; from the latter and the post-thorax the wing-cases extend laterally and nearly meet together ventrally. On the ventral surface the head is anterior, with protuberant eye-pieces; the proboscis, antennæ, and legs are between the wing-cases. The anterior abdominal spiracles are subdorsal, and the others are lateral.

Rudimentary tubercle setæ correspond to the larval tubercles in position (fig. 19). In some groups, as *Rhopalocera*, prominent protuberances are developed. In most groups the armature of the posterior extremity of the pupæ is most interesting. *Nyctemera annulata* (*Arctidæ*) has a blunt posterior extremity, with about a dozen weak, thin, hooked bristles arranged postero-dorsally (fig. 23). *Melanchra composita* (*Noctuæ*) has a less blunt extremity, terminated by two strong spines, in front of which on each side are a lateral and a subdorsal spine (fig. 21).

The pupa of *Asaphodes megaspilata* (*Geometræ*) has a pointed extremity and two strong spines, and a single weaker spine on each side (fig. 22). *Vanessa gonerilla* (*Rhopalocera*) has the extremity of the pupa extended considerably, with a large number of terminal hooks by which it is firmly suspended from its silken pad.

Species which feed externally during larval existence may be pitted with small cavities or minutely rough on surface of the pupal segments, but have no segmental spines except at the posterior extremity; there may be exceptions, but this is characteristic. Species which feed internally during larval existence—in fruit or wood—or live in cases, have an interesting character in the pupal stage, in segmental spines or hooks, which assist the pupa to emerge from the larval habitat.

Hepialidæ have numerous points or spines (not hooks), which are placed close together along the anterior and posterior ridges of the dorsum of the abdominal segments, and also ventral spines; these are all directed posterior, are not present on the anal segments, which are without terminal armature. *Carpocapsa pomonella* (*Tortricidæ*) has anterior and posterior segmental spines on the dorsum; these spines are a little distance apart, directed posterior, and extend to the anal segments. There are no ventral spines, but the blunt anal extremity has an armature composed of a pair subdorsal a pair sublateral hooks on each side (fig. 24). *Œceticus omnivorus* (*Psychidæ*) is remarkable in the male pupa, which is provided with numerous small hooks on the posterior edge of the 3rd, 4th, and 5th abdominal segments dorsally; these are directed anterior. On segments 6, 7, and 8 a mid-dorsal patch of about twelve very strong hooks are directed posterior. The anal extremity is blunt, with a pair of strong hooks curved ventrally (figs. 19, 20).

It is unnecessary to refer to the structure of the imago stage, Mr. G. V. Hudson having done so in his work on New Zealand *Macro-lepidoptera*, but in my next papers, if you will have them, I shall give descriptions of the structure and life-histories in detail of those species of New Zealand *Lepidoptera* which I have been able to study and which have not hitherto been published.

EXPLANATION OF PLATE IX.

Fig. 1. *Vanessa gonerilla*, ovum, lateral view; × 50.
Fig. 2. „ ovum, apex.
Fig. 3. *Tinea pellionella*, ovum, lateral view; × 100.
Fig. 4. *Asaphodes megaspilata*, ovum, lateral view; × 50.
Fig. 5. „ 3rd abdominal segment, larva, first skin, lateral view; × 200.
Fig. 6. „ 6th and 7th abdominal segments, ditto.
Fig. 7. „ 9th and 10th abdominal segments, ditto, dorsal view.
Fig. 8. „ tubercle seta, much enlarged.
Fig. 9. *Vanessa gonerilla*, 3rd abdominal segment, larva, first skin, lateral view; × 200.
Fig. 10. „ 3rd abdominal segment, ditto, dorsal view.
Fig. 11. „ tubercle seta, much enlarged.
Fig. 12. „ 3rd abdominal segment, larva, second skin, dorsal view; × 50.
Fig. 13. *Rhapsa scotosialis*, 4th abdominal segment, larva, second skin, lateral view; × 50.
Fig. 14. „ trapezoidal tubercle and skin-growth; × 200.
Fig. 15. *Tinea pellionella*, 3rd abdominal segment, larva, first skin, lateral view; × 200.
Fig. 16. *Œceticus omnivorus*, 3rd abdominal segment, larva, first skin, lateral view; × 200.
Fig. 17. „ 3rd abdominal segment, ditto, dorsal view.
Fig. 18. *Metacrias strategica*, 3rd abdominal segment, larva, first skin, lateral view; × 200.
Fig. 19. *Œceticus omnivorus*, 6th abdominal segment, pupa, dorsal view; × 50.
Fig. 20. „ 9th and 10th abdominal segments, pupa, lateral view; × 50.
Fig. 21. *Melanchra composita*, 10th abdominal segment, pupa, dorsal view; × 50.
Fig. 22. *Asaphodes megaspilata*, 10th abdominal segment, pupa, dorsal view; × 200.
Fig. 23. *Nyctemera annulata*, 10th abdominal segment, pupa, dorsal view; × 50.
Fig. 24. *Carpocapsa pomonella*, 7th to 10th abdominal segments, pupa, lateral view; × 50.

(The magnification quoted is approximate, not absolute.)

Art. XVI.—*On "Sugaring" for* Lepidoptera *in Southland.*

By Alfred Philpott.

Communicated by G. V. Hudson, F.E.S.

[*Read before the Wellington Philosophical Society, 15th January, 1901.*]

During the spring and summer months moths are always more or less plentiful, and can generally be taken at various blossoms or netted in the evening, so that "sugaring" at this period is not an important means of obtaining specimens. But when the days grow shorter, and there are no attractive flowers in bloom, then "sugar" may be used with advantage. Even in midwinter many fine species may be secured, especially if the rigours of the season be broken by a few mild days. During June and July I have taken *Melanchra mutans*, *plena*, and *stipata*, *Bityla defigurata*, *Declana floccosa*, *Hydriomena gobiata*, *Xanthorhoe rosearia*, *Elvia glaucata*, *Selidosema dejectaria* and *panagrata*, and *Ctenopseustis obliquana*. In August several of the early spring moths are out, such as *utistriga* and *vitiosa*, *beata*, *semifissata*, and *suavis*, and these come eagerly to the alluring sweets. I think that midsummer is the poorest season to use "sugar"; there are then so many attractive flowers in bloom that artificial sweets seem to be despised.

It is of little use laying "sugar" in native bush, even if good tracks can be followed. The best situation is a few good trees surrounded by cultivation. I remember once travelling some distance to what I thought would be a splendid place for "sugaring." It was a little open space, almost surrounded by native bush, and with native herbage growing luxuriantly amongst the scattered tree-trunks. The night was warm and dark, an ideal night for moths; but after two hours' work I had taken but a dozen specimens. Before setting out, however, I had laid some "sugar" on a few *Pinus insignis* which shelter my orchard and garden, and on my return I found these trees absolutely swarming with moths.

The "sugaring" mixture should be placed on the sheltered side of the trees, and should be well rubbed in with the brush; if only laid on lightly much of it will trickle down on to the ground, where it is inconvenient to bottle the moths.

I prepare my "sugaring" mixture by adding a wine-glass each of beer and rum to a pound of black treacle and stirring thoroughly. I have tried port wine instead of beer and rum, and found it answer very well; but I do not think its effects are so lasting. If not in too exposed a situation the beer-and-rum mixture will attract very well for a week, without fresh material being laid. I have also tried condensed milk as a base instead of treacle, but, though apparently equally attractive, it is much too sticky to be recommended.

It is best to have two or three killing-bottles. One often has to take more than one specimen from the same tree, and if but one bottle is used it is probable that the first moth will escape while the second is being secured. It is well also to have a bottle or box to place the dead moths in, as they are liable to be knocked about by the freshly taken specimens.

The present season has, so far, been a poor one for "sugaring." Though the weather has been for the most part delightfully fine, chill easterly breezes have prevailed, a condition of things fatal to the success of "sugaring" operations.

Art. XVII.—*A Catalogue of the* Lepidoptera *of Southland.*

By Alfred Philpott.

Communicated by G. V. Hudson, F.E.S.

[*Read before the Wellington Philosophical Society, 16th October, 1900.*]

Nyctemera annulata.

Common everywhere. I have taken imagines from the 22nd September to the 4th June. Apparently full-fed larvæ are to be found in midwinter sheltering under logs and in crevices. During summer these moths may be seen shortly after daylight, often hovering about the foliage of tall trees. My friend Mr. George Howes possesses a specimen with no trace of the white spot on the hind wings.

Metacrias strategica.

I have taken this moth in the larval stage at West Plains, Otatara, Morton Mains, and Waihopai. I have been successful in rearing one male and several females. On the 19th November I obtained several larvæ and pupæ from Waihopai; from these some female moths emerged about the 25th November. From other larvæ secured I got some more female moths about the middle of January, and on the 13th February found small larvæ again at Waihopai. On the 25th February I found numerous larvæ at Otatara, varying in length from $2\frac{1}{2}$ to 9 lines. On the 6th October a full-fed larva was found at Morton Mains. The larvæ at Waihopai were found under the edges of logs lying on the grass; those at Otatara on the sides of the road, amongst herbage, or on the bare sandy soil. The pupæ are found under logs, enclosed in a slight oval cocoon composed of silk and the larval hairs. The female moth possesses but the vestiges of wings, but has strong legs, and antennæ about 2 lines in length. The male pupæ are more elongate than the females.

Orthosia comma.
Not common. November to March. During February specimens may be found on the flowers of the ragweed (*Senecio crucifolius*). Localities: West Plains, Mount Linton.

O. immunis.
Mr. Howes has an example of this moth, taken at West Plains on the 27th March. It was attracted by "sugar."

Physetica cœrulea.
Mr. Eli Fortune has taken several examples of this species at Orepuki.

Leucania griseipennis.
This moth may be taken at "sugar" early in October, and comes more freely during November. I have also taken it in the middle of March, and as late as the 4th April, but at no time is the moth abundant. West Plains.

L. nullifera.
I have not met with this moth, but Mr. George Howes has a fine specimen, taken at Waipori.

L. atristriga.
My earliest capture of this moth is the 21st January. During the latter part of February it frequents the flowers of the ragweed in great numbers, and may be taken till about the middle of April. The moth also visits the flowers of scabious, and comes freely to "sugar." West Plains and Mount Linton.

L. propria.
Fairly common, but, as I for a long time confused this species with *atristriga*, I am unable to give the dates of its appearance. West Plains.

L. alopa.
I have only met with four specimens of this moth, all taken at "sugar" on the 29th November. West Plains.

L. micrastra.
Two examples of this species were taken at "sugar" on the 13th March. West Plains.

L. sulcana.

This fine moth may be taken at "sugar" early in February, and is common during March and early April. West Plains, Waihopai.

L. semivittata.

Very common during November at flowers of white rata, and fairly common during February on ragweed. May also be taken in fair numbers at "sugar."

Ichneutica ceraunias.

Through the kindness of my friend Mr. George Howes, I have several examples of this fine moth in my collection. They were taken at Waipori.

Melanchra disjungens.

Mr. Howes has also furnished me with examples of this species, taken at Waipori.

M. paracausta.

My first example of this moth was obtained from a pupa found enclosed in a slight cocoon under a piece of bark on a fallen tree. On the 28th June, 1896, I took a caterpillar, which produced a female *paracausta* on the 22nd September. I give a brief description of this caterpillar: Length, 13 lines; dull-whitish; dorsal line of indistinct darker colour; subdorsal very faint; lateral stripe more pronounced; many minute specks of colour; head pale-brownish, with darker markings; dorsal surface of first thoracic segment darker. I took three or four larvæ about the same time which very much resembled this one, but they all produced *M. infensa.* In Hudson's "New Zealand Moths and Butterflies" an unfortunate error has crept in. In a note to the description of *M. paracausta* it is stated on my authority that the larva of *M. paracausta* greatly resembles that of *M. vitiosa.* This was a mistake of mine; *vitiosa* should have been *infensa.* I did not again meet with the moth till the 8th November, 1899, about which time I took five or six fine specimens at "sugar."

M. insignis.

This moth appears early in September, and in October occurs in great profusion, but appears to be over by the end of November. About the middle of February a second brood begins to emerge, and may be taken right on to the end of May. The moth visits the flowers of the ragweed, and comes readily to "sugar" and light. I have several examples in which the green shading is replaced more or less by yellow; but, apart from the difference in depth of colouring, there are no important variations. West Plains.

M. plena.

This moth may be taken nearly all the year round. I have taken specimens in every month but January and July, and no doubt with careful searching specimens might be brought to light in these months also. At the flowers of the white rata in November this moth is to be found in great numbers, and from April to June "sugar" will produce numerous examples. This species varies a great deal in the colour of the fore wings. The majority of the specimens are of a deep-green, but some examples are distinctly ochreous; others are very pale-green, while some are almost white, having but a faint tinge of green colour. I possess one example which inclines clearly to a blue shade. West Plains.

M. mutans.

Common in all localities. There seems to be a succession of broods from August to May. From larvæ and pupæ kept I have had moths emerge in August, December, April, and May. One larva pupated on the 17th July, the moth emerging on the 23rd September. Another pupated on the 14th October, the moth coming out on the 1st December. It is commonly found in May, and I have taken the moth as late as the middle of June, but it is most abundant in the latter part of October and in November. The moth comes freely to light and "sugar," and in February and March many specimens are to be found at the flowers of the ragweed. The female moth varies considerably in the ground-colour of the fore wings. I have several specimens in which the greater portion of the wing is white, and one example in which the colour very nearly approaches the silvery-grey of the female *ustistriga.* The male moth also exhibits some variation in shade, but not to such a large extent as the female.

M. pelistis.

I have not met with this moth during the spring and summer months, but during February and March the flowers of the ragweed swarm with them. In the middle of February I found many pairs in copulation on the gorse hedges. I have not met with any striking varieties. West Plains.

M. proteastis.

I took a few specimens of this species at "sugar" on the 8th April, 1900. West Plains.

M. vitiosa.

Early in September this moth may be taken at "sugar," and in October becomes fairly common, but during November its numbers quickly decrease. A second brood makes its appearance about the middle of March, and continues through April. Considerable variation is displayed in the ground-colour of the fore wings, some examples being a light-brown and others much darker than *proteastis*—almost black, in fact. West Plains.

M. tartarea.
Rare. I possess two specimens—one beaten from brushwood in April, 1897, and the other secured at "sugar" in April, 1900. West Plains.

M. homoscia.
This moth is also a rarity. I have one specimen, taken at "sugar" on the 9th October, 1899. West Plains.

M. composita.
This moth appears to be local, but is generally to be found in numbers near a field of red-clover. It does not seem to travel far from the clover-fields, as I have found that "sugar" laid at a distance of a few hundred yards from a field of clover would be visited by very few moths, while "sugar" laid on trees bordering the clover would attract hundreds of specimens. I have taken it from November to May, and have met with it at West Plains and Rimu, but I expect that it is pretty generally distributed.

M. steropastis.
I took several examples of this moth in October and November of this year (1900). West Plains.

M. infensa.
Fairly common about end of November. May be taken at "sugar" or on flowers of rata. My earliest spring capture is the 17th October, and I am inclined to think that the moth is not about much earlier than that date, as several specimens which I reared emerged on the 28th October and the 16th and 20th November. West Plains.

M. dotata.
A single example of this species is in the collection of Mr. E. Fortune, taken at Orepuki.

M. stipata.
This fine moth appears early in September, and is common till about the middle of October, after which it is rarely met with till the members of a second brood emerge, during February. This autumn brood, however, does not come up to the spring brood in point of numbers. I have taken examples as late as the 2nd June, but do not think that any of the moths live through the winter. "Sugar" proves very attractive to this species. West Plains.

M. octans.
One specimen, taken in March, at Mount Linton, on a block of bare limestone. The colour and markings of the

moth blended admirably with the rough surface of the rock, and were protective in a high degree.

M. rubescens.

Not common. An occasional specimen comes to "sugar." There appears to be an autumn brood only, as I have only met with the moth from about the end of January to the beginning of April. West Plains.

M. cœleno.

Mr. George Howes took two examples of this moth at West Plains on the 21st October, one of which he very kindly added to my collection.

M. ustistriga.

One of the earliest spring moths. My earliest record is the 31st August. During September and October the moth is extremely abundant, and comes freely to "sugar." A brood which I reared emerged from the egg — which is hemispherical, ribbed, and pale greenish-yellow in colour—about the 17th November; the caterpillars began to spin up on the 1st January, and the imagines to appear on the 15th February. In February and March the ragweed attracts a number of specimens, and the moth may be taken well on into April. West Plains.

M. prionistis.

Not common. I have met with a few specimens at "sugar" in October and April, and a few more at ivy-blossom in May. West Plains.

M. cucullina.

Mr. Howes has several specimens of this moth, taken at Waipori.

(Erana graminosa.)

I had a moth in my collection which was supposed to be *graminosa*, but as the specimen was in very poor condition, and as I have since lost sight of it altogether, I have placed this species among the doubtful ones.

Bityla defigurata.

Not plentiful at any time. Good specimens may be obtained from November to March, and, as the insect hybernates in the imago state, worn examples may be taken during the winter. These winter specimens appear to hybernate in companies, as I have several times found from ten to twenty specimens under the same piece of loose bark. The moth frequents the flowers of the ragweed, and also comes to light and "sugar." West Plains, Rimu, Orepuki.

Agrotis ypsilon.

Not common. First appears early in October. A second brood comes out late in February, and is most numerous about the middle of April. I have taken it at "sugar" and from flowers of ragweed. West Plains.

Dasypodia selenophora.

Mr. Howes informs me that a specimen of this fine moth was taken in a fruiterer's shop in Invercargill, probably brought down with fruit from the North.

Rhapsa scotosialis.

This is one of the earliest moths to appear in the evening. During October and November numbers of them may be found fluttering awkwardly round the edges of the bush. From March to May "sugar" proves attractive, and a good series can be obtained. The moth, however, must be carefully handled, being very easily damaged. The variation chiefly consists in light and dark forms, but there is also considerable difference in point of size. West Plains.

Tatosoma agrionata.

Not common. September to March. May be found in dense bush or in more open situations. In March the flowers of the ragweed attract a fair number of specimens, and often splendid examples may be taken from tree-trunks, in which case the protective value of the insects' colouring is exemplified, as the most exposed situations are often selected. West Plains, Otara.

T. timora.

Rather commoner than *agrionata*. Appears about the middle of October, and may be taken till the middle of May. "Sugar" will attract this moth, and it is frequently found at the blossoms of ragweed, white rata, and ivy. West Plains.

Paradetis porphyrias.

Extremely rare, but owing to its habit of flitting about amongst low herbage it is possibly often overlooked. I have met with but one specimen, taken on the 14th February, 1899. This specimen was taken during the day-time, from a patch of ragweed. West Plains.

Chloroclystis plinthina.

Not common. I have taken examples at Waihopai about the middle of November, and others in October and December at West Plains. The insect is subject to considerable variation. The type form, with the white patch in the centre of the fore wings, is, in this locality, much the rarest form. Mr. Howes tells me that he met with the moth at Stewart Island.

C. bilineolata.

Common. February to the end of May. Frequents the flowers of ragweed. West Plains.

C. antarctica.

I took five specimens of this moth in the summer of 1895–96, but I have not since met with the insect. West Plains.

C. lichenodes.

I have met with but two specimens of this pretty moth, both taken in the month of January. West Plains.

Elvia glaucata.

This beautiful insect is fairly common during February and March at the flowers of the ragweed. I have also taken it in May and July, but have no record of its appearance in the spring. West Plains.

Hydriomena gobiata.

Present nearly all the year round. The first specimens appear in September, and may be taken right on till June. Frequents the ragweed, and comes readily to "sugar." Hardly two specimens of this moth are exactly alike; in most examples the waved lines which cross the fore wings tend to form an oblique central band, which in some cases is so pronounced as to lose almost all trace of the lines which compose it. There is also considerable range in the depth of the ground-colour; I have specimens ranging from pale brownish-white to bright yellowish-brown. West Plains, Waihopai.

H. deltoidata.

Commonest in midsummer, but fairly numerous on ragweed in February and March. I found it in great profusion on the limestone cliffs near Mount Linton, and have also taken it at West Plains and Waihopai. This species varies even more than the preceding, but I have not met with any form strikingly distinct from the fine series of variations figured in Hudson's "New Zealand Moths and Butterflies."

H. rixata.

Not common. Most plentiful in January. Ragweed attracts a few specimens during February. West Plains.

H. similata.

Fairly common. November to end of May. During February and May examples may be secured from the ragweed-blossoms. West Plains, Waihopai, Pahia.

H. siria.

I am indebted to Mr. Howes for my example of this species. He found it fairly common at Waihopai during November.

Asthena schistaria.

I have taken this moth from February to April, generally in or near manuka. Ragweed proves very attractive to this species. West Plains, Otatara, Mount Linton. The Mount Linton specimens are smaller and somewhat darker than those from the less elevated districts.

Venusia verriculata.

I have one specimen of this moth, taken at a lighted window in Invercargill during April. Mr. Howes has several examples taken under similar conditions.

V. undosata.

Fairly common. October to March. Plentiful during March at the ragweed-blossoms. I have often beaten the moth from the pepper-tree, the leaves of which are greenish-yellow, edged with brown; the yellow wings of the moth, with their brown border, blend admirably with these leaves. West Plains and Waihopai.

Euchœa rubropunctaria.

Though this moth is probably abundant in open situations, I have but one specimen, taken on the 17th December at New River on the tutu-covered sandhills.

Asaphodes abrogata.

Abundant in open situations, especially in swampy places where there is plenty of rough herbage. In hilly country it frequents the gullies. I have taken it in March and April. Light proves strongly attractive. West Plains, Mount Linton.

A. megaspilata.

Abundant from October to March. It frequents the white-rata blossom, and comes readily to light. One of the earliest moths to appear in the evening. West Plains, Waihopai.

(A parora.)

A moth, which is probably this species, was taken at "sugar" on the 23rd May, 1899. West Plains.

Xanthorhoe rosearia.

This species may be taken all the year round; even in midwinter good specimens come to "sugar." West Plains.

X. semifissata.

Common. August to April. West Plains and Waihopai, but probably generally distributed.

X. præfectata.

Rare. One specimen at Pahia in February, and another one at West Plains.

X. clarata.

Taken during the summer months at Seaward Moss, Otatara, West Plains, and Mount Linton. The Mount

Linton examples are much larger and finer than those from the lower localities.

X. beata.

This beautiful moth is very common in wooded districts. It appears early in August, and may be taken till April. Large numbers frequent the white rata and ragweed, and "sugar" also proves attractive. West Plains, Waihopai.

X. ægrota.

Common. October to April. Frequents the flowers of ragweed, and comes also to "sugar." West Plains.

X. prasinias.

Not common. A few specimens at Waihopai in November, and others at West Plains in January.

X. cineraria.

The large form of this moth appears to be the summer brood, being about from November to March, while the small form appears in March, and is on the wing till July. West Plains, Mount Linton, Orepuki.

X. bulbulata.

I have a single specimen of this moth, taken at Mount Linton in March.

Lythria euclidiata.

I took a few examples of this pretty moth at Mount Linton in March. They were flitting about on the bare sheep-tracks.

Notoreas brephos.

I have not met with this moth in any situation but bare and dry roadways. During the summer months it is fairly common, but difficult to catch. West Plains, Mount Linton, Otatara, Seaward Moss, New River.

Leptomeris rubraria.

Apparently local. In 1894 I found it common at Rimu, about the end of April. I have not met with it anywhere else.

Epirranthis alectoraria.

Not common. A few specimens in February and one in June. West Plains. Extremely variable.

E. hemipteraria.

Very rare. One example taken in the summer of 1891–92. West Plains.

Selidosema suavis.

Not uncommon from March to May. I have also met with it in August, and have obtained good specimens in mid-winter. Considerable variation is exhibited in the depth of colouring, and also in clearness of the bands which cross the fore wings. West Plains, Orepuki.

S. productata.

Not uncommon. Appears towards the end of September, and may be taken till May. One example which I reared from a pupa found emerged on the 6th May. Fine specimens may often be secured by searching the trunks of trees at night. West Plains, Otara.

S. melinata.

Somewhat rare. A few taken in January at West Plains, and one at Pahia in February.

S. dejectaria.

Common. May be taken all the year round. In February and March it frequents the ragweed-blossom in great numbers, and on mild evenings in midwinter numerous specimens come to "sugar." The insect is very variable, but it is not improbable that some of the forms at present considered to be varieties may ultimately prove to be distinct species. West Plains, Pahia.

S. panagrata.

Extremely common. September to June. Comes readily to "sugar," and occurs in great numbers at the ragweed-blossoms in February and March. More variable even than the preceding species. West Plains, Otara.

Chalastra pelurgata.

I took several specimens of this moth in the spring of 1894 at Otara, but have not met with it elsewhere.

Sestra humeraria.

Very common during summer in the forest. West Plains, Waihopai. This moth exhibits considerable variation. I have one specimen with the surface of the fore wings thickly covered with minute dark specks. There are also a number of similar specks on the hind wings, and the ground-colour of the fore wings, between the basal line and the terminal series of black spots, is very much lighter than usual.

Drepanodes muriferata.

I met with this moth in the spring of 1894 at Otara. Mr. Howes has also taken it at West Plains. A pupa which I brought from Otara produced a fine moth on the 8th October.

Azelina gallaria.

Mr. Howes has taken a single specimen of this handsome insect at West Plains.

A. fortinata.

Not common. I have met with it in September, and have taken a few examples from the flowers of the ragweed in February and March. West Plains, Otara.

Ipana leptomera.

Fairly common at ragweed in March. I have also met with it in October. West Plains.

Declana floccosa.

This beautiful moth is not uncommon. It may be taken all the year round; "sugar," even in midwinter, will often attract some splendid specimens. Many curious varieties of this moth occur. I have examples of all the forms described in Hudson's "New Zealand Moths and Butterflies," and have also two or three varieties not there described. The first of these has the veins of the fore wings prominently outlined in black, and is a most striking variety, while another has the fore wings crossed at about two-thirds by a thin line of bright yellowish-red. There is also an interrupted red basal line and an irregular series of reddish spots near the termen. The thorax is also ornamented with two large reddish spots, and a single spot is placed on the abdomen.

D. hermione.

Mr. Howes has a fine example of this species, taken at Invercargill.

Sesia tipuliformis.

This introduced species is fairly common about currant-bushes during the summer. West Plains.

Sphinx convolvuli.

I have a mutilated specimen of what is probably this moth; it was brought to me in March, 1893. A good example was recently taken at Limestone Plains.

Vanessa gonerilla.

Towards the end of August the hybernated specimens of this fine butterfly begin to appear, and during September and October the insect is fairly common. A new brood appears about midsummer, and specimens may be taken till the end of March. I have met with it in mild seasons as late as the end of April. Generally distributed.

V. cardui.

I think I have seen this butterfly at West Plains, and Mr. Howes found it fairly common at Hastings.

(V. itea.)

Mr. Howes informs me that he saw a specimen of what was probably this species at Hastings.

Argyrophenga antipodum.

Very common in open situations. November to April. I found it extremely plentiful at Mount Linton, especially in the gullies on the hills. The flight of this butterfly is weak and irregular, and when a slight breeze is blowing the insect may be easily captured.

Chrysophanus salustius.

Generally distributed. Frequents the edges of and openings in bush. Appears in November, and is over by the end of February.

C. boldenarum.

Abundant during summer months. Frequents shingle near river-banks and similar situations. Mount Linton, Otatara, Hastings, Sandy Point.

(L. phœbe.)

A few seen at Mount Linton in November; perhaps referable to *oxleyi.*

Œceticus omnivorous.

This species is, I fancy, much rarer than formerly. I have not yet been successful in rearing a male, though I have fed a number of caterpillars. Generally distributed.

Orophora unicolor.

In the Dunedin Museum there are several specimens of this moth reared from cocoons taken at the roots of *Pinus insignis*, in Invercargill.

Porina dinodes.

My friend Mr. Eli Fortune has taken this fine moth at Orepuki.

P. cervinata.

Fairly common. Comes in numbers to light during November. West Plains.

P. despecta.

Fairly common. I am not very well acquainted with this species, but Mr. Howes, who has handled many hundreds of this and the preceding species, tells me that he is inclined to think that *despecta* is simply the female of *cervinata.*

P. umbraculata.

The commonest of the *Porinas.* Comes to light in great numbers during December. I have seen dozens of this moth fluttering at my lighted window during steady rain. West Plains, Mount Linton.

Diasemia graminalis.

Mr. Howes took several examples of this species at Sandy Point.

Nesarcha hybreadalis.

This handsome species is about from October to February. It is much commoner during some seasons than others. West Plains.

Mecyna flavidalis.

Generally distributed. Common in bushy situations and amongst rough herbage.

M. deprivalis.

Rare. I reared a few from pupæ found in crevices in the bark of a matai-tree. From nine pupæ obtained I reared four moths, all of which emerged during the latter part of November. West Plains.

M. marmarina.

Mr. Howes has a specimen of this moth, taken at Clifton in December.

Scoparia cyamenta.

Appears in September, and is very common during spring, summer, and autumn. I have also met with the moth in midwinter. Generally distributed.

S. psammitis.

Not common. September to middle of April. West Plains.

S. dinodes.

Not uncommon during spring and summer. West Plains.

S. chalicodes.

I have one example, taken in November. West Plains.

S. sabuloselia.

Extremely plentiful during the summer. Generally distributed.

S. rotuella.

Not common. I have obtained specimens in October, March, and April. West Plains.

S. submarginalis.

Generally distributed in bush districts. In some seasons the moth is comparatively rare, and in others it occurs in great abundance.

S. axena.

Mr. Howes has taken this moth at light in March at Invercargill.

S. philerga.

This species occurred in great abundance in the summer of 1898–99, but it is generally rather scarce. West Plains.

S. ustimacula.
Rare. A few examples taken in October and November. West Plains.

S. feredayi.
Rare. I have taken the moth in February at West Plains, and in April at Rimu.

S. trivirgata.
I found this moth fairly common at Mount Linton in December. Mr. Howes has specimens from Waipori.

S. colpota.
I have one specimen, taken at West Plains in December.

S. chlamydota.
Rare. January to March. West Plains.

Crambus flexuosellus.
Extremely abundant during spring and summer. Generally distributed.

Crambus siriellus.
I found this moth fairly common at Seaward Moss in January.

Diptycophora lepidella.
Fairly common from December to February. West Plains.

D. helioctypa.
I found this moth common at New River in December, and also plentiful at Seaward Moss in January and February.

D. auriscriptella.
A few examples were taken at Seaward Moss in January.

Musotima nitidalis.
Common amongst ferns and low herbage from November to February. West Plains.

Cryptomina acerella.
Not common. November and January. West Plains.

Tortrix leucaniana.
A few specimens in January and February, in swampy situations. West Plains.

Adoxophyes conditana.
Fairly common. December to March. West Plains.

Pyrgotis plagiatana.
Occurs all the year round, and is very abundant in the spring and summer. I have taken the larvæ in company with *obliquana* feeding on plum-leaves. West Plains.

Dipterina jactatana.
Fairly common in January and February. West Plains.

Cacœcia astrologana.

Not common. January and February. West Plains.

C. excessana.

Common. I have reared this moth from larvæ found feeding on plum-leaves and black-maple. May be taken in September, and is about till June. West Plains.

Ctenopseustis obliquana.

Abundant. May be taken all the year round, but is most plentiful in the spring and autumn. In the larval stage the moth is somewhat of a pest in the orchard, attacking apples and plums. It does not bore deeply into the flesh of the apple, but eats away the rind, causing much disfigurement. Plums are eaten into much more deeply than apples, but are not so liable to be attacked. No moth with which I am acquainted is easier to rear. The larva is an omnivorous feeder. Besides apples and plums, I have found them feeding on holly, black-maple, native fuchsia, pepper-tree, and many other native shrubs. Both this moth and *excessana* are extremely variable, and it is often a hard matter to separate the species. Generally distributed.

Heterocrossa epomiana.

Not uncommon from November to February. West Plains, Otatara.

H. adreptella.

Abundant during summer and autumn. Generally distributed.

H. exochana.

Not common. October to December. West Plains.

Microdes epicryptis.

Rare. September to January. West Plains.

Phryganostola achlyoessa.

Rare. One specimen in December.

Simæthis combinatana.

Not common. December to March. West Plains.

Tinea terranea.

Fairly common about outbuildings during the spring and summer. Generally distributed.

T. tapetiella.

Rare. A few examples in January and February. West Plains.

Blabophanes ethellela.

Common throughout the year. Generally distributed.

Atomotricha ommatias.

Plentiful during the spring. Comes readily to "sugar." West Plains.

Lysiphragma epixyla.

Not common. November and December. West Plains. The larvæ may often be found under the bark of dead broadleaf-trees, and the cocoons of the pupæ may be found in similar situations.

Semiocosma picarella.

Rare. A few examples in November and January. West Plains.

S. paraneura.

Rare. One specimen in October and two others in December. West Plains.

(S. austera.)

I have two or three examples of a moth which is probably *austera.*

Phæosaces liochroa.

Very rare. A single specimen in January. West Plains.

P. compsotypa.

Rare. Two examples in January. West Plains.

P. apocrypta.

Fairly common during the summer months. West Plains.

Heliostibes illita.

One specimen taken on the 25th January, on flower of Canadian thistle.

H. atychioides.

I have several examples of this moth, bred from larvæ found on manuka. West Plains.

Gymnobathra tholodella.

Very common. Generally distributed. January to April.

G. coarctatella.

Not uncommon. October to February. West Plains, Waihopai, Mount Linton.

G. omphalota.

This little moth is very difficult to capture, as it flits to and fro in the hottest sunshine. It is not common, but may be taken in fair numbers in November and December. West Plains.

G. parca.

Rare. Two examples, both taken in December. West Plains.

Mallobathra homalopa.

Not common. October and November. West Plains.

Capua semiferana.

Not common. November to January. West Plains.

Nymphostola galactina.

Very rare. One example in January and one in February. West Plains.

Plutella antiphona.

Not common. October to March. West Plains.

Gelechia monophragma.

Fairly common. November and December. West Plains.

Œcophora pseudospretella.

Common. December to March. West Plains.

Œ. siderodeta.

Common. November to January. Generally distributed.

Œ. macarella.

Very common. November to January. Generally distributed.

Œ. hemimochla.

Very common. November to January. Generally distributed.

Œ. griseata.

Mr. Howes has several specimens of this species, taken at West Plains.

Œ. oporea.

Rare. One example, in November. West Plains.

Endrosis fenestrella.

Common about dwellinghouses all the year round. Generally distributed.

Choreutis bjerkandrella.

I found this pretty little moth fairly common in October, flitting about manuka shrubs and other herbage in a swampy situation. West Plains.

Sagephora phortegella.

Not common. September to January. West Plains.

Eschatotypa derogatella.

Rare. December and January. West Plains.

Protosynæma steropucha.

Fairly common. September to April. West Plains, Waihopai.

Erechthias charadrota.

Fairly common. November and December. West Plains.

Strepsicrates zopherana.

Common in swampy situations in October. West Plains.

S. emplasta.

Fairly common in the spring months, in dense forest. West Plains.

S. ejectana.

I found this species very common among manuka scrub at Mount Linton.

Stathmopoda skelloni.

Not uncommon in December and January. West Plains.

S. caminora.

A few examples in December. West Plains.

Megacraspedus calamogonus.

The larvæ feed on the flower-heads of the toitoi (*Arundo*), and may be found in hundreds in February and March. I have reared several moths from the larval stage, and found that my imagines appeared in April and May. West Plains.

Platyptilia falcatalis.

September to March. Occurs in great abundance during some seasons, but is rather scarce in others. West Plains.

Pterophorus innotatalis.

I found this moth abundant at Mount Linton in March, and at New River in December and January.

P. lycosemus.

Mr. Gibb took a specimen of this moth at Haldane in February.

P. monospilalis.

Mr. George Howes has a single example of this species, taken at Waihopai in March.

Palæomicra chalcophanes.

Rare. One example at West Plains, in October.

Additional Species.

Melanchra diatmeta.

I have a single specimen of this species, taken at West Plains, but I have no record of date of capture.

Agrotis sericea.

Mr. George Howes has one, taken at Hastings.

Scoparia octophora.

I have one example, taken at West Plains.

Crambus apicellus.

One example, from Mount Linton.

Crambus ramosellus.

I have several moths which may be referable to this species, but they differ considerably from the type.

Art. XVIII.—Lepidoptera *of Mount Ida.*

By J. H. Lewis.

Communicated by G. V. Hudson, F.E.S.

[*Read before the Wellington Philosophical Society, 25th September, 1900.*]

The mountain-range that runs inland from the coast south of Oamaru, and loses itself in the broken country behind Mount St. Bathans, attains its highest altitude in Mount Ida (5,600 ft.). Situated as it is in the heart of the dry belt, the insect fauna of this mountain is extremely meagre, but withal exhibits some peculiar features, not the least interesting of which is the rapid and complete succession of species throughout the summer, more especially in the *Lepidoptera*.

On the shingle slopes near the summit *Erebia pluto*, the black mountain butterfly, is common enough, and, with swarms of *Argyrophenga antipodum*, lends an interest to the otherwise dreary prospect of tussock and shingle. No "Society for the Preservation of Butterflies" is needed to save these two hardy little species from extinction; they are secure in the possession of country that laughs to scorn the improving settler.

Between 3,000 ft. and 4,000 ft. *Notoreas insignis* occurs in March and April in abundance; it is particularly attached to a species of *Raoulia*. Except a few "micros." and a single *Dasyuris hectori*, I have seen no other moths on the higher parts of the range.

On the lower half, however, between 2,000 ft. and 3,500 ft., many species occur. Swarms of *Crambidæ* are out on every hot day, and, of the twenty species that I took last summer, no particular one had exclusive possession of the field, as is so often the case in other parts of the colony. *Crambus corruptus* may be excepted, but only in the very early spring. Of the rarer *Crambidæ*, I have taken *Thinasotia claviferella* commonly in March amongst sedge, while *Crambus flexuosellus* is a rarity represented by one specimen. On the Maniototo Plains, 1,000 ft. lower, *flexuosellus* is common enough. *Chrysophanus boldenarum* and *Lythria euclidiata* occur all through the summer in swarms, as well as a duller Geometrid, apparently new, which has the same habits as *euclidiata*.

The succession of species in the *Geometridæ* is somewhat marked on the lower levels, though not so noticeable as with the *Noctuidæ*. *Theoxena scissaria* shows first; indeed, my first specimen was taken at light while the snow was lying on the ground. I have seen none after August, but its habits in Canterbury appear to be different. Hybernated individuals of *Xanthorhoe semifissata* begin to show up in September, and with them the common *Xanthorhoe bulbulata*, which keeps on in undiminished numbers until Christmas, and then takes a back seat, though never disappearing. *Xanthorhoe cineraria* appears in October and November; and a week's hot weather in December is sure to bring out *X. orophylla* and *Notoreas brephos* in force. *Xanthorhoe clarata* appears in February (two months later than near the coast), and the last to show themselves are *Hybernia indocilis* and *Xanthorhoe semifissata*, both being attached to *Discaria toumatou*.

But it is with the *Noctuidæ* that the succession of species is the most striking. *Leucania acontistis*, one of the earliest, disappears completely after September, to be replaced by swarms of *Leucania griseipennis*, which prevails through November, but after Christmas is no longer to be seen. *Leucania unica*, *propria*, and *Melanchra lithias* hold the field each for a short time during January and February, but are generally extinguished after a night or two by *M. mutans*.

Such species as *Leucania nullifera* (the yellow form), *L. atristriga*, *Melanchra composita*, *rubescens*, *phricias*, and *ustistriga* come to light only in singles, and *Orthosia comma* occurs, but not commonly, throughout the summer. Amongst the rarities taken were *Miselia pessota* and *Bityla defigurata*. Of *Heliolhis armigera*, *Plusia chalcites*, and *Agrotis ypsilon* not a single specimen was seen.

The *Coleoptera* of the district are strongest in *Otiorhynchidæ*, the various species of which occur in plenty. With the exception of two large species of *Inophlœus*, none of the kinds are represented in my collection by less than twenty specimens. The species of the genus *Nicæana* are especially abundant, living as a rule in the patch plants on the shingle flats, and, as usual in a dominant genus, variation is rampant. The sexes also differ considerably, so that the list of established species must be severely revised.

In striking contrast to the Dunedin district, from which such a long list of *Pterostichi* have been recorded, only four species have turned up, *ovatellus* and *fultoni* being the commonest.

Our largest necrophagous beetle, *Necrophilus prolongatus*, attends to the waste products of the rabbit trade. Although only known from New Zealand, so far as I am aware, this species, like *Metriorhynchus* and a few others, is so unlike the general type of our fauna as to suggest naturalisation.

Art. XIX.—*On the Occurrence of* Metacrias strategica *at Invercargill.*

By George Howes, F.E.S.

Communicated by G. V. Hudson, F.E.S.

[*Read before the Wellington Philosophical Society, 28th August, 1900.*]

Seeing that only a single specimen of this insect appears to have been previously met with, a record of its occurrence in the Invercargill district, and a brief account of the habits and life-history of the species, may perhaps be deemed worthy of a place in the "Transactions of the New Zealand Institute." I shall not at present attempt to give a technical description of this moth in any of its stages, but shall only give a simple record of my experience in finding and rearing the larvæ.

My first specimen of the moth I reared in 1897 from a chrysalis taken from under a log in a swampy locality about four miles east of Invercargill. The cocoon was spun amongst those of *Nyctemera annulata* on the under-surface of the log.

On the 13th August I took several larvæ from under logs in the bush, which, from their resemblance to the caterpillar-skin adhering to the chrysalis of the *strategica* I had reared, I thought must be the larvæ of that moth. I found them in similar circumstances to the other—at the roots of grasses on the surface of the ground under logs. They harmonized so well with the dark-brown bush-earth and the brown stalks of the grass that it was hard to detect them. The bush from which I took them is on the banks of the Waihopai River, about two miles north of Invercargill. At various times I took as many as fifty caterpillars from this one place, and although I looked in other portions of the surrounding bush I could find no traces of the insect, although the conditions seemed identical. The area over which I found them scattered was about 4 chains long by about half a chain broad.

My records of captures give me: 13th August, 1899, six larvæ; 31st October, 1899, sixteen larvæ; 29th October, 1899, three larvæ, three pupæ; 10th September, 1899, fourteen larvæ; 22nd October, 1899, fourteen larvæ, two pupæ. These resulted in imagos as follows: 19th November, 1899—one male and one female emerged; 20th November, 1899—one male emerged; 29th November, 1899—one male and one female emerged; 5th December, 1899—two males and two females emerged; 7th December, 1899—one male emerged (the wings of this specimen never developed properly).

On the 27th November, 1899, I found a female moth in the bush at West Plains (about five miles north-west of Invercargill); it was lying under a log, and had laid its eggs in the usual manner—*i.e.*, it had burst open. Many of the eggs were lying scattered about, but the majority were still lying in the shell of their parent. Of these eggs about forty produced caterpillars, but, unfortunately, they all died within a week, so I suppose I had not placed them under their natural conditions. The caterpillars when first emerged were of a very pale golden-brown, and very small. The hairs were thinly scattered, and seemed very long in proportion to the size of the body. Of the female moths which I reared three laid eggs, but all the eggs proved unfertile, and as the moths simply fell to pieces I lost them also. The eggs are of a dull-white colour, and about the same size as those of *N. annulata*. I also took one female from the bush where I had originally taken the caterpillars, but the eggs produced no larvæ. On the 11th February, 1900, I again took six larvæ from this bush, but they were of small size.

On the 27th February, when passing down an unformed sand road at Otatara (due west from Invercargill, and about eight miles by road), I found these larvæ in fair numbers crawling along the sandy road in the full glare of the sunshine. They seemed to do very little feeding, but I noticed one or two that stopped to rear themselves up against a blade of grass for that purpose. They were all travelling towards the north, and varied in size from very small to half-grown.

On the 8th March I took six more from the same road. These were all about half-grown, with the exception of one, which was as small as though freshly emerged. All these were feeding, and it seemed to me that perhaps the period during which they wander might be over.

I noticed that there were two distinct types in this caterpillar, the one being a glossy-black above merging into rich-brown underneath, the other a deep glossy-brown above merging into light-brown below. The brown is, I think, the future male moth, and is generally larger than the black, or future female moth. The caterpillars, especially the darker ones, strongly resemble those of *N. annulata*, and I found I was liable to pass over them as such. This similarity may account for this moth being so little known, as it certainly spreads over a considerable area here. The hairs of the *Metacrias* caterpillar are longer, and are also arranged in denser tufts. There are also several long grey hairs projecting from its anal extremity. On being alarmed it rolls itself up into a ball and remains in that position for a considerable time. The caterpillars generally feed by day, but when nearly full-grown I noticed them feeding by night also. When full fed they measure about 1¼ in. in length. I found a caterpillar of this length under the same log with one of about ¼ in. in length. The small one died without pupating.

When about to pupate the caterpillar spins for itself a brown cocoon, into which it works its own hairs in a wonderful manner. The larval skin remains firmly attached to the extremity of the chrysalis. The chrysalis is jet black, and is incapable of movement. The head is very stout and blunted at the top, and the abdomen bends in slightly, so that the pupa has a curious curved appearance.

The moths emerged during the night or early in the morning, and in the case of the males had their wings dried by the evening. They were never restless, even when I kept them in the breeding-cage for several days. Of those I reared I only remember to have seen one flying.

When looking for pupæ in the bush I saw two moths flying, which I identified as *M. strategica,* but I could not catch them. Their flight was very swift, about 7 ft. from the ground, and greatly resembles that of the humble-bee.

The specimen figured by Mr. Hudson in his "New Zealand Moths and Butterflies" seems to be larger and more brilliant than those I have, but the markings in one of mine are somewhat similar. The female moth is wingless and of a dull-grey colour. The legs are exceedingly weak, and the moth can only crawl along very slowly by their aid. The female moth is very weak, and several of those I have reared never properly emerged from the pupæ, having pieces of it adhering to them. Two of them never left the cocoon, apparently lacking the strength to force their way out.

The larvæ I collected were free from ichneumons, but when collecting in the bush from which I had taken them I found a cocoon containing the fragments of a pupa, and by the side of these two ichneumon chrysalises from which the imagines had emerged.

Art. XX.—*Breeding Black Sheep: a Study in Colour.*

By Taylor White.

[*Read before the Hawke's Bay Philosophical Institute, 26th October, 1900.*]

For many years I have felt a great desire to experiment in an attempt to mate the black ewes which occasionally appear even in well-bred and carefully selected flocks of white sheep of different breeds with the black rams appearing in the same manner, not that I believe in the romantic biblical account of the mild swindle worked by the patriarch Jacob to obtain coloured and spotted cattle in the flocks of his uncle Laban, by placing rods having their bark removed in alternate rings in situations to be seen and noticed by the breeding-flocks when coming to the drinking-places, and thereby bringing about many cases of "mother-marking"; nor do I believe in the necessity for the great precautions taken by the late Mr. Macombie (the one time celebrated breeder of black polled Angus cattle) to have high paling fences erected, so as to prevent his pregnant cows from seeing other beasts of various colours when such might be passing along the contiguous main road, and thereby bring about cases of mother-marking. And, in my opinion, the incident mentioned in connection with this herd, in which several parti-coloured calves were at one season produced, the mothers having been influenced by the sight of coloured steers grazing in an adjoining field, is absurd. I think possibly the true cause was that among these supposed steers was an immature bull, which may have entered the adjoining field among the black cows unknown to Mr. Macombie, who would thus conclude that the red-and-white calves afterwards born were the result of an impression received through the eyesight of the mothers when pregnant to a black bull of the Angus breed.

If mother-marking were possible we might expect animals to be born of abnormal colouring—such as green, blue, scarlet, &c.; but we find that any species of animal can only vary in colours or shades of colouring within certain limits. These limits include accidental cases of melanism, or blackness, and albinism, or deficiency of the secretion of the substance named "pigment," or colouring-matter. True cases of albinism rarely occur among those animals which prove capable of thorough domestication by man. Grey horses, white cattle and sheep, and the Angora goat are not true albinos, for their eyes, horns, and hoofs retain the colouring-pigment; but rabbits, ferrets, rats, and mice produce true albinos, as seen in their pink eyes, there being no colouring-matter to hide the minute pink veins which ramify in all directions in the eye-ball; and these true albinos may be said to be held in captivity by man, rather than as being domesticated by him. It seems obvious that such animals as are readily domesticated are in like manner capable of assuming other colours than those of their wild prototype within certain limits, and especially the habit of becoming pied or marked with white. Some, too, lose all colouring-matter in the hair, although perhaps still retaining a ground-colour in the skin.

For some years I kept white bulls—father, son, and grandson—and when carrying the short summer coat, or hair, each of them showed a dark dappling on the skin when viewed at short range, but none of them had colouring on the ears. I never heard of an albino ox, but I believe such is sometimes found among horses, although I am unable to name any authority for such belief.

We hear of albinism among cats, but in such cases the eyes are of a blue colour, and they are said to be invariably deaf. In the dog I know of no case of pure albinism, the eyes always retaining their colour. Of these two animals—the cat and dog—the cat easily takes up a wild roaming life and becomes feral, as is indicated by this affinity to albinism.

Among poultry we have, by domestication, introduced white hens, ducks, and geese. The latter, however, are seldom a perfect white, which indicates a less perfect stage of domestication, although the so-called Chinese geese, having the raised knob at the base of the bill, are a pure-white bird, and thus show a period of longer domestication than those of Europe.

In a state of nature we have the white swan; or has the swan's colour altered under the hands of man? We know that the swans on the River Thames belonged to the Municipality, and that the young birds at the coming round of the season were pinioned and had placed on them an ownership mark. This custom is historical, and dates back into the long ago. Undoubtedly we have the opposite colour to white—namely, black—in the wild black swan of Australia, and which now roams wild through New Zealand. The ancients fully believed a black swan to be an impossibility, as will be seen by the old Latin proverb, expressive of incredulity, "*Rara avis in terris, nigroque simillima cygno*" (a scarce bird in the world, and very like a black swan).

The various colourings on one and the same feather seen on many kinds of birds has always been beyond my comprehension. For instance, the tail-feathers of the huia were so prized by the old-time Maori for head-ornaments that special flat-shaped boxes, having their lids elaborately carved, were made to contain these *kura*, or valuables. At the feather's tip there is an oval of pure white, about $\frac{1}{3}$ in., the main feather being a jet black. This marking is no seasonal or accidental occurrence, for each bird has its tail-feathers so marked, whilst there is no white on any other of its feathers, which are of a black colour. Truly we have much yet to learn on this subject.

Notice the colouring of the wild rabbit—reddish-grey on top and white underneath its belly, as we roughly term it. Some one says this is the case because the lower parts are away from the stronger light of day; but how about the tail, which is generally carried so as to have the white underside turned upward to view? This exposure of the white part of its scut by the rabbit so attracted the notice of that eminent naturalist Charles Darwin that he speaks of the habit as probably being of great service in guiding other rabbits, when fleeing before a common enemy, in the right direction to reach the warren or cover wherein a chance of safety existed. It would be rough on the followers if the leading rabbit was so flustered by fear that he carried his "signal-flag" in the direction away from home. But our question is this: Why is the scut of the rabbit on the upper half a rusty-grey colour and on the lower half a pure white? What guides the colouring-matter to the one part and prevents its approach to the other part? The whole scut, when divested of its hairy covering, is almost as insignificant in volume as the tail-feather of a small bird.

I have occasionally seen notice taken of locks of wool from coloured or black sheep which along their length showed different shades of colouring—perhaps among the darker bands would come one perfectly white. Such variations might originate from climatic changes or from an abundance or scarcity of feed at various seasons. I have seen this commented on in Australian newspapers. I have never seen samples of this myself, but my first coloured ram, which was of a rusty-buff colour, and was in consequence named "Tanner," was, when shorn, of a silvery-grey colour, although he would resume his original colour when the wool began to grow again.

What is the cause of saddle or collar galls or sores, when healed, having white hair growing upon them? You will sometimes see a black- or chestnut-coloured horse with white places where once these sores have been. I remember when a child seeing a boy who, though he had reddish hair, had at one side of his head quite a patch of pure-white hairs. From such an occurrence we may suppose the personal name of "Whitelock" originated.

We know by induction that the ordinary domestic duck is a domesticated form of the European wild duck, the male of which we term a "mallard." The mallard has this special peculiarity: that during winter and spring he is most beautifully coloured, the head and neck being of a glossy green; the breast dark-chestnut; the back light-grey, as of white feathers plentifully dotted or marked with a dark shade (possibly we might name it slate-colour); the tail and tail-coverts blackish, with several dark feathers curling up and backward; and an approximate colouring to this is seen in some breeds of the domestic drake. But during the seasons of summer and autumn all this bright colouring is lost, the colouring of the male bird then approaching that of the female; even the white ring around the neck between the green and chestnut colours is absent. How is this change of colour brought about? The change is gradual, because feathers of the new colour are seen among those of the former plumage. But I do not think the bird moults or sheds the feathers, for the strong flight- or pen-feathers certainly remain in position when the bird takes on the more brilliant plumage. The flight-feathers are annually changed during late summer, when the young birds of the season and many of the older birds are unable to fly owing to these pen-feathers being absent. At this stage they are termed "flappers," and are easily caught. We can see this gradual change of colouring in tame birds having the mallard colours, and it causes us to wonder whether they really change or shed their body-plumage. If we take either the Aylesbury or the white call duck we see no colour-change, and therefore we never have any suspicion that they moult twice during the year. On the other hand, the drake's curled tail-feathers are not visible when the bird is in autumn dress: are they shed, or do they lose the curl and lay flat along the other feathers of the tail?

Young ducks and other birds in their first plumage are all approximate in colour to that of the female or mother bird, and some do not take on the colours of the male until the ensuing spring, yet they have the inherent faculty or possession, held in abeyance, of the colours of the male; and, what is a still more singular thing, a female bird may for years be clad in appropriate female costume, but should ovarian disease cause her to be unfertile she is capable of putting on the dress of the male. Here we have birds carrying the unchanged or same cuticle, but capable of producing feathers other than those suitable to their sex. Such are often seen among domestic fowls and pheasants. I have also had two instances among my hybrid ducks, which had lived to a considerable age: these ducks also carried the curled tail-feathers, but one never took on the green head and neck of the male.

The European grey-linnet becomes much brighter in colours in early spring, but is said not to do so when caged.

Take special notice and you will see no change of colour during any season among domestic ducks, the drakes alone having the possibility of brighter colours. The drakes can be known at any season by the green colour of their beaks.

No doubt learned men have already studied and come to a reasonable conclusion on this matter of colour-change, but, if so, I have never had the luck to read their writings in explanation. Therefore, if I am behind the age in expressing wonder and surprise that these colour-changes are possible, I beg to be excused.

In ducks we have two pure breeds which, from the effect of melanism, are lustrous-black in colour. The larger of these is very similar in form and size to the ordinary domestic duck, and, if I remember rightly, is named the "Cuyagua"; the second is of smaller size and capable of flight, and is termed "Buenos Ayres," or "East Indian." Both breeds possess the curled tail-feathers as in the mallard, which is a sufficient indication of their being a domestic form or offshoot of *Anas boschos*, the European or northern wild duck.

Before entering upon an account of my personal experience in breeding a flock of black sheep I will make mention of information obtained elsewhere. Mr. Thomas McWhirter, the manager of Morven Hills Station, near Tarras, Otago, in answer to my inquiries, says that about six years ago there were about a hundred black sheep on the station, and he decided to separate them from the white sheep of the flocks and attempt to raise a black flock from them, and that now (1899) they number about a thousand head of black merinos. The first year there were a few white lambs born, but this was probably caused by a white ram accidentally straying into the flock. Some of the ewes were spotted, in which case they invariably had spotted lambs. Many of the lambs have a small white patch on the forehead and also have the tail white, the body being of a whole black colour. After the first year no white lambs were produced, and, although many experienced sheep-farmers scoffed at the idea of a black ewe having a black lamb, the result proved that, provided both parents were coloured, their progeny would be coloured also. Mr. McWhirter, in answer to my question, "Have any of the black merinos a small oval white spot below either eye, as I find to be mostly present in the Lincoln-merino cross?" replied that none of his sheep had these spots on the face. This is worthy of notice. The success of this flock is amply proved by the returns. Last season Mr. McWhirter had ten bales of black wool, which, as it was a larger line than usual, commanded some little attention, and the price realised was

10½d. per pound, which was equal to 1s. a pound for white wool, because the latter is always skirted and classed, whereas the black fleece was rolled up just as taken from the sheep's back, the belly-pieces being also left in. As Mr. McWhirter says, the unskirted black wool sold for equal value to the samples or bales containing his best skirted white wool. For example, white wool divides, when skirted by the roller at the wool-table, thus: Belly pieces, say, 6d. per pound; first pieces, 8d. per pound; stained pieces, 5d. per pound; the remaining fleece, 1s. per pound; fragments or locks, 4d. per pound. Now, all these inferior portions were included in the black fleece, unsorted, and realised 10½d. per pound.

The *Queensland Agricultural Journal* gives an account of a black merino flock of sheep owned by Mr. Allan, of Braeside, Queensland, which was started twenty-two years ago. Mr. Allan noticed that in spite of drastic culling black sheep occurred in all flocks, and was struck with the idea that possibly sheep were originally black. To test this theory he put pure merino sires to black merino ewes, and found that right from the initiation the experiment was a complete success, the lambs dropped being all black. An almost universal characteristic of these sheep is a small white spot on the forehead and another on the tip of the tail. Mr. Allan continued to breed from black sires and ewes for many years until the flock reached 2,000, at which it remained for some years. It has now been reduced to 20 rams, 600 ewes, and 250 wethers and weaners—a total of 870. The blackness of these sheep does not stop at the wool, but extends to the skin also, and Mr. Allan makes it a *sine qua non* that the tongue and the roof of the mouth should be black as well. The flesh of the animal is darker in colour and sweeter than that of the white sheep, and has a distinctly "gamey" flavour, akin to the taste of venison. It is thought that these sheep are much hardier and less liable to disease than the white ones. At the London sales in 1885 Braeside black wool brought 1s. 6½d. per pound for the fleece all round in the grease—that is to say, it realised just double what white wool of a similar character grown on the same country brought at that date. The black wool was principally used at that time—and still is—for undyed underclothing under Dr. Jaeger's system; also, there is a demand at times for black wool for certain continental religious orders who have to wear undyed woollen clothing. Latterly it fell in price through successful dyed imitations being used. Last December the Braeside black wool brought 10¾d. in Brisbane for the fleece. The black sheep cut from ½ lb. to ¾ lb. less wool than the white ones. There is less yolk or grease in the black wool, and hence there may be equal bulk of wool-fibre to compare with a white-woolled fleece of a heavier weight. This flock is mentioned by Bruni in his work " Sheep-breeding in Australia."

There are several other flocks of black merinos in Australia, the best known being those of Mr. W. A. Murray, Cappeedee, South Australia, and Mr. H. Beattie, Mount Aitkin. Mr. P. McFarland also had a black flock at Barooga, New South Wales.

My own coloured flock was commenced about ten years ago from a mixed lot of merino and Lincoln-merino ewes which I obtained by writing a circular letter to many of the principal sheep-owners in Hawke's Bay, asking for the gift of their black or coloured ewe lambs for the season. Messrs. Nelson Brothers, of the meat-freezing works at Tomoana, kindly offered to receive and paddock any black lambs forwarded for this purpose in mobs of fat wethers sent to their works until such time as a drive of black lambs should be collected together. Those collected, including some brought to Mr. John Harding's station at Mount Vernon, Waipukurau, made a total of ninety, which I brought on to my present location at Wimbledon. These ewes were bred to a reddish-coloured crossbred ram obtained for me by Mr. J. N. Williams, of Frimley, and the lambs of the first season—the produce of the black or coloured ewes, sired by the reddish-coloured ram—were all so-called black lambs. A few were parti-coloured or greyish, and several were tan-coloured, but there was not a single white lamb among them. Of the lighter coloured, or greys, it was noticeable that the lower parts of the body and the legs were of a distinctly darker hue than the back and sides, giving them the appearance of a wet water-mark such as would result from wading through discoloured water: their ears and faces were mostly a good black, and below either eye was a small oval or lozenge-shaped spot of white. These white marks may possibly be found to occur as special marks among one of the feral forms of the genus *Ovis*, and, if so, might thereby show a connection by descent of the domestic sheep from the feral *Ovidæ* having similar white spots on the face.

Charles Darwin and others specially discuss the subject of those singular circular tan spots seen on many different breeds of dogs, but are unable to point to any feral *Canidæ* carrying similar tan spots. One writer in *Nature* went so far as to suggest that the tan spots on the dog's forehead were specially designed to give the seeming of watchful eyes when the dog was sleeping, forgetting that the dog when at rest is mostly coiled in a circular form with the face turned inward.

For upwards of ten years I have continued to breed these black sheep, using black rams with a strong infusion of the Lincoln blood, and with the exception of one or two cases, which were easily traceable to a black ewe getting away in the season to a neighbour's white ram, not a white lamb has been born in the flock. Last shearing the black flock numbered 1,300. When using a black ram to white ewes some of the lambs are white, but about half the number are black.

Last autumn I used white Lincoln rams, and the black ewes have now following them pure-white lambs, many of which are twins or pairs. There are a few black lambs, about four to every hundred white ones. Six pairs of twins have compromised matters, in that one of the two is white and the other black.

The reason of my changing the colour of my flock is that my neighbours sell their white wool for 2d. per pound over the price given for black wool of the Lincoln type, which is a vast difference now wool is selling at such a low figure; and to produce fat sheep for the freezing business it is necessary to breed away from the merino, whose wool is of more value when black, and which is made up into the finer clothing materials.

You will see from this result that by using white rams in two years' time my flock will be entirely changed from black to white, notwithstanding that the ewes have some ten generations of black ancestors.

I will modify my description of the faces of the lighter-coloured sheep of my flock, in that these have light-coloured marks or bending stripes on a dark ground, and the outer edges of the lips of a light colour. These marks give the face a peculiar finished, perfect, or natural appearance, as of the type of a feral ancestor. The mouth, tongue, and inner skin of the lips are black.

Since this paper was written I have met with the following paragraph in *Nature* of the 28th June, 1900, page 201:—

"In a communication to the latest issue of the 'Proceedings of the Philadelphia Academy,' Mr. Witmer Stone shows that the various species of eider-duck, as well as the red-breasted merganser, have a 'summer moulting plumage' analogous to that assumed by the mallard after the breeding season. As in the last-named species, this plumage lasts only during the time when the birds are unable to fly, owing to the shedding of their flight-feathers, and its dull colouration is doubtless for the purpose of rendering them as inconspicuous as possible during this period. The author calls attention to the circumstance that the feathers of this temporary dress, like those of the first plumage of all birds, are very inferior in their structure. The moulting plumage of the eider-duck has hitherto been considered as the ordinary dress of immature birds."

So far as my own observation extends, I am of opinion that most or all of the *Anatidæ* become "flappers" in the early autumn, owing to the loss of the pen-feathers. In New Zealand the paradise-duck (*Casarca variegata*) and the mountain blue-duck (*Hymenolemus malacorhynchus*?) I have seen as flappers, but they undergo no change in colour during that period. But I have no recollection of ever seeing the mature grey-duck (*Anas superciliosa*) without flight-feathers, but this might be owing to their retirement to large water areas. If a duck is sitting on a second hatching of eggs the time of moulting is deferred, which is a singular instance of adaptation to circumstances.

Art. XXI.—*On Hybridism.*

By Taylor White.

[*Read before the Hawke's Bay Philosophical Institute, 26th October, 1900.*]

The study of hybridism, when such can be systematically and successfully followed out, will no doubt be one of the great factors whereby we shall in a great measure obtain a more correct insight into the secrets of creation and the origin of species. By inference we can conclude that all vegetable and animal life having kindred affinities has descended to our time along the one ancestral line. Take the ruminants, for instance, whose internal conformation is so arranged that they are fitted to chew the cud, and so are enabled to hurriedly collect food-materials with which they retire to a secluded or favourite "camp," where they contentedly put it all through the mill a second time: it is not possible for us of the present time to hold any theory admitting of a separately distinct creation of all the many species of ruminants; rather we assume they are all descended along the branches of the one ancestral tree. Admitting such descent along the same ancestral line, we are confronted by these problems: Why do closely allied species not breed together in a state of nature? At what stage did they lose the sexual instinct between a newly formed species and that from which it had immediately descended? Was it necessary for either species to be geographically divided? What influence—atmospheric, geographic, or otherwise—caused species to differentiate, and why do we now find all species stable, and incapable of throwing off a further distinct species?

At the present time species may vary within certain limits only—for instance, among the domestic sheep we find many varieties, but they still remain sheep, and the numerous kinds are all mutually fertile, though in many instances differing greatly in size or appearance one from the other, and the fact of their mutual fertility proves them to be varieties of the one species and not the evolution of new species.

Considering the great advance made in all branches of science during the last fifty years, it is not safe to assert that the limit of any particular branch of study has been already attained; rather let us keep watch for any opening which may give us a clue to the object desired. The subject of hybridism is of great interest to the breeders of domestic animals; and, if the reason for the unfertility of such animals should be at a future time properly understood and removed, there is every probability that useful domestic animals other than those we now possess might be added to our possessions. At present the ordinary mule, obtained by crossing the mare with the ass, is the only useful hybrid in the service of man; but Professor Ewart, of Edinburgh, is at present engaged in experiments hybridizing the horse and the zebra, and some very useful animals have resulted, such as might, if in sufficient numbers, be of great service in South Africa, where the horse is specially subject to certain diseases.

The study of hybridism is as yet only in its infancy, and should embrace the breeding-together of more than two allied species. For instance, Darwin mentions that a hybrid ass and zebra produced offspring by the horse; and in the Zoological Gardens at Regent's Park the bull, the gyall, and the American bison have been joined in the one animal. But to carry out such experiments on a sufficient scale to insure success should be a national undertaking; the lifetime of one or two enthusiasts is far too short, and persons having such tendencies seldom are supplied with sufficient capital.

It is noticeable how men of science are at times led astray by the writings of others, especially of those who lived in olden times and in foreign countries. Take the following extract from "Darwinism," by Alfred R. Wallace (page 163): "Geoff. St. Hilaire was the first to mention, I believe, that in different parts of South America the ram is more usually crossed with the she goat than the sheep with the he goat. The well-known 'pellones' of Chili are produced by the second and third generations of such hybrids" (Gay, Hist. de Chile, vol. i., page 466—Agriculture, 1862). Hybrids bred from goat and sheep are called in French "*chabin*," and "*cabruno*" in Spanish. In Chili such hybrids are called "*carneros lanudos*"*; their breeding *inter se* appears to be not always

* "*Carneros lanudos*" is Spanish for "wool-bearing sheep"—*i.e.*, the alpaca—as a distinction from the llama, which has no fleece. Compare with Latin *carnis*, flesh; *lana*, wool = woolly mutton.

successful, and often the original cross has to be recommenced to obtain the proportion of three-eighths of he goat and five-eighths of sheep or of three-eighths of ram and five-eighths of she goat, such being the reputed best hybrids.

And take this extract from "The Angora Goat," an American publication, by John L. Hayes (page 131): "The Alpaca and its Congeners.—When the Spaniards under Pizarro made the conquest of Peru in 1533 they found in the country four species of animals a little different from each other, to which, from their coarse resemblance to the domestic sheep, they gave the name of 'sheep of the country' (*carneros de la tierra*). Two of the species—the llama and the alpaca—had been in a state of domestication among the natives; . . . the two others—the guanaco and the vicuna—lived wild in the high mountains of the Andes." Mr. Ledger says all four species are fertile together—the wild vicuna seeks the female alpaca at rutting-time.* At page 137 Mr. Hayes quotes from the old-time Spanish writer Pedro de Cieza de Leon as follows: "It appears to me that in no part of the world have sheep like those of the Indians been found or heard of. These sheep are among the most excellent creatures that God has created, and the most useful. . . . To supply this need the giver of all good things, who is God our Lord, created such vast flocks of these animals, which we call 'sheep', that if the Spaniards had not diminished their number in the wars there would be no possibility of containing them."

Quoting from "On Colonial Wools," by Thomas Southey (1848): "It is said that not only are hybrids between the goat and sheep common in Chili and Peru, but that in those countries goats and sheep are mated intentionally to produce them." He also quotes Dr. Adam Smith ("Peru as it is," 1839), to the effect that "in Chili it has been frequently found that by crossing the goat with the sheep the fleece has resulted of a long, lank, lustrous, and consistent quality, and when woven has greatly imitated the finest camlets. The intention of this was originally to avoid the tedious process of plaiting the sheep's fleece on the skin to make it suitable for 'pellones,' or saddle-covers, and the experiment succeeded beyond expectation. The best and largest 'pellones' come from Arauca, where the Indians, chiefly leading a pastoral life, take great care in selecting the best breeds for mixture, and in preparing them (by a peculiar method) for their own use and for the purposes of trade. The skins are large, light when dry, and the wool is allowed to grow to a great length

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* Mr. Ledger imported these animals to Australia some fifty years ago, and made a special study of their habits in their native land.

(10 in. or 12 in. at times) before the animals are killed. The colour is generally bluish. They are used as covers for the deep saddles of those countries, sometimes three or four skins being thrown over one saddle, and in the sudden and violent rains which are common there these 'pellones' are found useful as a shelter for rider and horse."

I think we may safely come to the conclusion that the sheep and goat hybrids here mentioned were the domesticated alpaca, which gave the required length of wool even in the time of the Peruvian Incas. The animals are ruminant, but are more allied to the camel than to the sheep, having two toes on either foot, and not hoofs.

I read that the first marketable fabric from alpaca wool was made in Europe about 1832 by Benjamin Outram, of Greetland, near Halifax, England. In 1839 Mr. (afterwards Sir) Titus Salt was the only spinner of alpaca yarn in Bradford.

A further instance of mistakes made by old-time authors is found by quoting Pliny, who says that in his time the Corsican goat interbred with the sheep. This is easily corrected. Here, without doubt, the wild sheep indigenous to the Island of Corsica, called the "mufflon"—a true sheep—is mistaken for a goat. If Pliny had not mentioned Corsica his mistake would not have been so readily detected.

Mr. Low, in "Domesticated Animals of Great Britain, says, "It has been long known to shepherds, though questioned by naturalists, that the progeny of the cross between the sheep and goat is fertile. Breeds of this mixed race are numerous in the North of Europe." Dr. A. R. Wallace remarks, "Nothing appears to be known of such hydrids either in Scandinavia or in Italy."

That such sheep hybrids may occasionally occur is not to be denied. The naturalist Buffon ("Supplement," tom. iii., p. 7, 1756) obtained one such hybrid in 1751 and eight in 1752. Sanson ("La Culture," vol. vi., p. 372, published 1865) mentions one in the Vosges, France.

I may here remark that many persons, through ignorance and the remnant of some ancient superstition, consider that the breeding of hybrids is incestuous, and contrary to the laws of God—quite overlooking the fact that the ruler of all things himself can decide whether such things shall occur or not with or without the intervention of man. Possibly not one of such prejudiced persons could quote the biblical command given to the Jews—"Thou shalt not suffer thine animals to gender with diverse kinds." The most remarkable point in this command appears to be in the fact that to produce hybrids is a most difficult matter, and therefore hardly worthy of special legislation. In any case, such a superstition in the hands of the ignorant, so far as my experience goes, is likely to cause any such *lusus naturæ* to be put to death.

Mr. S. C. Cronwright Schreiner, in "The Angora Goat," published at the instance of the South African Goat-breeders' Society in 1898, says. "Crossing between the goat and sheep is not unknown in Cape Colony. I have seen four animals represented as being the hybrid progeny of such a cross—three exhibited at Port Elizabeth shows and one at the Queenstown show—all, I believe, purporting to be crosses between the Angora goat and the Cape (Africander) sheep. That exhibited at Queenstown was said to be such a cross. I examined it closely, and am quite satisfied it was a hybrid between an Angora and a sheep, probably an Africander sheep. It was a well-grown animal, about six or eight months old, not having yet cut its teeth"—(*i.e.*, its two middle teeth of the mature mouth, indicating the age of eighteen months or thereabout, as is the case in both sheep and goats)—"and was fat and healthy. Looked at not too critically from a few yards distance it would be mistaken for a sheep, owing mainly to the shape of the horns, which were curled close to the skull, imparting to the head a sheep-like appearance, and to the fleece, which had an even 'top,' and showed no ringlets. When examined closely, however, the face, though covered with soft down and quiet in expression, more resembled a goat's, and the compact fleece when opened was found to be mohair, peculiar looking and crimped somewhat like wool, but undoubtedly mohair, about 2 in. in length—the inch length nearest the skin being bright lustrous-yellow, the colour due, no doubt, to the exudation of some natural secretion of the skin. The animal's legs were not woolled."

This description of the Angora-Africander sheep hybrid would at first sight seem to be clear and sufficient, but when we remember that the Angora and Africander sheep carry no wool or down on the face, and that the latter has no wool on any part of its body, the question arises, From which parent is the face covered with soft down inherited? Somewhat of that style of face might be found among high-class merinos, but all or most other breeds of sheep have the face covered in short hairs, excluding the tuft or topknot between the ears, which in certain breeds is a fair wool, and in others is entirely wanting. Possibly Mr. Schreiner wrote the description of this animal from memory, some time after seeing it.

Of the genus *Bos*, or oxen, nearly all the different species are mutually fertile with each other and *inter se*, excepting the Indian buffalo and the European bison, sometimes called the "Aurochs." This latter animal, I believe, has never been successfully tamed or subdued by man. A cross between the Indian zebu, or humped ox, and our domestic oxen is said to have been the original foundation of most of the large herds of oxen now inhabiting Tasmania. Various species of *Bos* may have originally been domesticated by primitive man, obtained in lands wide apart, so far back as the Neolithic or Polished Stone age. These different species have, no doubt, in many cases been accidentally interbred one with the other as man migrated from place to place, according to the exigencies of the time in which they lived; and so new breeds of oxen were originated of whose origin we have now no record.

I consider that the laws of hybridism should be systematically studied, and that before long scientists will understand that hybridism can be worked among kindred races of animals on similar lines to those of hand fertilisation, now successfully carried out by the horticulturist among plants, but that among animals the service of one female will require to be transferred to a female of the kindred race.

I may here mention my own experiment in endeavouring to produce hybrids between the sheep and the Angora buck goat by placing twelve ewes (all of which, excepting one crossbred Lincoln-merino, were pure merino) in a well-fenced paddock (field) with two twelve-month-old Angora bucks. To insure their remaining with the sheep, one of the young bucks was fastened by a dog-coupling chain and collars to one of the strongest ewes, which caused his mate, the other buck, to become accustomed to feed with the sheep, and there appeared every chance of some hybrid offspring resulting; but when the season for lambing came round none of the ewes dropped a lamb. Keeping these same animals together, and adding to them twelve other ewes (making a total of twenty-four), a similar trial was made during the following season, and from the activity of the buck running free every expectation of a successful result was entertained; but later on a merino ram was turned into the paddock, and each ewe produced a late lamb from the merino ram.

After several years' trial I raised fertile hybrids between the common European domestic duck, which no doubt are the result of domestication from the wild duck or mallard of Europe (*Anas boschos*), and the male of the New Zealand grey-duck (*A. superciliosa*). These I have bred together (*inter se*) for some fifteen years, and they still remain fertile. They are intermediate in size between the two pure breeds, and so far have shown no inclination to interbreed with the wild grey-duck, though (as at the present time) there are usually six to nine of the wild birds on the same small pond which come and go at will. If the hybrid drakes were taken away I have little doubt that some of the grey-drakes would mate with the hybrid ducks. At the same time I feel assured that if the common domestic duck were allowed on the pond they would intermix with the hybrids readily. The grey-ducks, being smaller than the hybrids, are made to keep their distance by the larger birds, though still passing backwards and forwards among the hybrids on the pond.

In trying to breed for the light-green speculum seen on the wing of the grey-duck in preference to the green-blue of the domestic duck, the result has been that the top coverts of the wing-bar are white, while the pen-feathers are becoming grey-brown edged with white in place of the green-blue; so that by further selection a white speculum might be obtained, or, on the other hand, the speculum would be obliterated, the entire wing becoming similar to the colour of the rest of the bird's plumage.

Among these hybrids two instances of very old ducks becoming barren and assuming the plumage of the male have been noted. The first showed full male plumage, even to the curled tail-feathers, excepting that the neck and head still retained their original colour. The duck now alive never gets the speckled white breast or back-feathers perfect; her head and neck inclines to green, and the tail and tail-coverts are blackish as in the mallard, and she has also the curled feathers. In both ducks the bill retained its colour of yellow and black, and did not become green, as in the perfect drake. The bill and legs of the *A. superciliosa* are blackish, and it is notable that the hybrid ducklings have dark down with black legs and bill, although when mature their legs become orange-yellow. From nine to eleven young are hatched out by these hybrids after inbreeding for many years; but they seldom nest a second time during the one season.

The drakes have the breast, thighs, and back of speckled white feathers; neck and head, the green of the mallard. I have tried to breed out the white neck-ring and the chestnut-red breast which occasionally appears. The tail and coverts are blackish. The ducks are of two shades of yellow-brown, each feather beautifully marked by dark lines or spots. The lighter-coloured ducks seemingly correspond with the chestnut-breasted drake. Why there should be a number of ducks uniform in colour of a light shade, and others equally uniform of a darker shade and with somewhat different markings on each feather, I am at a loss to decide. There are none of various or intermediate colours—just the two shades of colour, and of the two the light-coloured ducks are somewhat larger than the others.

Comprised in the small museum of curios collected in the entrance-hall of the Tavistock Hotel, Waipukurau, Hawke's Bay, is a very handsome specimen of a female hybrid of the third generation from the domestic duck crossed with the

New Zealand grey-duck, and the progeny again bred to the grey-duck. This bird I lost when travelling to my present location some twelve or more years ago. It is of a white colour, slightly shaded about the breast with yellowish-grey, but very lightly—scarcely perceptible; speculum or wing-bar green, as that of the grey-duck; bill and legs blackish. The mother of this bird was very similar to the wild grey-duck, both in size and colour, and her second laying of eggs always produced these white shaded birds, but only two were ever reared to maturity—this duck and a small-sized drake of similar but rather more rufous shading on the breast; speculum also a like shade of bright-green.

The following newspaper-cutting is of interest: "Mr. De Lautour, the present curator of the Masterton Fish-hatcheries, alleges that the indiscriminate use of male fish in impregnating trout-ova in the past has resulted in the production of 'mules,' and that male fish suitable for breeding are scarce in consequence. Spawning for present season is nearly completed at the Masterton Fish-hatcheries. So far 410,000 brown-trout eggs have been secured, and 10,000 are hatched; 185,000 rainbow eggs, and 25,000 hatched to date. The largest fish secured for stripping by the curator, from the Ruamahunga River, was a female fish weighing $11\frac{3}{4}$ lb.; the largest male fish secured weighed $9\frac{3}{4}$ lb." Judging from the remarks here made I would suppose that these "mule" fish were perfectly barren and unable to produce milt, whilst the female "mules" would in like manner be deficient in spawn. This would indicate that in hybrid fish of the same genus the fiat "Thus far and no further" was clearly defined.

I have two plants in my garden, growing very much greenery and 6 ft. in height, just coming into flower—biennial. They are from a radish fertilised naturally from one of the cabbages, but, like plants grown seven years ago, they will have no seed.

Art. XXII.—*On the Fresh-water Shells of Rissington, Hawke's Bay.*

By F. Hutchinson, Jun.

[*Read before the Hawke's Bay Philosophical Institute, 26th October, 1900.*]

Rissington is a small sheep-run situated about seventeen miles north-west of Napier. It stands, as one might say, on the border between the rich monotonous hills and plains of the seaboard and the wilder gorge-rent uplands that lift wave upon wave inland to rest at last on the stony flanks of the great Kaweka Range.

The surface-features of its 4,000 acres consist of a bold limestone-crowned hill standing out from a base of the hummocky rolling country—such a feature of the papa country of this north-east portion of Hawke's Bay; sweep upon sweep of low rounded hills, drained by a network of tiny gullies feeding the four main streams that with the wear-and-tear of ages have cut great clefts lengthwise down the place—clefts wide and tame in their lower courses, where they join the Mangaone, a tributary of the Tutaekuri, but deepening inland into the wildest of gorges, walled with great cliffs of blue marl and brown conglomerate.

The gullies of the uplands for the most part are poor in springs, furnishing each its tiny creek of surface-water during the winter rains, but grass-bottomed and dry in the summer months. Here and there, however, a spring supplies a quiet earth-bottomed stream, swampy, with still, deep pools—pools loved by the poor hunted ducks when persecuted from their feeding-grounds in the wide lakes and swamps of the lowlands—pools that in two cases broaden out into the dignity of small lakes. The main creeks of the gorges are of a totally different character—wearing, tearing, turbulent shingle-carriers, hurrying down over wastes of rounded pebbles that ever shift and grind and pummel each other on their way to feed the great shingle-spits of the coast. But one and all—lakes, pools, and brawling torrents—have their quaint little shelled inhabitants, from the smallest yard-wide pool of permanent water, with its score or so of univalves and bivalves, to the countless hosts crawling over the mud of the lake-bottoms or clinging to the water-worn boulders of the creeks.

Now, we have in New Zealand some twenty-three species of fresh-water shells, eighteen of which are univalves or spirals, and five are bivalves. Of these we have on Rissington eight species, of which six are univalves and two are bivalves. We have thus, roughly speaking, a third of the number of fresh-water shells ranging through our Islands. Dividing the univalves again, we have two of the river-snails, or *Hydrobiidæ*, and four of the pond-snails, or *Limnæidæ*.

To understand the distinction between these river-snails and pond-snails, let me take you down to the mouth of Sturm's Gully for a few minutes. You will find the rocks of the beach there studded with the shells of two relatives of the English periwinkle—one, *Littorina cincta*, a small edition in shape and colouring of the English shell; the other, *Littorina cærulescens*, a dirty-white shell with a broad band of slate-blue running round its turns or whorls. Pick one off the rock, and you will find it quickly shuts up the entrance of its shell with a neatly fitting horny cap or lid, the operculum. If you look about in the fennel-jungles of the cliff-bottom you will find plenty of that handsome familiar garden-pest, the common snail. Notice that as he drags himself, bubbling, into the recesses of his shell he has no operculum. The periwinkles have gills, breathing water; the snails have lungs, breathing air. Now, the river-snail is, broadly speaking, a periwinkle that in the course of ages has taken to the fresh water instead of the salt—in fact, "river-periwinkle" would be a much more appropriate name for it; the pond-snail is a relative of the snail that has taken to fresh water in preference to a land-existence, still retaining, however, its lungs.

River-snails (Hydrobiidæ).

Our two species of river-snails are *Potamopyrgus antipodarum* and *Potamopyrgus corolla*. They are both very common in all our creeks, lakes, and pools—in fact, in any of our permanent water. Drag out a bundle of duckweed, water-cress, or any floating herbage or timber, and you will be sure to find it studded with tiny black-brown spirals, varying in size from young shells the size of a pin's head to adults up to $\frac{1}{4}$ in. in length. As a rule, in the more rapid creeks they are under this size, but in the still mud-bottomed pools of our narrow flats they come well up to this measurement.

Potamopyrgus antipodarum is by far the commonest. You will see it is not unlike its sea-going relative, the brown periwinkle—the same rounded whorls, with the mouth of the shell closed by an operculum.

Potamopyrgus corolla is a more striking shell than the preceding species, the whorls being angled or turreted, and along the angle of the last three whorls is a row of spines. These spines are well developed in the shells from still water, but in our rapid creeks they are worn down to short stumps or absent altogether, only the angle remaining to distinguish it from *P. antipodarum.*

POND-SNAILS (LIMNÆIDÆ).

Of these our four species are *Amphipeplea ampulla*, *Bulimus antipodeus*, *Bulimus variabilis*, and *Planorbis corinna.*

Amphipeplea ampulla is common in all our lakes and pools, and occasionally in the still back-waters of our larger creeks and rivers. As its specific name "*ampulla*" denotes, it is not unlike a flask, the first three whorls being perched in a small spire on the greatly enlarged body-whorl. It is a fragile, translucent, horn-coloured shell, from $\frac{1}{4}$ in. to $\frac{3}{8}$ in. in length. Its fragility probably accounts for its absence from the more rapid reaches of our streams. On the shallow, turbulent shingle bottoms its place is taken by the more solid river-snails. Compared with the river-snails, notice the larger, fleshier body, and the absence of the operculum.

Bulimus antipodeus, the largest of our fresh-water spirals, is a stronger, more opaque shell than the "flask snail," and has in the adult a longer, narrower spire. The turns or whorls of the shell run in the opposite direction to those of the "flask snail," going from left to right, and so termed a left-handed or sinistral spiral. The "flask snail," as also the great majority of shells, are right-handed or dextral spirals. Note that the whorls are not keeled or angled, a distinction separating it from the next species, *B. variabilis*, which always has the body-whorl more or less angled. It seems to me that *B. antipodeus* merges by transition forms into *B. variabilis*, but as it is placed as a distinct species I give it as such.

Bulimus variabilis, as its name denotes, is an extremely variable shell—so much so that some authorities rank its varieties, *B. mœsta* and *tabulata*, as distinct species. It is distinguished from *B. antipodeus* by the body-whorl being more or less angled or keeled. *Bulimus* and *Amphipeplea* resemble each other rather closely in the young state, the body-whorl of the former being larger and of the latter smaller in proportion than in the adult shells; but an unfailing distinction is that, whereas the whorls of *Amphipeplea* run from right to left, a right-handed or dextral spiral, those of *Bulimus* run from left to right, a left-hand or sinistral shell.

Planorbis corinna, our last fresh-water spiral, is the solitary member of its genus in New Zealand—and a very small and inconspicuous member too. Of a very different form from the preceding shells, its whorls, instead of being elevated more or less into a spire, all lie on the level, in the same plane—that is, the whorls increasing gradually in size, so that the last or body-whorl is not so large in comparison with the other whorls as in *Amphipeplea* and *Bulimus*. In size it ranges here from

$\frac{1}{8}$ in. downwards. In some parts of New Zealand it is decidedly larger. The little brown discs are easily overlooked, as they haunt the neutral-tinted reeds and raupo-stems and other floating *débris* of our lakes, particularly as, in common with nearly all fresh-water shells, they are often coated with an earthy deposit—so thickly at times as to blind the inner whorls completely.

Of the common river-mussel I need say but little. We can only just claim it as an occupant of Rissington: in fact, I doubt if we have any living within the boundary, all I have found being dead shells on the banks of the Waihau Creek. A small feeder (dry in hot summers) comes into this creek from one of the Ardlarsa Lakes, in which mussels are plentiful. Heavy floods, raising this lake, will send a few mussels occasionally down the feeder—dead shells, as I have said, careful search having failed to reveal any living bivalves in the Waihau.

Its small ally, *Pisidium novæ-zelandiæ*, our so-called fresh-water cockle, will often escape the ordinary observer from its small size and retiring habits. A translucent shell, varying in colour from pale-horn to nearly white, it is to be found in great numbers sunk in the black ooze or gliding over the sandy mud in all our still, permanent water, in company with the pond-snails, though, like them, absent from the rapid shingle-bottomed streams. Our largest specimens are $\frac{1}{8}$ in. in length.

Distribution.

Just a few words as to the distribution of these fresh-water shells in Hawke's Bay.

Taking first the river-snails, you will find them almost omnipresent in all permanent water, whether rapid or sluggish. Far up in the rugged subalpine gorges of the Kaweka, amongst the beginnings of our rivers, I have found the tiny black spirals abundant; following down these streams, in the turbulent cataracts of the middle reaches, they cling in colonies round the boulders, and crawl in thousands over the mud of the back-waters; down through the long shallow shingle-stretches as they widen out between the ever-lowering hills, to shrink again to the deeper sluggish channels of the plains, right down to the salt swamps of our river-mouths, these shells swarm. Yes, in teeming millions they fringe the quiet, reedy, bird-haunted creeks that—draining our Napier Swamp and the rounded sun-baked hills of the seaboard—feed and fill the ever-shallowing Inner Harbour. Right down all these into water with a good strong tang of the salt in it, only ceasing, in fact, as the channels burgeon out into the wide mud-flats of the harbour. They get at times, in this way, into very mixed company, lying huddled under the tide-touched salt weed, fringing the countless crab-holes, holding common ground with the coast-loving sea-folk, grey whelks, black auger-shells, and all the fascinating denizens of a swampy littoral. In fact, a mild admixture of salt seems to suit them better than quite fresh water. I have got my largest and most perfect specimens round these sea-creeks; and, as a rule, the farther up country one goes, and the more rapid the stream, the smaller will the river-snails be. Does not the fact of their flourishing so well in these brackish swamps give a clue to their originally salt-water origin? Curious connecting-links between land- and sea-shells are furnished by two species of the same genus that are common about the Inner Harbour of Napier—*Potamopyrgus cumingiani* and *pupoides*. Both plentiful in the lower courses of the Napier Swamp creeks, they shun alike the pure fresh water above tidal influence and the stronger salt of the broads of the Inner Harbour.

Let me quote a short passage from that delightful book, "The Dispersal of Shells," by H. W. Kew: "Fresh-water forms are said to have been originally derived from the sea; and, even now, marine animals in all probability are gradually adapting themselves to fresh water." May we not class these shells as being of those that "are gradually adapting themselves to a fresh-water existence"?

The pond-snails are more fastidious in their choice of a home than the river-snails. They frequent, as I have said before, our lakes and stiller weed-choked streams and pools. The "flask snail" I have occasionally found in the back-waters of rapid streams, also *Planorbis;* but *Bulimus* seems altogether confined, in our district at least, to lakes and the still pools of the mud-bottomed creeks of the uplands. Unlike the river-snails, our pond-snails give the salt water a wide berth, pausing inland along our river-banks long before the river-snails have attained the limit of their seaward march amongst the purple wastes of crab-haunted salt weed.

I have said that our fresh-water mussel is common in many of our lakes. It is, however, rather local in my own district —that is, the country lying between Napier and the Kaweka Range. Extremely abundant in the small lakes on the Petane side of the Flagstaff Range, it is absent from many of the lakes farther inland. I find it only in the upper reaches of the before-mentioned Waihau Creek and the Mangaone River. In this it is very unlike its small relative the fresh-water cockle, which is with us almost universally distributed, spreading also with great rapidity. A small pool formed in one of our home paddocks some two years ago by the building of a road-embankment, and isolated from the surrounding well-stocked creeks and drains, has now numbers of the *Pisidium* in it.

Now, the question arises, How did these slow-moving, water-loving shells manage to so thoroughly populate these isolated outlying lakes and pools? One can understand their presence up all the streams: they are free-swimming for a time after leaving the egg, thus enabling them to disperse rapidly over the stiller waters, though this would act rather as a disadvantage than otherwise in our rapid streams—the feeble, tiny folk must be swept out to sea in millions during floods; more is due to the slow crawling of the adult shells, working through the ages up stream.

But, though both pond- and river-snails will pass up or down the tiniest of runlets, or even over moist ground for short distances, the tracts of dry land between many of our pools and the nearest running water are far too wide for their crossing unaided. As for the river mussel and cockle, their powers of locomotion are even more limited.

It was not without purpose that I mentioned our waters as the refuge for hunted water-fowl. Let me quote a celebrated experiment of Mr. Darwin's: "I suspended the feet of a duck in an aquarium where many ova of fresh-water shells were hatching, and I found that numbers of the extremely minute and just-hatched shells crawled on the feet, and clung to them so firmly that, when taken out, they could not be jarred off, though at a somewhat more advanced age they would drop off. These just-hatched molluscs, though aquatic in their nature, survived on the duck's feet in damp air from twelve to twenty hours; and in this length of time a duck or heron might fly at least six or seven hundred miles, and, if blown across the sea to an oceanic island, or to any other distant point, would be sure to alight in a pond or rivulet." Now, just watch a wild duck as, with startled resonant "quack," he rises from the water or oozy shore of his feeding-grounds, how neatly the folded web-feet are tucked under his tail as he hurries off inland for, perhaps, a thirty-mile flight before resting the sole of his foot on ground again. Look round any of our lake-edges and still streams, and note what hosts of tiny shells there are in the ooze of the margin; then imagine the broad, lined surface of the duck's foot strewn with these shells, as, with restful, satisfied splash, he alights in some quiet upland pool, to tenant it unwittingly with tiny shells.

On a visit to the Flagstaff waterholes—small lakes that, as I have said before, swarm with mussels—searching in the mud of the margin, I found young river snails and cockles very abundant, pond-snails decidedly scarce, and of mussel-fry none at all, only securing specimens of the last with the aid of a hand-net in from 2 ft. to 4 ft. of water. These young mussels were about the size of a pea; the other shells ranged down to the size of a small pin's-head.

If this rule in any way holds good for other lakes, one can easily see that, apart from their larger size, the chance of the mussels being carried away by duck, or even the long-legged wading pukekos, would be infinitesimally small compared to that of the other shells. Certain it is that newly formed pools are soon stocked, in some way or other. The pool referred to as having been formed only some two years ago has now some four species of shells inhabiting it. I watched with great interest the development of its fauna and flora. At first a raw stretch of yellow water, ebbing round drowned docks and grasses; its earliest tenants, and that in a very few weeks' time, were the larval forms of gnats and dragon-flies. In about a year's time young shells of *Amphipeplea ampulla* appeared; then, later, *Potamopyrgus antipodum;* then the white shells of *Pisidium;* and, lastly, the flattened brown form of *Planorbis corinna.* Hosts of *Cypris*, a minute bivalve Crustacean, appeared after the first year. Besides these, the pool, now brown and clear, supports a mixed assemblage of lowly organized plants: the wool-like green algæ soon appeared; brown blobs of the same family roll about the bottom, with shapeless masses of clear jelly, and delicate network sacs, evidently low forms of animal life. And all these were carried in, I imagine, on the feet of wandering cattle, or by the pukekos as they stalked to and from the adjacent well-stocked creek and drain.

These fresh-water shells are one of our few native families that benefit by the introduction of an alien. Since the rapid spread of that rampant cross-bearer, the water-cress, pools and drains once dry during summer now lie shrouded in protecting green, affording pleasant moist shelter, and probably food also, to these and a host of water-loving insects.

ART. XXIII.—*Scinde Island, from a Naturalist's Point of View.*

By F. HUTCHINSON, Jun.

[*Read before the Hawke's Bay Philosophical Institute, 9th July, 1900.*]

THIS is most emphatically not a deep paper from a scientific point of view, being just a rough sketch of a few of the most interesting features of the natural history of this most interesting island. Perhaps I ought to have termed it the "Shores of Scinde Island," for it is upon the shores rather than upon the hills that one finds by far the greater part of the wild life here. I say "wild" advisedly, for it is with the wild folk that I wish to deal, whether they be native—whose forbears have swum, crawled, or flown here since the land first rose as marshes from a shallow Pliocene sea—or the horde of familiar European types of wild life that have come in the track of civilisation.

Therefore, beginning with the highest forms, our first wild type is that familiar savage the common grey rat. I need scarcely tell you that rats are common in Napier. Long years ago, when the first traders came to Napier, the slim-built *Kiore maori*, the true native rat, held possession. Whether it was ever really common here I cannot say, but its bones have been found plentiful in the piles of shells, bones, and other matter that mark the old Maori camps, or "kitchen-middens" as they are sometimes called, which have been found on many parts of the Napier hills. Only the other day, as I roamed over the new sections of the late Mr. Colenso's property, I noticed that some one, in peeling off the sod to form a garden, had laid bare one of these shell-heaps. I could find no bone fragments of any sort, they having probably long ago rotted away to their original lime, but of shells there were a great abundance—of the cockles, pipis, pupus, pawas, &c., so common on our coasts. I suppose this relic of very old times will have to give place to an assemblage of foreign shrubs and alien weeds, unappreciated save perhaps as a means of paving a garden-path. With these traders came rats, whether our familiar grey Norwegian or the black Polynesian, or both, I am not sure. It is certain that for a time the black rat swarmed all over the country, driving out (we suppose) the brown *Kiore maori*, for even now in bush districts the black rat is common, though vanishing, with the clearing, before the fiercer Norwegian. We still have them in the small patches of bush that are found in the gullies of our poorer uplands some eighteen miles from Napier. They have a different gait to the grey rat; one that we caught in the open hopped more than ran, in the fashion of a kangaroo. I am afraid the only good point that I can bring forward for this grey Viking of ours is that he is a great devourer of snails.

In some of the ruder walls that prop our Napier gardens—those built just of ragged crags of limestone and uncemented—the crannies are used as cave-dwellings by the rats. In a Coote Road wall they are literally crammed with the broken shells of *Helix aspersa*, the garden snail, cracked and devoured by these rapacious rodents. The smaller, flatter, shining, horn-coloured shell, *Helix cellaria*, that is also common in the gardens, is not appreciated by the rats for some reason; I have found them crawling about in safety in these same cave-dwellings. In the few remaining patches of scrub that mark the one-time bushed Sturm's Gully you will find the shelters strewn with broken shells in the same way; in this case the rats may be helped by the blackbirds and thrushes, though as a rule these birds prefer to kill in the open.

But when we come to the next class of our "island life"—the birds—we need no fierce immigrants to bridge the gap, as with the mammals. For, thanks to the sea in front and the weedy wastes and shallows of the swamp behind, Napier, in spite of its publicity, can boast of a longer list of native birds than many a more sequestered situation inland. The following list is, I am certain, by no means a full one, being made up by a non-resident, who knows little of the winged sea-folk to be seen by those who boat in the Inner Harbour, or, better still, the open waters of the bay.

LIST OF NAPIER BIRDS.

Accipitres.

Circus gouldi. (Harrier; kahu.)
Athene novæ-zealandiæ. (Morepork; ruru.)

Passeres.

Halcyon vagans. (Kingfisher; kotare.)
Prosthemadera novæ-zealandiæ. (Tui.)
Zosterops lateralis. (Blight-bird; tauhou.)
Gerygone flaviventris. (Grey-warbler; riroriro.)
Anthus novæ-zealandiæ. (Ground-lark; pihoihoi.)
Rhipidura flabellifera. (Fantail; piwakawaka.)

Scansores.

Platycercus novæ-zealandiæ. (Parrakeet.)
Nestor meridionalis. (Kaka.)
Eudynamis taitensis. (Long-tailed cuckoo.)
Chrysococcyx lucidus. (Shining cuckoo.)

Grallæ.

Charadrius bicinctus. (Dottrel.)
Ardea pœciloptila. (Bittern.)
Limosa baueri. (Godwit; curlew.)
Himantopus leucocephalus. (Red Stilt.)
Himantopus novæ-zealandiæ. (Black Stilt.)
Ocydromus earli. (Weka.)
Rallus philippensis. (Striped rail.)
Porphyrio melanotus. (Swamp-hen; pukeko.)

Anseres.

Anas superciliosa. (Grey-duck; parera.)
Larus dominicanus. (Black-backed gull; karoro.)
Larus scopulinus. (Mackerel gull; tarapunga.)
Sterna caspia. (Caspian tern; taranui.)
Sterna frontalis. (Sea-swallow; tara.)
Dysporus serrator. (Gannet; takapu.)
Phalacrocorax novæ-hollandiæ. (Black shag.)
Phalacrocorax brevirostris. (White-throated shag.)

We all know the common hawk, or harrier. One may see one or more at almost any time of the day sailing in majestic spirals over the island or the swamp. Those who frequent the swamp for business or pleasure will have often noticed this bird, a motionless brown figure in the purple salt weed, or waddling awkwardly over it in search of crabs and other small game or the carrion on which he mostly feeds, for in spite of his size and formidable beak and talons he attacks nothing but the dying and defenceless; and, even in his aerial combats with his fellows, there is little of earnest onset and much peevish squealing and whirling of wings. I have watched him flee like a gawky brahma before a bantam at the whirlwind attack of his fierce little kinsman the sparrow-hawk. The latter I have never seen in Napier, though I have heard old residents speak of seeing him here in the early days.

Thanks to our dense plantations, we still have that quaint little owl the morepork on the island. Only a short time ago, as I passed the mouth of Coote Road, a round brown form winged noiselessly across opposite the drillshed, and settled in a small tree overhanging the first of the steep lanes that scramble up the sides of the gulch through which the road runs. I followed the bird up, and found a morepork blinking his yellow eyes in the failing light. Two small boys saw him at the same time. I caught a whisper of "Watch him while I get my shanghai," and one of them hurried off up the steep track, so I waited awhile to give the wee owl timely warning of his return. But it was not needed. Before the youngster returned, breathless, "ruru" quietly slipped off again—moth-hunting I expect—down to the Parade and round out of sight into the darkness and quiet of the bluff-face.

The kingfisher, blight-bird, grey warbler, and ground-lark are all permanent residents here. The tui is only an occasional visitant.

Of the family of the *Turdidæ*, or thrushes, we have no native representative, but rather an excess of enterprising British members of the family—the black-bird and common thrush, to wit. Those of us who know the fascination of an English hedge-row will remember finding occasionally flattened stones surrounded by piles of broken snail-shells. I found just such a thrushes' killing-stone in the fennel jungle at the mouth of Sturm's Gully some months ago. It was a flattened slab of limestone, quarried at some time from the bluff-face—a grim relic of the Pliocene sea-floor put to the same use as the thrushes of the Plain of York put the worn boulders of the glacial drift.

Another well-known family, the *Sturnidæ*, or starlings, is wanting here in the native birds, save—as with the thrushes—in the less-known portions of our islands. It is a sturdy Britisher who, in his thousands, wheezes and whistles from bluff-face or telegraph-wire, intensifying the heat of our sunlit days.

The parrakeet, the kaka, and the long-tailed cuckoo are, like the tui, but occasional visitors, but the beautiful little shining cuckoo may be seen, or more often heard, yearly on the hill.

After these we come to those birds that frequent the marsh and the seaboard. The dotterel is common. The bittern, thanks to the pot-hunter, is fast becoming rare. I have only once seen one actually on the Scinde Island side of the swamp-channels. It is not till this bird rises in flight that one recognises him as a heron. His beautiful kinsman, the blue heron, has, I am afraid, disappeared from here. They were to be seen on the Napier beach of forty years ago, but have moved now to the quieter refuge of the Kidnappers and Mahia.

About the end of November flocks of a long-billed brown-plumaged wading-bird appear on the swamp—the godwit, or curlew as it is more commonly called. This bird is one of our few migrants, and takes a yearly course almost from pole to pole. I give an extract from Buller's "Birds of New Zealand": "Our bird spends a portion of the year in Siberia, and visits, in the course of its annual migration, the islands of the Indian Archipelago, Polynesia, Australia, and New Zealand. Von Middendorff, who met with these birds in great numbers in Northern Siberia (74–75° N. latitude), states that they appeared there on the 3rd June, and left again in the beginning of August. In the months of September and April Swinhoe observed migratory flocks on the coast of Formosa, and during the winter months he met with this species still further south. Von Middendorff found it also in summer on the south coast of the Sea of Okhotsk, although it did not appear to breed there. It has likewise been observed in China, Japan, Java, Celebes, Timor, Norfolk Island, and the New Hebrides, and its range doubtless extends much further; but it has never been met with in India, this being probably too far west of its annual course." Sir Walter Buller says that the main body of these migrants leave the North Island about the beginning of April. I do not know how long stragglers have been known to stay here, but I saw a party of half a dozen of these birds wading off our Swamp Road on the third week of last May.

Both pied and black stilts may be seen occasionally working the sand-spits above the Petane Bridge.

I have put down the weka as an inhabitant of Scinde Island, but must admit that I have never seen his familiar brown figure on the Napier side of the swamp-channels. I have seen that small kinsman of his, the striped rail, cross the Swamp Road a very short distance from the town.

The last of the rail family, the swamp-hen or pukeko, occasionally crosses on to the island.

Coming to the order of Swimmers, the first of them is the grey-duck. If this bird were not "game" we should probably have the pleasure of seeing them flocking the channels with the familiarity of their kinsfolk the gulls and terns. But, as it is, it is only an occasional glimpse that we get of grey forms stealing up the cut or the sheltered channels in the raupo behind the town—shy, wary pairs that have escaped the persecution of "the season."

The great black-backed gull may be seen almost anywhere round the shores of the island, whether winging along in the trough of the breakers of the open coast or wading solemnly up the swamp-channels. I was much puzzled at first by the brown plumage of the young birds—in fact, I thought it was another species till I watched a tame bird in a friend's garden change from sombre brown to the black monk's robe and spotless vestments of the mature bird.

The mackerel gull is that dainty, cheerful little slate-backed sea-bird that congregates in such numbers on the tilted crags of the breakwater's end.

The terns I have noticed more on the Inner Harbour and the sand-spits and shingle-banks that lie naked with every tide above the Petane Bridge. The big Caspian tern is a bird of much dignity, and somewhat shier than his lesser relative the common tern, or sea-swallow, who is a jeering noisy fellow, a "larrikin" of birds, whose quick harsh note fits his rapid dashing flight, so different from the stately sweep and solemn clangour of the great gulls.

The gannet, that regal relative of the shag, is only to be seen on the wing here, as a rule. Now and again I have watched one fishing well out to sea off the Marine Parade. I hear that one was picked up in a Napier garden some time ago in an exhausted condition after a gale; and I saw a bird, full sized but still in his speckled youth, waddling about, draggled and dirty, with his great wings drooping useless, in a garden down Emerson Street. How he must have longed for a cleaving dive in clean salt-water, and a clear fly home to the fish-strewn ridge of the Kidnappers.

Of the cormorants, or shags, we have two species—the black and the white-throated. The black shag is by far the commonest; one may see him all round the island, whether stolidly watching the waves buffet the breakwater or gliding low in the water up the swamp-channels. The white-throated shag I have seen perched on the buoy of the outer anchorage, and occasionally on the deserted punts moored above the Petane Bridge.

Of our local fishes I know too little to venture on a list of them. But it is interesting to note the meeting of river-fish and sea-fish on common ground (or rather water) in the channels about here. Of course, we all know that even our river-fish wend seaward yearly to spawn, but one needs the sight of them down here to realise it. This I had the pleasure of doing a few days ago at the mouth of the New Cut. There, under the silt-banks opposite the brickyards, I found a host of the minnows or inanga, so common in our upland streams, feeding amongst the tresses of a matted water-grass. And with them were larger, darker forms that stole away into the depths of the channel at my approach. They were "spotties," those voracious little sea-fish so well known round the wharves and harbours of our coast.

After the fishes we come to the reptiles. Though of few species, we have this class well represented in numbers by the little brown lizards that swarm in the crannies of the limestone. Turning to the Maori middens again, in them have been found the bones of a great ancestor of these lizards—in fact, the last living representative of those early lizards the great Saurians. I allude to *Sphenodon punctata*, the tuatara of the Maoris. Though once abundant, it is now extinct on the mainland of New Zealand, being found only on a few of the outlying islets.

Of the Batrachians we have no native species on the island, but are well supplied with a beautiful immigrant—a Frenchman, I believe—the golden-eyed green-garbed frog of our marshes. I remember how delighted we were when the first hoarse notes of a pioneer pair rose from our Woolshed Swamp, some seventeen miles inland. Now, in their numbers, their prelude blends to a low roar, sustained the day long and far into the warm summer nights, making one understand the feelings that prompted the French seigneurs to send their peasants nightly to thrash the marshes.

The reptiles are the last and lowest of the vertebrates. Of the invertebrates, the highest members are the *Tunicata*.

Tunicaries, or "sea-squirts" as they are termed, may often be found sticking to the rocks cast up by the tide on the Sturm's Gully beach. I have also dredged them up in the Inner Harbour, fast to the dead shells and fragments of the great *Pinna neozelanica*. In form they are a cone of a tough, leathery substance, pale-brown in colour; the cone is filled with sea-water, which they expel with considerable force when captured, thus earning their name of "sea-squirt."

The next step downwards is to a family familiar to every one in the form of shells—the *Mollusca*. I will not attempt any detailed description of this great class. As in the case of the birds, our joint possession of fresh and salt water, dry land and swamp, gives us a splendid variety, from the waifs of the open sea that are whirled ashore with gales, and the hosts that creep and crawl between the limits of high and low tide, to the familiar brown-mantled pest of our gardens. Between beach and hill, salt tide and fresh-water stream, we can find, besides the types of settled, orderly habits, strange intermediates, sea-shells climbing so far shorewards that it is only a daily splash of spray that they need, land-shells turning again to their original water life till they can take air at one inhalation to last them for many hours' submersion in the depths of the river-pools.

Below the *Mollusca* comes that great group the *Arthropoda*, consisting of the *Insecta*, the *Myriapoda*, the *Onychophora*, the *Arachnida*, and *Crustacea*. Of all these classes save one (the *Onychophora*) we can find abundant representatives in the small patch of untouched native ground that I have already referred to—Sturm's Gully. Beetles, flies, butterflies and moths, and other members of the insect class abound. Under dead twigs and leaf-mould are *Myriapoda* in plenty. These are mostly of the harmless "thousand-legged" species, whose only protection appears to be to curl themselves into a spiral and emit an evil-smelling fluid; but one occasionally gets one of the "hundred-legs," or "Meggy-monny-legs," who, with his well-armed, fierce appearance, has gained the reputation of being poisonous. Of course, "thousand-legs" and "hundred-legs" are both great exaggerations. I believe the Arabs come nearest to scientific correctness in calling them "*arba-wal-arbarin*," which, translated, signifies "forty-four legs," some of the tropical species having forty-two legs, and, counting the poison-claws, forty-four. The Persians call them "worm-rosaries."

Spiders hurry away, carrying their precious silken bags of eggs. But a spider-like form amongst them, on being disturbed, shuts all his legs tight upon his body and shams death. If you examine this animal you will find that his abdomen is formed of a series of hard horny rings, like many insects. He is a curious connecting-link between the spiders and insects, and, though harmless with us, the family is much dreaded from its poisonous bite in tropical countries. You may also find a harmless member of another notoriously poisonous branch of the spider family—the scorpions. It is a very tiny fellow, with a body scarcely ⅛ in. in length; the same formidable nippers of the scorpion, but devoid of the lengthened stinging tail. It is fitly named a pseudo-scorpion—*Obisium*, sp.

Most of the Crustaceans are water-animals, only a few having adopted the dry land as a habitat; and then it is usually in damp shady places that we find them. I think of the land Crustaceans the best known to most of us is the common slater, or woodlouse. Now, you never find a wood-louse in dry open ground; it is always under some form of shelter—firewood, old sacks, dead leaves (or the living masses of our garden plants), always under something that gives dampness and coolness. In the Sturm's Gully mould you will find two species—one the familiar, dull, armoured imported slater, the other a smoother, shinier animal, a native species. Like the shells, one may follow the family out to the habitat of their primal ancestor, the sea. The slater pauses under the stones at the gully's mouth, and goes no further seaward; but under the rocks that are splashed by the spray of high tide you will find a slimmer more active member of the slater family, with the shining armour of the native slater, but with long antennæ drooping backwards over its segments and a pair of tail-like appendages nearly the length of the body.

Lastly, in the pools left by the tide on the shores of the Inner Harbour, and working right up into the brackish water of the sea-creeks, is a pretty little yellow Crustacean, broader, shorter, and shallower than either of these others, whose hinder segments are furnished with lobes, with which it swims with considerable rapidity. It curls itself up into the same protecting roll as do its land representatives.

Of the crabs proper we have the countless hosts of little brown-green fellows that haunt the shallows of the harbour, besides numerous species on the open coast. About the handsomest of these last is a great purple-and-pink fellow that you may see occasionally as he vanishes with a rattle of arms into the rugged caves of the tide-touched limestone boulders of the Sturm's Gully beach.

It is a far cry from the vertebrate rat to the invertebrate crab that he devours, and from the crab to the primal life-form as a blob of jelly is farther still, so I will leave the lower forms for another paper by abler hands than mine.

Art. XXIV.—*Notes on New Zealand Land Planarians: Part IV.*

By Arthur Dendy, D.Sc., F.L.S., Professor of Biology in the Canterbury College, University of New Zealand.

[*Read before the Philosophical Institute of Canterbury, 27th February, 1901.*]

The last part of these notes was read before this Institute more than four years ago, and in the interval a considerable amount of valuable material has accumulated in my hands. I am indebted to the kindness of various correspondents, whose names are mentioned in the sequel, for specimens from many parts of New Zealand, and I have myself been able to make small collections in the neighbourhood of Jackson's, on the West Coast Road (Westland), in the beginning of 1898; in the neighbourhood of Lake Te Anau in the early part of 1900; and on Chatham Island in January, 1901. While only seven new species are proposed in this communication, it has been found necessary to describe no less than eight new varieties of *Geoplana graffii*. The wide distribution of this species and the manner in which it tends to produce slight local varieties, of restricted range, are extremely interesting, though at the same time not a little perplexing to the systematist. In addition to these varieties, I have to record the occurrence of another common Australian species (*Geoplana munda*) in the South Island of New Zealand, and to record new localities for various species previously described.

It might have been expected that the Land Planarian fauna of Chatham Island would show considerable differences from that of the mainland. This expectation, however, was not fulfilled. Only four species were met with in the limited time at my disposal. These include the ubiquitous *Geoplana graffii* and a well-marked local variety of the same (var. *wharekauriensis*), the almost equally ubiquitous *Geoplana subquadrangulata*, a new but not very strikingly characterized species which I have named *G. latero-punctata*, and a hitherto undescribed and very distinct species which I have termed *G. exulans*, believing it to be probably an emigrant from New Zealand, a single specimen having been collected in the North Island by Mr. R. M. Laing. It is well known that a southward current from the North Island of New Zealand carries logs of timber and other *débris* — such as kauri-gum and pumice-stone—to the shores of Chatham Island, and this may well account for the distribution of *Geoplana exulans*. Thus, out of four species found on Chatham Island only one is not already known from the mainland of New Zealand, a result affording a striking contrast to that obtained by Whitelegge and Spencer in the case of Lord Howe Island, whose Planarian fauna is strikingly peculiar both as compared with that of New Zealand and that of Australia.

Since the appearance of the last part of these notes an event of great interest to zoologists has taken place, in the publication of Professor von Graff's magnificent monograph of the Land Planarians.* This great work deals with the Land Planarians, so far as yet known, of the whole world, and brings our knowledge completely up to date. At some future time it will be necessary to revise the nomenclature of the New Zealand species in the light of Professor von Graff's results—thus, for example, *Geoplana mariæ* will probably fall in von Graff's new genus *Artioposthia*—but for the present the necessary anatomical and microscopical investigations must be postponed. It appears to me that the proper way in which to work up our local Planarian fauna is first to get together as complete a collection as possible from all parts of the country, to classify and describe these as species and varieties in accordance with external characters (laying special stress upon the colours of the living animal), and ultimately to work out the internal anatomy of as many species as possible before attempting the final arrangement in genera. In the meanwhile we must refer all the *Geoplanidæ* found in New Zealand to the old genus *Geoplana*.

There must be a large number of New Zealand species of Land Planarians still unknown, and it is of great importance that these should be described before the destruction of our primeval forests has made the work impossible. I therefore again venture to appeal to local naturalists and collectors for assistance in this matter, and to remind them that instructions for collecting and packing specimens will be found in the first part of these notes.†

For specimens described in the present contribution I have to thank especially Captain Hutton, Professor Benham, Mr. W. T. Locke Travers, Mr. R. M. Laing, Mr. W. W. Smith, Mr. H. Suter, and Mr. George Howes.

Geoplana sanguinea, Moseley.

Peel Forest.—March–April, 1898. One specimen; coll., W. W. Smith, Esq. This specimen agrees exactly with the Australian form, so far as I can tell. In spirit it is about 77 mm. long and 6 mm. in greatest breadth, with the genital

* "Monographie der Turbellarien," ii., Tricladida Terricola (Landplanarien). Leipzig, 1899 (with an atlas of fifty-eight plates).

† "Transactions o the New Zealand Institute," vol. xxvii., p. 177.

aperture 16 mm. and the peripharyngeal aperture 30 mm. from the posterior extremity. The body is flat below, convex above, with slightly crinkled margins, tapering very gradually and evenly in front, not quite so gradually behind. Eyes in single series anteriorly and antero-laterally, and extending far back, perhaps nearly to the posterior end. My notes on the living animal state that it resembled the Australian *G. sanguinea* in colour and shape. In spirit it is almost colourless (yellowish-grey) all over, with no stripes.

Near Jackson's (West Coast Road).—One specimen.

Invercargill (in a garden; coll., G. Howes, Esq.).—One specimen, in spirit. Eyes not observed.

Geoplana triangulata, Dendy.

St. Martin's, Christchurch.—One typical specimen; coll., R. M. Laing, Esq.

Geoplana triangulata, var. **australis,** Dendy.

Peel Forest.—March–April, 1898. A number of large specimens; coll., W. W. Smith, Esq.

"*Bush*" (presumably near Invercargill).—Two specimens; coll., G. Howes, Esq.

Geoplana flavimarginata, Dendy.

I have now received larger specimens of this species than previously recorded. One received by post (presumably from Mr. Travers) measures, after preservation in spirit, about 87 mm. in length by 6·5 mm. in greatest breadth, with the genital aperture about 19 mm. and the peripharyngeal aperture 34 mm. from the posterior extremity. In life the dorsal surface was rather bright Indian-red, with yellow margins. The ventral surface was yellow. There were no spots.

Geoplana graffii, Dendy.

Whangamarino, Chatham Islands.—Five specimens. January, 1901. I have already recorded this species from the Chatham Islands, where I have now found it myself at Whangamarino. The specimens agree very closely with the types from Christchurch, except that they are considerably larger. The living animal when at rest is flat and leaf-like and very broad. Dorsal surface dark-brown, with much paler rather narrow median and supramarginal bands of brown. Flecked all over with small whitish or greenish-white specks. Margins of the median band sometimes paler than the middle, owing to the presence of numerous small whitish specks. The dark-brown ground-colour becomes intensified along the margins of the pale bands. The ventral surface is finely mottled in light and darker brown, with paler narrow submarginal and median bands. The pale submarginal and supramarginal bands are continuous with one another and form an uninterrupted pale marginal band (as is also the case in the Christchurch types, in which I have omitted to mention the pale submarginal bands, and have not laid sufficient stress upon the minutely dark-speckled appearance of the ventral surface which distinguishes this form from *G. moseleyi*).

The largest of the five spirit specimens which I preserved measures now 34 mm. in length by 8 mm. in breadth, with the genital aperture 9·5 mm. and the peripharyngeal aperture 15·5 mm. from the posterior extremity.

Toitoi, Southland.—Coll., Miss J. G. Rich. A number of fine broad specimens, attaining a large size—up to 42 mm. by 8 mm. in spirit—mostly with a strong tendency to suppression of the pale longitudinal bands on both surfaces.

Peel Forest.—March, 1898. Coll., W. W. Smith, Esq. Two specimens, much like the typical *G. graffii* in shape of body, and one of them having the pale-brown supramarginal bands fairly well defined. My notes on the living animal say, "Dorsal surface dark-brown, with narrow median longitudinal band of paler brown and paler brown lateral margins, with small pale longitudinal dashes of whitish or iridescent blue all over it. Ventral surface with no bands, but finely mottled with pale- and dark-brown. Shape as in *G. graffii*." The colouration of these specimens approaches nearly to that of *G. graffii*, var. *angusta* and var. *somersii*.

Geoplana graffii, var. **castanea**, nov. var.

Shape and size in life as in *G. graffii;* dorsal surface of a warm chestnut-colour, with a narrow median band and not very well-defined supramarginal bands of pale yellowish-brown; speckled, especially in the darker parts, with minute spots of pale iridescent green or bluish, which are also very abundant just on the margin of the body; ventral surface nearly white, abundantly but minutely speckled with pale-brown dots, which are almost absent in the middle line, leaving a median whitish band; anterior tip brown. Eyes very numerous. In spirit the body is rather broad, about 24 mm. in length by 6 mm. in greatest breadth; the genital aperture about 5 mm. and the peripharyngeal aperture about 10 mm. from the posterior extremity; convex above, nearly flat below, tapering fairly gradually in front and behind, but narrower in front. The margins of the body are rather broadly rounded. The brown colour of the dorsal surface assumes in spirit a characteristic purplish tint, with numerous minute white specks, and the median stripe of yellow is very well defined, about one-eleventh of the total width.

Locality.—Near Invercargill. Two specimens, collected by G. Howes, Esq. (one specimen on the 17th April, 1898, five miles from Invercargill).

Geoplana graffii, var. **ocellata**, nov. var.

Body at rest (in life) very broad, flat, and thin; about 22 mm. long by 9·5 mm. broad; tapering gradually to the horse-shoe-shaped anterior extremity and to a sharp point behind; with a slightly developed median dorsal ridge. When crawling about 31 mm. long; strongly convex and rounded above, flattened beneath. Eyes as usual, in two crowded lateral patches, and continued in single series round the horse-shoe-shaped anterior end. Dorsal surface in life dark mahogany-brown, with irregularly scattered paler blotches of rounded shape. The margins of the body are occupied by a very narrow pale band, merging dorsalwards in a row of very irregular small patches of the same tint, some of which are quite isolated. In the mid-dorsal line is a single row of the pale rounded blotches at irregular and wide intervals, each with a conspicuous central "eye" of a pale-green, nearly white, colour. (The spirit specimen shows the pale blotches for some distance on either side of the mid-dorsal line to be less distinctly "eyed.") The entire dorsal surface, except about the middle line, is dusted with minute specks of very pale iridescent green, showing a tendency to arrangement in longitudinal rows. The ventral surface in life was pale-brown, pretty uniformly but rather sparsely speckled with small rounded spots of dark-brown, absent for a narrow space submarginally but present in the middle. The pale ground-colour greatly preponderates, and the dark spots are widely separated from one another. Margins dusted with minute specks of the pale iridescent green.

In spirit the body is strongly convex above, flattened below, with narrow, slightly prominent margins; about 23 mm. long and 5 mm. broad, with the genital aperture (?) mm. and the peripharyngeal aperture 9·5 mm. from the posterior extremity.

This variety apparently comes near to *Geoplana gelatinosa*. The single specimen was sent to Dr. Benham by Mrs. Mason, who said it was luminous.

Locality.—Paradise (Lake Wakatipu).

Geoplana graffii, var. **wharekauriensis**, nov. var.

Body in life much flattened; when at rest may be triangular in section, flat beneath, and with a rather prominent mid-dorsal ridge; shape altogether like *G. graffii*. In life the colour of the dorsal surface is mahogany-brown, with a narrow paler reddish-brown stripe down the middle, and sometimes a more or less definite pale stripe above each margin, but the latter is commonly wanting. Minute specks of darker brown are abundantly scattered all over the dorsal surface (including the pale stripes). There are also less numerous bluish(?)-white spots more or less surrounded by very dark-brown shading. These white spots are largest and most conspicuous along the margins of the pale median band, where there may be some fifteen on each side, but quite irregularly arranged, and with the dark shading round their outer margins only; they are usually entirely absent from the median band itself. The ventral surface is pale-brown, closely and minutely speckled with darker brown, sometimes with an indication of a paler narrow median band. Eyes numerous, but apparently absent from the extreme anterior end.

In spirit the body is flat below, convex above, with narrow lateral margins; commonly rather broader behind than in front. A full-grown specimen measures, in spirit, 24 mm. in length by 6 mm. in greatest breadth, with the genital aperture 7 mm. and the peripharyngeal aperture 11 mm. from the posterior extremity.

The spotted appearance of the dorsal surface in this variety is extremely characteristic.

Locality.—Very common under rotten logs at Wharekauri (Mr. Chudleigh's estate), Chatham Island. January, 1901.

Geoplana graffii, var. **nodosa,** nov. var.

Shape as usual in *G. graffii.* A typical spirit specimen measures about 40 mm. by 5·5 mm., with the genital aperture 12·5 mm. and the peripharyngeal aperture 5·5 mm. from the posterior extremity. In this specimen the dorsal surface in life was dark-brown, with a narrow, interrupted, nodose, greenish-yellow mid-dorsal line. Ground-colour flecked with very minute specks of pale iridescent blue. Margins of body occupied by a very narrow but well-defined band of pale yellowish-brown, and flecked with small dashes of pale greenish-yellow like those of the mid-dorsal line, but smaller. Ventral surface light-brown, closely and finely mottled with a darker tint, with no pale median band.

This variety comes very near to *G. graffii,* var. *somersii,* but differs in the typically well-defined narrow marginal pale bands and the more distinct nodose mid-dorsal line; perhaps also in the greater breadth and altogether larger size of the body. Some specimens show traces of a pale median ventral band. The variety attains a large size, one specimen in spirit measuring 50 mm. by 10 mm., and is subject to slight variation in colour-markings which make it impossible to define it sharply. It appears to be characteristic of the Invercargill bush.

Locality.—Invercargill. Several specimens; coll., George Howes, Esq.

Geoplana graffii, var. **dorso-marmorata,** nov. var.

Body at rest (in life) flattened or concave below, strongly convex above, somewhat triangular in section. Eyes numerous. Dorsal surface in life pale yellowish-brown, irregularly marbled with much darker brown, except for narrow median and supramarginal bands of the ground-colour. Ventral surface pale yellowish-brown, thickly peppered with small specks of darker brown, except for narrow marginal bands where the dark specks are absent; with an indication posteriorly of a narrow median band free from specks.

In spirit the body is slightly concave below, convex above, with slightly prominent narrow margins; about 24 mm. long by 4·5 mm. broad, with the genital aperture 8 mm. and the peripharyngeal aperture 12 mm. from the posterior extremity.

Locality.—The Nuggets (between Otago Harbour and the Bluff). One specimen, collected by Dr. Benham.

Geoplana graffii, var. **clintonensis**, var. nov.

My notes on the living specimens merely state that they are very similar to *G. graffii*. The two spirit specimens are of the usual form, but the peripharyngeal aperture is well behind the middle of the body. Length of specimen in spirit, 23 mm.; breadth, 3·5 mm.; genital aperture about 6 mm. and peripharyngeal aperture about 9 mm. from the posterior extremity.

The variety is characterized especially by the well-defined character of the pale median dorsal and supramarginal bands. The pale median band has no included stripes and little or no mottling. The supramarginal pale stripes are mottled, like the ventral surface, with a darker tint. The dark ground-colour of the dorsal surface forms two broad bands, in which the pigment is intensified at the edges, and which are finely mottled with the paler shade. The colours of the dorsal surface in spirit are dirty-yellow and dark-grey. The ventral surface is dull-yellow in spirit, finely and uniformly mottled all over with light-grey. There is no pale median ventral band. Eyes as usual in the genus.

Locality.—Near Mr. Garvey's house, Clinton Valley, head of Lake Te Anau. January, 1900. Two specimens.

Geoplana graffii, var. **angusta**, var. nov.

I have received this variety from several localities in the South Island, and were it not for the occurrence of intermediate forms I should regard it as a distinct species. The variety is characterized by the comparatively long and narrow body, the difference in shape as compared with the typical form of *G. graffii* being very noticeable in spirit specimens. The colouration is also characteristic, especially the numerous small white specks in the ground-colour of the dorsal surface and the narrow median longitudinal stripe of a yellowish tint, the ventral surface being very similarly coloured, but paler, and with no median longitudinal stripe. The absence of a distinct supramarginal stripe may also be regarded as characteristic. The variety certainly comes near to var. *somersii*, from Springburn.

Localities.

The Nuggets (on the coast between Otago Harbour and the Bluff).—One living specimen, received from Dr. Benham on the 19th April, 1899. The body when at rest was broad and flat, but markedly triangular in section, with a prominent median dorsal ridge; much broader behind than in front; tapering gradually to the horse-shoe-shaped anterior extremity; bluntly pointed behind. Eyes numerous, arranged as usual. The ground-colour of the dorsal surface in life was dark olive-brown, with a narrow median longitudinal band of dark dull-orange. The ground-colour, except in the middle line, was flecked with numerous irregular dashes and dots of dirty-white, varying greatly in shape and size, but all small. The anterior tip was pale-brown. The ground-colour of the ventral surface was pale olive-brown, flecked uniformly all over with irregular specks of dirty-white of varying shape and size, but all small. After preservation in spirit the animal measures about 37 mm. in length by 5·5 mm. in greatest breadth, with the genital aperture about 9 mm. and the peripharyngeal aperture 16 mm. from the posterior extremity. The dorsal surface is slightly convex, the ventral nearly flat; the margins of the body are narrow, slightly prominent, and marked by a fine pale line.

Toitoi, Southland.—Four specimens; collected by Miss J. G. Rich (from the Canterbury Museum).

Bush, near Invercargill. —Two fairly typical specimens; collected by Mr. George Howes. In one the mid-dorsal yellowish line is fairly broad, and there is a strong development of long (in spirit) white dashes in the dark ground-colour on each side of it. The ventral surface (in spirit) is dark-grey, with numerous small white specks.

Invercargill (five miles from).—A living specimen of this variety was received from Mr. G. Howes, together with the living specimen of the variety *castanea* described above. My notes on the living animal only state that it is similar to the latter (var. *castanea*), but with the brown of a much greyer tint, and no pale mid-ventral band. The same specimen in spirit has the dorsal surface dark-grey, fading at the margins, and flecked with small white specks all over, but more abundantly towards the margins, where the relative proportions of grey and white become gradually reversed. The ventral surface (in spirit) is dirty-white finely mottled with grey. The body (in spirit) measures about 37 mm. by 4 mm., with the genital aperture 10 mm. and the peripharyngeal aperture 15·5 mm. from the posterior extremity. The margins of the body are sharper than in var. *castanea*, and tend to form narrow ridges, marked by a light line; the body tapers gradually to both ends, but is rather narrower in front than behind.

Geoplana graffii, var. **otiraensis,** Dendy.

Near Jackson's (West Coast Road). — February–March, 1898. A considerable number of large specimens were met with in this locality, under logs on the Teremakau Flat. Fifteen specimens were preserved, and these agree so closely with one another and differ so much from the typical *G. graffii* that it may become necessary to consider them as belonging to a distinct species. The original specimens from Otira were hardly so characteristic as those now under consideration, one of which latter may be described from life as follows: "When at rest very broad and flat; when crawling flat below, strongly convex above, tapering very gradually in front and behind. Dorsal surface in life dark-brown, with a narrow median darker line; finely and abundantly speckled (except in the median line) with iridescent green, more sparingly speckled (all over) with much larger longitudinal dashes of opaque white. Ventral surface very pale-brown, abundantly mottled with dark purplish-brown, the mottling rather less abundant in the middle line."

Spirit specimens average about 60 mm. in length by 7 mm. in breadth, with the genital aperture about 19 mm. and the peripharyngeal aperture about 28 mm. from the posterior extremity. The dorsal surface is dark-brown or grey, intensified to nearly black in a narrow median stripe which may become obsolete, and flecked with various-sized specks and dashes of white which may or may not be especially developed about the middle line. The ventral surface is pale-brown, closely mottled with small purplish specks, with narrow pale marginal and median bands where the purplish specks are more or less wanting.

Geoplana graffii, var. **nigrescens,** nov. var.

This variety differs from var. *otiraensis* in the total suppression of the white specks on the dorsal surface. The following description was taken from a living specimen found under a log on the Teremakau Flat, near Jackson's: "When at rest broad and flat. When crawling, which it does very rapidly, the ventral surface is flat and the dorsal strongly convex, with the anterior end elongated and narrow and the posterior end broader but gradually sharp-pointed. The dorsal surface was shining-black all over, but in a good light a fine median longitudinal darker line could be distinguished, and where stretched by a contained egg-capsule a brownish-black mottling could also be distinguished. There was a narrow marginal band of pale-brown, and the ventral surface was pale-brown mottled finely with a darker tint. The length of the animal when crawling fully extended was about 85 mm., and the breadth about 6·5 mm. The cocoon was extruded through the back of the animal when placed in dilute alcohol."

Another specimen when at rest measured about 35 mm. by 10 mm., was not quite so black, and had a distinct narrow median whitish band on the ventral surface. Two more specimens also show the pale mid-ventral band.

Locality.—Under logs on the Teremakau Flat, near Jackson's (West Coast Road). February–March, 1898. Four specimens.

Geoplana graffii, var. **occidentalis,** Dendy.

Near Jackson's (West Coast Road).—February–March, 1898. One specimen, resembling those previously obtained from Otira, and, like the latter, differing from the Lake Mahinapua specimens in the possession of comparatively large (in spirit) whitish specks on the dark portions of the dorsal surface. The specimen was found beneath a log on the Teremakau Flat.

Geoplana iris, Dendy.

Peel Forest.—March, 1898. I received from Mr. W. W. Smith eight specimens collected in this locality. They showed in life the typical colouration, except that the outer margins of the dorsal orange stripes were yellow rather than green, but sometimes with a greenish tint in the case of the more median ones. They are mostly considerably larger than the original specimens, the largest specimen in spirit measuring 38 mm. in length by 8 mm. in greatest breadth, with the genital aperture 9 mm. and the peripharyngeal aperture 17 mm. from the posterior extremity. The body in spirit is flat below, convex above, broader behind than in front.

The species makes a very near approach to the Victorian *G. adæ*, as well as to *G. graffii* and its allies in New Zealand.

Geoplana latero-punctata, n. sp.

Dorsal surface in life strongly convex, ventral flattened as usual. In spirit the body is short and thick, strongly convex dorsally, flattened ventrally, with broadly rounded not prominent margins. The anterior extremity, with its prominent horse-shoe-shaped sensory ridge, is rather sharply marked off by sudden narrowing from the rest of the body, while the posterior extremity tapers more evenly but rather rapidly to a blunt point (in spirit).

A spirit specimen measures about 11·5 mm. by 2·5 mm., with the genital aperture 3·75 mm. and the peripharyngeal aperture 6·25 mm. from the posterior extremity. The eyes are numerous and continued in close-set single series round the horse-shoe-shaped anterior extremity as usual.

The dorsal surface in life is dark-brown or almost black, with microscopic pale-bluish specks all over. The ventral surface is pale-brown, shading into the darker dorsal tint. The sides of the body are sprinkled with small bluish-white or very pale-greenish specks visible to the naked eye, and extending (for a short distance only) both dorsally and ventrally. The anterior extremity in one of the two spirit specimens is dark-brown above and nearly white beneath, in the other it has a pinkish tint dorsally.

Locality. — Whangamarino, Chatham Island. January, 1901. Two specimens (rotten wood).

Geoplana agricola, Dendy.

I have much pleasure in again recording this species, hitherto known only from a single specimen. On the 18th November, 1897, I received four typical living specimens collected by Mr. R. M. Laing at St. Martin's, near Christchurch. The animal when crawling was long and narrow, strongly convex above, flat below, narrower in front. The largest specimen in spirit measures about 57 mm. in length by 5 mm. in greatest width, with the genital aperture 15 mm. and the peripharyngeal aperture 26 mm. from the posterior extremity. The body in spirit is convex dorsally and characteristically concave ventrally, with inturned lateral margins; tapering gradually and evenly in front, more suddenly behind.

In life the dorsal surface showed a rather narrow median longitudinal band of pale dull-yellow, followed on each side by a very broad band (twice the width of the median) of dark purplish-brown, almost black; then comes on each side another band of pale dull-yellow about as wide as the median band, bounded externally by a very narrow but well-defined marginal or slightly supramarginal line of dark purplish-brown. Anterior tip in life pink; ventral surface pale greyish-yellow, with two broad bands of finely mottled greyish-brown leaving narrow median and submarginal bands of the ground-colour free from mottling. In spirit the broad brown bands of the dorsal surface assume a greenish tint.

I also found two specimens of this species in a mixed collection of Land Planarians given to me by Mr. H. Suter, with no further locality than "Native bush, New Zealand."

G. agricola, var. **maori,** var. nov.

This variety differs from the type in the suppression of the mid-dorsal and mid-ventral narrow yellow bands, the broad darker bands meeting in the middle line on both surfaces. I have two specimens of this variety, one from St. Martin's, received together with the typical specimens and showing a narrow remnant of the mid-dorsal yellow band anteriorly, and one in Mr. Suter's collection.

Geoplana fagicola, n. sp.

In life rather broad, flat below, convex above, rather blunt behind. In spirit about 37 mm. long and 4·5 mm. broad; flat below, strongly convex above; tapering rather more gradually in front than behind; with rather prominent and sharp lateral margins. Eyes very minute and inconspicuous, visible chiefly around the horse-shoe-shaped anterior extremity. Genital aperture (in spirit) about 9·5 mm. and peripharyngeal aperture about 14·5 mm. from the posterior extremity.

Dorsal surface in life rather dark-brown, fading gradually towards the margins, and with a well-defined, narrow, pale-brown median stripe. Ventral surface the same but lighter, fading to the margins, and with a narrow, pale median stripe. Anterior tip pink.

Locality.—Near Mr. Garvey's, Clinton Valley, head of Lake Te Anau, in a rotten tree. January, 1900. One specimen.

Geoplana exulans, n. sp.

Long and narrow, especially when crawling, when it may attain a length of 45 mm. An average specimen, killed by immersion in strong spirit, measures about 26 mm. by 2 mm., the body being flat below, strongly convex above, and tapering rather gradually in front and behind. The genital aperture in the same specimen is 9 mm. and the peripharyngeal aperture 13 mm. from the posterior extremity. Eyes as usual, numerous and small.

The ground-colour of the dorsal surface in life is dirty-white. There is a broad, well-defined, median longitudinal band of dark chocolate-brown occupying about one-fifth of the total width of the dorsal surface. On each side of this median band are a number of irregular, more or less discontinuous and anastomosing, narrow, wavy, longitudinal stripes of the same dark chocolate-brown colour. This fine longitudinal striation extends to the margin of the dorsal surface on either side. In addition to the dark stripes, numerous minute specks of the same colour occur, chiefly in the ground-colour on each side of the mid-dorsal band.

The ground-colour of the ventral surface in life is dirty-white, with two broad longitudinal bands of chocolate (paler than that of the dorsal surface) dividing the ground-colour into three narrow stripes, one median and one submarginal on each side. A few minute specks of chocolate-brown occur sparsely scattered in these bands of ground-colour. Anterior extremity in life pinkish.

This is a very distinct and well-characterized species.

Localities. — Chatham Island; common; widely distributed in and under rotten logs (Whangamarino, Wharekauri; January, 1901). Ara-tea-tea, North Island of New Zealand; one very typical specimen; coll., R. M. Laing, Esq.

Geoplana garveyi, n. sp.

Body even when at rest long and narrow, very gradually tapering behind, convex above and flat beneath. When crawling very long and narrow, the larger of the two specimens attaining a length of about 50 mm. In spirit the larger specimen measures about 42 mm. by 2·5 mm., and the smaller about 32 mm. by 2·5 mm. In the larger specimen (in spirit) the genital aperture is distant 21 mm. and the peripharyngeal aperture 29 mm. from the posterior extremity; in the smaller specimen the corresponding distances are 13·5 mm. and 19·5 mm. The shape in spirit is long and narrow, more gradually tapering behind than in front, convex dorsally and flat ventrally, but with gradually rounded margins.

The colour in life was an almost uniform bluish-grey, rather paler in the mid-dorsal line and at the margins. The ventral surface paler grey, except for a pair of ill-defined longitudinal stripes (or, one might say, grey, fading in the middle line and towards the margins). The anterior tip was pinkish-brown.

Eyes numerous, continued laterally almost to the extreme posterior end, but more abundant at the sides of the anterior end.

The species is evidently nearly related to *G. purpurea*, from which it differs in colouration.

Locality.—Near Mr. Garvey's house, Clinton Valley, head of Lake Te Anau; in rotten trees. January, 1900.

Geoplana aucklandica, n. sp.

The single specimen was given to me with the following description, evidently taken from the living animal: "Undersurface of a rusty colour, with whitish median line. Upper surface: ground white, with very fine black meandering longitudinal lines; a rather broad median longitudinal brown band, with darker margins and central line. Extended: length, 25, breadth, 3–4 mm. Cross-section half-round."

In spirit the body is strongly convex dorsally. The ventral surface is nearly flat, but with a pair of slightly prominent longitudinal ridges, one halfway between the middle line and the margin on either side. The dorso-lateral margins are sharp and well defined. The body tapers rather bluntly both in front and behind. Length, about 14 mm.; breadth, about 4 mm.; genital aperture 4·5 mm. and peripharyngeal 9·5 mm. from the posterior end.

The dorsal surface in spirit shows a whitish ground-colour, with a broad median band of dark-brown equal in width to about one-fourth the width of the whole dorsal surface. In this dark band the brown colour is intensified to form a narrow median and broader marginal lines. Between the dark median band and the margin of the dorsal surface the ground-colour is thickly strewn with minute dark-brown specks, more or less running together to form slender meandering lines, but almost absent for a narrow space on either side of the dark median band. The ventral surface is of a finely mottled chestnut-brown colour, with a narrow pale-whitish median band, where the brown mottling is less abundant, and a similar but less definite narrow pale band along each of the longitudinal ridges before mentioned. Outside these ridges the chestnut colour darkens towards the margins of the ventral surface; inside the ridges it darkens towards the margins of the pale median band. Anteriorly the pale median ventral band becomes confluent with the almost colourless anterior extremity, where the absence of pigment is continued backwards for a short distance, so as to make a deep indentation in the front end of the dark mid-dorsal band. I was unable to make out the eyes satisfactorily.

This is a remarkably well-characterized species, so that I feel perfectly justified in describing it from a single specimen. The peculiar shape of the body recalls that of *G. subquadrangulata*, but the dorsal surface is more strongly convex, and the lateral surfaces are less sharply differentiated from the ventral (in which I have included them in the above description).

Locality.—Old Cemetery Gully, Auckland; coll., H. Suter, Esq.

Geoplana cucullata, Dendy.

Near Jackson's, on the Teremakau (West Coast Road).—February, 1898. One typical specimen, found under wood. When at rest very broad and flat, with a very slight median dorsal longitudinal ridge. The hollow under the anterior end, conspicuous in spirit, was not noticeable in life. The colour of the dorsal surface in life was pale-orange, finely speckled with darker brownish-orange, and with a faint indication of a narrow median longitudinal band of the paler colour; anterior tip dorsally dark-brown, ventrally colourless for some distance; ventral surface pale-orange, finely speckled with darker brownish-orange. Length in spirit, 21 mm.; breadth, 7 mm.

Near Mr. Garvey's House, Clinton Valley, Head of Lake Te Anau.—In this locality I obtained two specimens in rotten trees, both typical. The larger one is thus described in my notes. "At rest very broad and flat. Dorsal surface in life nearly uniform gamboge-yellow, rather paler in the middle line. Numerous thickly scattered minute brown specks visible under a pocket-lens. Anterior tip coloured like rest of body. Eyes numerous, as usual. Ventral surface rather paler than dorsal. Nearly uniform yellowish-brown. Movements very sluggish." In spirit the hood-like or beak-like form of the anterior extremity is very conspicuous.

Geoplana munda, Fletcher and Hamilton.

The two specimens agree very closely indeed with the well-known and common Australian form. I received them both in spirit, but, as usual in the species, the colours are well preserved. The Invercargill specimen is about 17 mm. long and 3 mm. broad, with the genital aperture about 5·5 mm. and the peripharyngeal aperture about 7·5 mm. from the posterior extremity. Thus the peripharyngeal aperture is a little further back than usual in the species, but this may be, in part at any rate, due to unequal contraction.* The body is strongly convex above, flattened below, tapering rather more gradually in front than behind. The ground-colour of the dorsal surface (in spirit) is yellowish-brown, with four distinct longitudinal stripes of dark chestnut-brown—viz., a pair of very narrow well-defined stripes, one on each side of a very narrow median stripe of ground-colour, and a pair of much broader stripes, one halfway between each narrow dark stripe and the margin of the body. The narrow dark stripes have their outer margins uneven, the broad dark stripes have both margins very uneven. In the pale ground-colour between the

* The Toitoi specimen is slightly damaged, and I have not quite satisfied myself as to the apertures.

narrow and broad stripes, and between the latter and the margins of the body, are scattered numerous small specks of the dark-brown colour, just visible to the naked eye.

The ventral surface appears to the naked eye of a uniform very pale brown colour. Microscopic examination shows numerous very minute superficial specks of brown pigment thickly dusted all over both dorsal and ventral surfaces, but paler on the latter. On the dorsal surface they lie more superficially than the dark markings already described.

Specimens from Victoria show a precisely similar microscopic dusting. Eyes numerous, but exact arrangement difficult to make out.

Locality.—Invercargill; one specimen, collected in the bush by G. Howes, Esq. Toitoi, Southland; one specimen, collected by Miss J. G. Rich.

Geoplana subquadrangulata, Dendy.

Near Jackson's (West Coast Road).—Six good-sized specimens, with the three dark dorsal stripes very well defined, and a fairly well-defined narrow dark submarginal stripe. The ventral surface and ground-colour of the dorsal surface show little or no mottling in the spirit specimens. The paired dorsal stripes are very much broader than the median one. The specimens were found under logs on the Teremakau Flat.

Near Mr. Garvey's House, Clinton Valley, Head of Lake Te Anau.—Two specimens, with the three dark dorsal stripes well defined (the paired stripes being broad). The ventral surface and ground-colour of the dorsal surface show little or no mottling in the spirit specimens, but the larger of the two shows an ill-defined narrow marginal stripe.

Peel Forest.—March, 1898. Coll., W. W. Smith, Esq. Three unusually large specimens, the largest measuring in spirit 26 mm. in length by 3·5 mm. in breadth, with the genital aperture 6 mm. and the peripharyngeal aperture 9 mm. from the posterior extremity. The protruded pharynx is narrow and subcylindrical in shape. The dorsal surface (in spirit) is flat, the ventral and lateral convex and indistinguishable from one another. The three dorsal stripes of dark-brown are present as usual—viz., a narrow median one and a broader one at some distance on each side of it. Between the narrow and broad stripes the yellowish ground-colour is abundantly speckled with dark-brown, and there is an ill-defined band of small dark specks on each side of the body, separated from the outer dark stripe by a fairly broad interval of ground-colour almost free from specks. The ventral surface is devoid of dark specks, or very nearly so.

Toitoi, Southland. — Coll., Miss J. G. Rich. A number (seven) of good-sized specimens agreeing closely with one another in shape and colour; with the dorsal surface very sharply marked off from the lateral surfaces by acute, slightly prominent margins, and the inwardly sloping lateral surfaces distinguished from the narrow ventral surface by their somewhat darker tint and more or less speckled character. Three dorsal stripes as usual, but now (in spirit) the colours are very pale.

Invercargill.—Nine specimens, mostly very similar to (*a*) of the original description, found in a garden by G. Howes, Esq.

Chatham Island.—January, 1901. Abundant (rotten logs). Two specimens referable to var. (*a*) of the original description, but mostly with three well-defined dorsal stripes (one narrow and two broad), and well-defined minute brown specks sparsely scattered on the lateral and ventral surfaces, and sometimes between the dorsal stripes.

Geoplana howesi, n. sp.

When crawling very long and narrow; subcylindrical, but flattened below. In spirit contracts very much, measuring finally 24 mm. long by 3·5 mm. broad, with the genital aperture 4·5 mm. and the peripharyngeal aperture 9 mm. from the posterior extremity. The body in spirit is approximately oval in transverse section; flattened below and sometimes also above; of almost uniform diameter throughout, but tapering rather bluntly at each extremity. Colour in life pale-yellow all over, except for the pink anterior tip and three narrow longitudinal stripes of dark-brown on the dorsal surface. The median stripe is narrower than the other two, which are about equidistant between the median stripe and the margins. All the stripes are well defined, and they divide the ground-colour of the dorsal surface into four broad longitudinal zones of about equal width. There are no dark specks either between the stripes or on the ventral surface. In spirit the ventral surface shows a differentiation into three longitudinal bands of about equal width* and very sharply defined, the median band being of a paler tint than the others. Eyes numerous, in single series round the horse-shoe-shaped anterior extremity (? elsewhere).

This species is certainly nearly related to *G. subquadrangulata*, from which it differs in the more elongated body, which is also more oval in section; in the narrowness and sharp definition of all three dorsal stripes; and in the absence of dark specks from the ground-colour. The paired ventral bands of ground-colour, darkening in spirit, evidently repre-

* The median band may be wider than the other two.

sent the lateral surfaces of *G. subquadrangulata.* I have much pleasure in naming the species after Mr. George Howes.

Locality.—Invercargill bush. Three specimens, one alive and two in spirit; collected by G. Howes, Esq.

Geoplana suteri, Dendy.

Invercargill (bush).—One specimen; collected by G. Howes, Esq. The species is immediately recognised by the peculiar arrangement of the six narrow dark lines on the dorsal surface. The present specimen (in spirit) shows a differentiation of the ventral surface into three longitudinal zones of about equal width, the outer ones distinguished by a brownish tint and very sharply defined from the paler median zone. Traces of a similar differentiation are visible in one of my spirit specimens from Dunedin.

Toitoi, Southland.—Coll., Miss J. G. Rich. Two specimens in a bad state of preservation (in spirit), but showing clearly the differentiation of the ventral surface into three longitudinal zones of about equal width, the two outer being of a darker tint than the median one. Body nearly oval in transverse section.

Geoplana cooperi, n. sp.

Body (in spirit) more or less oval in section, more or less flattened both dorsally and ventrally; rather blunt at both extremities. The larger of the two specimens measures about 18 mm. in length by 3·5 mm. in breadth, with the genital aperture 6·5 mm. and the peripharyngeal aperture 7·5 mm. from the posterior extremity. Eyes numerous, arranged much as usual in the genus.

The colour of the dorsal surface (in spirit) is brownish-yellow, with five conspicuous, nearly black, longitudinal stripes equidistant from one another. The median dark stripe is more intense in colour, better defined, and may be somewhat broader than the others; it appears to be made up of two parallel stripes placed close together side by side, there being (at any rate in one specimen) an indication of an extremely fine pale line down the middle. The outer edge of the outermost stripe is marginal. The bands of ground-colour between the dark stripes are about equal in width to the stripes themselves, and contain a few irregularly scattered minute specks of the darker colour by more or less intense concentration of which the dark stripes themselves seem to be made up.

The true ventral surface is pale-yellow without markings, but it is separated from the dorsal surface by well-defined lateral bands about half as wide as the ventral surface, and distinguished by a fine dusting of minute brown specks, visible under a lens.

This is a well-characterized species, but it appears to be related to *G. suteri* and *G. subquadrangulata*. I am indebted for the two specimens to Mr. H. Suter.

Locality. — Omaha (Auckland Province). Coll., Charles Cooper, Esq. Two specimens.

Geoplana mariæ, Dendy.

Near Mr. Garvey's House, Clinton Valley, Head of Lake Te Anau.—I found one small specimen which is probably a young individual of this species. The colouration and the shape of the body in spirit agree closely with the typical form, but I was unable to make out the eyes and apertures. The living animal is thus described in my notes: "When crawling long and narrow. Triangular in section, dorsal surface forming a prominent ridge, ventral flat, tapering gradually in front and behind. Dorsal surface yellow speckled with olive-brown, the brown specks concentrating on each side of a narrow median stripe of yellow, up the middle of which runs a row of very minute indistinct pale-brown spots. Anterior tip slightly pinkish. Ventral surface pale yellow flecked with minute specks of pale brown, which are absent in the middle line."

In spirit the body exhibits the characteristic convexity of both surfaces and uniformity of diameter almost to the extremities.

Art. XXV.—*Notes on* Salmonidæ *and their New Home in the South Pacific.*

By A. J. Rutherfurd, Chairman of the Wellington Acclimatisation Society.

[*Contributed to the Wellington Philosophical Society, 15th January, 1901.*]

The following notes were read by Mr. A. J. Rutherfurd, Chairman of the Wellington Acclimatisation Society, at the quarterly meeting of that body on the 3rd December. The subjects dealt with are chiefly a description of the waters into which salmon and trout have been introduced in New Zealand, and the results likely to be obtained owing to the change in their surroundings:—

I. Environment.

Situated between latitudes 34° and 47° S., in the Pacific Ocean, about a thousand miles from the main Australian Continent, the islands of New Zealand form an exceedingly interesting group, with their unique flora and fauna. They lie on the upper edge of the "Roaring Forties," along which the westerly gales (forming the northern parts of circular storms that extend into the Tasman Sea) prevail, so useful to eastward-bound vessels. Generally the ocean shelves off into deep water close to the coast, so that the conditions are widely different from those in the comparatively shallow North Sea, and approach more nearly to those of the Pacific Coasts of South America.

The fish frequenting the coasts of New Zealand correspond somewhat with those found in similar latitudes in the Northern Hemisphere—say, between Portugal and Madeira; and, roughly dividing the ocean belts into tropical, subtropical, temperate, and frigid zones, I think that the ocean surrounding New Zealand may be classed as intermediate between subtropical and temperate.

The great ocean-currents surrounding these Islands have a distinct bearing on the question under discussion, and I give my theories for what they are worth. In the ever-restless Pacific there is always a creep north of the waters cooled by the melting ice of the antarctic circle, which, sinking down, trend north in the deeper ocean. Conversely, there is always a set south of the warm water from the tropics, moving slowly along nearer the surface. Together with these two forces, there is a great easterly current influenced by the prevailing westerly gales, which, owing to the contour of New Zealand, is deflected towards the Chatham Islands.

In support of this theory I may mention the following interesting facts, supplied to me by Mr. Frederick Chapman, of Dunedin: (1.) Telegraph-poles washed overboard from the s.s. "Hinemoa," in Foveaux Strait, were some five weeks afterwards found at the Chatham Islands.—(Captain Fairchild.) (2.) A bucket washed overboard from the ship "New York," between the Snares and Auckland Islands, landed at the Chathams before the ship reached England. (3.) Wreckage from the Snares (ship "Assaye") landed on the Chathams, and supplied the inhabitants with candles. (4.) A supply of candles was washed ashore at the Chathams from the wreckage of the ship "Lastingham," wrecked in Cook Strait. (5.) Ice seen at the Chathams a few years ago was previously unknown to the Maoris, who have probably only been living on the islands sixty or seventy years. It is, however, reported that many years ago icebergs were stranded on Mahia Peninsula, north of Napier, and affected the climate there for three successive seasons.

Ice is seldom found so far north as the Auckland Islands, but it reaches into the Australian Bight, and very rarely up towards the Chathams. In other words, the ice-line sweeps south to clear New Zealand.

The cold antarctic flow probably rises as it strikes the shallow water on the south-east of New Zealand, and, working up the coast, seems to baffle between Otago Heads and Cook Strait with the warm tropical current which washes the northern end of New Zealand, works south into Cook Strait, and down the west coast of the South Island.

The usual meeting-place is probably somewhere about Banks Peninsula, but after a prevalence of southerly weather fish frequenting the colder waters are found as far north as Cook Strait. It may be that the meeting-place of these ocean-currents is one of the principal causes of the fogs so prevalent about Banks Peninsula, and, after southerly weather, in Cook Strait.

The migrations of the kanae, or grey mullet, seem to me to indicate the extreme limit of the warmer current, whilst the flying-fish, common enough in the Hauraki Gulf and Bay of Plenty, follows the flow of warmer water. The prevalence of mangrove vegetation in the estuaries in the northern parts of the Auckland Provincial District shows that the seaboard is directly influenced by the warm currents, which no doubt carried the floating seeds of this plant to the coast of New Zealand.

The kanae do not seem to work further down the coast than the estuaries running into Cook Strait, and I am not aware of their being caught south of Wellington Harbour. I believe they migrate with the seasons between the north of New Zealand and the extreme edge of the warmer current, in the same way that their representatives in the Mediterranean Sea migrate in similar latitudes on the Italian coast.

II. Rivers, Lakes, and Streams.

The beautiful system of rivers and lakes in New Zealand were recognised by the early settlers as admirably adapted for the well-being of *Salmonidæ*. In the South Island the rivers for the most part originate among snow-clad mountains of hard rock formations, flowing down through the low country, with shingle bottoms, which form excellent spawning-beds for trout. In parts of the North Island the same formations prevail to a large extent, but many of the rivers, such as the Manawatu, Ruamahanga, and Hawke's Bay Rivers, run for the greater length of their course through low country, and are not essentially snow-fed, though some of their tributaries are. The question of the chemical constitution of the water has never been carefully gone into, but I am inclined to think that in many of our mountain torrents and inland lakes there is a deficiency of salt; this, however, could only be determined by a careful experimental analysis.

As the geological formation is the basis of the banks and river-bed, so the fertility of the soil through which a river flows (altitude, climate, exposure, and the temperature of the water being also taken into consideration) determines the abundance and quality of the vegetation on land and under the water, and the supply of insect life, Crustaceans, &c., which form the staple food of the trout. As a rule cold snow-fed rivers contain much less food than those draining warmer lower levels, and the fish in them are later in getting into condition.

It must be borne in mind that each river has a limited permanent carrying-capacity, and will only do justice to a certain stock of fish. If overstocked the result must inevitably be deterioration ; hence it may be expected that in time our non-migratory *Salmonidæ* will deteriorate in size, and that we must look to annual visitors from the ocean (which, owing to the configuration of these Islands, is never far away) to keep up the record this colony holds for growing big trout, largely established at first by the fact that the virgin waters in which they were liberated contained abnormal quantities of food.

III. INDIGENOUS FISH.

Before proceeding to discuss subjects surrounding the introduction of *Salmonidæ* into New Zealand, it may be interesting to take a cursory glance at some of the indigenous fish inhabiting our rivers. The only true representative of the *Salmonidæ* is the beautiful little *Retropinna*, or smelt, two varieties of which at least are found in our rivers and lakes. Somewhat allied to this fish, the graceful upokororo (*Prototroctes oxyrhynchus*), or native grayling, about whose life-history and habits so little is known, is found in many of our streams. The upokororo used to be plentiful in our rivers, but of late years have been thinned out by the formidable trout we have introduced, by mining operations, and, no doubt, by clearing the bank vegetation for farming purposes. It is said to be an almost unique variety, very like the *Haplochiton*, which inhabits the cold, fresh waters of Tierra del Fuego, and is allied to a fish found in Australia, the Yarra herring. Though said to differ from a true Salmonoid in certain structures, it is, I believe, a representative of the family in this hemisphere. I have never heard of their being taken in salt water, but they certainly have a habit of disappearing and reappearing again in a ghostly fashion, which makes one wish for a further acquaintance with their migrations and spawning habits. I would suggest that the Westland Acclimatisation Society, who have their hatchery in a suitable place, be asked to keep some in their ponds for the purpose of studying their life-history.

The strictly fresh-water varieties of fish (such as carp) are intolerant of salt water, and on examination of the indigenous fresh-water varieties in this colony it will, I think, be found that they are all more or less tolerant of salt water, and probably, almost without exception, descended from marine ancestry at no very remote period in the world's history. Many of them, such as the smelt, eels, and inanga, at times frequent salt and brackish water; while some of our marine fishes, such as the flounder, grey mullet, and kahawai, run up into fresh water, the two former living and thriving in some waters in the North Island where they cannot obtain constant and permanent access to the sea.

IV. Salmonidæ in General.

In his opening chapter on *Salmonidæ*, Dr. Günther remarks that there is no other group of fishes which offers so many difficulties with regard to the distinction of the species, as well as certain points in their life-history, as this family. Their almost infinite variety is dependent on age, sexual development, food, the ever-varying properties of water, and the tendency to interbreed exhibited by many of the so-called varieties. Colouration seldom assists us in distinguishing the species, varying as it does with the haunts of the fish and the seasons of the year. It is imitative, the colour of the fish rapidly adapting itself to its surroundings. A living trout of dark colour placed in a white basin full of water becomes pale in half an hour, and in some days almost white. Conversely, a trout of light colour placed in a black vessel rapidly assumes the colour of the bottom. Hence, in almost every river the varieties of trout have local peculiarities of colour, which are favourable as a protection to the fish against its natural enemies. As a rule, clear rapid rivers produce trout with intense ocellated spots. In large lakes with pebbly bottoms the same fish are bright and silvery, with x-shaped black spots. In pools and parts of lakes with a muddy or peaty bottom they are of a darker colour generally, smudged and blotchy in their marking; and, when enclosed in caves and dark holes with but little light, often jet-black or nearly so. The action of brackish or salt water soon gives them a bright or silvery coat, as a rule sparsely spotted, none of the spots being ocellated.

Size depends chiefly on the amount of suitable food available, and the colour of the flesh on the particular nature of the food, the pink or red colour being probably produced by the red pigment of many salt- and fresh-water Crustaceans on which they greedily feed.

This group of fish may be divided into many varieties, including the Salmones proper, such as the species of salmon found in the Atlantic and Pacific Oceans, the many varieties and hybrids of the subgenera called trout—the *Salvelini*, or char; the *Coregoni*, such as the whitefish of America; the *Thymallus*, or grayling, &c.

Without going into the larger and more scientific question affecting the groups of this fish, which would require much study and elaboration, I wish in this short paper to discuss a few of the interesting questions involved in the introduction into the waters of the southern Pacific Ocean and rivers of the Islands of New Zealand of several forms of Salmonoids.

V. Salmonidæ Proper.

By these fish I mean the larger species, which live in the sea from the time they have reached the smolt stage, and only run into fresh water for the purpose of reproducing their species, or at times, perhaps, to rid themselves of sea parasites. From the time these fish enter the river they begin to deteriorate in condition, and when imprisoned in fresh water gradually lose many of their finest characteristics. The necessity for seeking their sustenance in the sea will be quite apparent if we reflect on the enormous quantity of food which would be required to feed the millions of large fish which annually run up the salmon rivers in the North to spawn.

Hitherto three species of the true Salmones have been introduced into the colony: (1.) The *Salmo salar*, or Atlantic species, the ova of which has been imported in large quantities, and a considerable number have been reproduced in captivity. This is the finest sporting species known, but its migrations in the Northern Hemisphere are chiefly confined to the temperate and sub-arctic zones, and hitherto its introduction has not been, as far as we know, permanently successful. This is much to be regretted from every point of view, and it would be of the utmost value to the colony if this fish could be successfully acclimatised. (2.) The *Oncorhynchus tschawytscha*, king, chinook, or quinnat salmon, a species growing to a large size. (3.) The *Oncorhynchus nerka*, sock-eye or blue-backed salmon, a smaller thick-set variety much used for canning in the Columbia River, some of the ova of which were introduced in one of the shipments to New Zealand. These—(2) and (3)—are species found in the North Pacific, and have a much wider geographical range than the Atlantic species, some of them being found from the far north down to Monterey Bay, in southern California, as well as in Japan and in northern Asia. Some of the ova of the quinnat and blue-back varieties have been introduced and the fry liberated. Fish caught in the Waitaki River have been sent to London and have, I am informed, been identified as belonging to the species found in the Pacific.

On the whole, I am inclined to think that, owing to our geographical position and ocean surroundings, we are more likely to be successful in introducing the forms of salmon found in the northern Pacific than our old friend *Salmo salar* of the Atlantic, which is a more delicate fish, and would probably find difficulties in ocean surroundings so widely different from those in its northern home.

It has been urged that it is a pity to introduce fish which do not, as a rule, give good sport in our rivers, though they are excellent sporting fish in the sea and estuaries. I do not think we need fear this at all. In introducing these fish we are stocking the ocean with very valuable fish from a commercial point of view; and I can see no reason why several varieties of salmon should not flourish on our coasts, and run up the rivers at different times of the year, as they do in the western rivers in Canada and the United States, in countless thousands. I believe, myself, that, owing to the warmer ocean-currents striking the coasts of the North Island, the best salmon rivers will be in the South, and consider that it will be good policy to endeavour to introduce the best species of salmon found on the coasts of British Columbia, Oregon, and California; and in doing so I think we shall succeed in permanently establishing one or more of these species, which will form a very valuable addition to the fishes of New Zealand, as well as probably of Tasmania, and any small islands to the south where there may be suitable streams for spawning.

VI. Salmo trutta, or Trout.

A number of varieties of trout have from time to time been introduced into New Zealand, such as *Salmo fario*, or brown trout; *Salmo levenensis*, or Loch Leven trout; *Salmo samardii*, variety, Scotch burn trout; *Salmo trutta*, sewen, sea trout, or white trout. Probably some of the ova originally brought out was crossed more or less with a strain of the *Salmo eriox*, or bull trout.

All these fish are gradually accommodating themselves to their new environment, and becoming very like the varieties found in corresponding northern latitudes—say, in Switzerland and northern Italy. Our Lake Wakatipu trout are almost identical with the trout I saw taken in the northern Italian lakes in nearly similar latitudes, and very much alike in their habits.

I believe, myself, that the varieties and hybrids of *Salmonidæ* called "trout" are merely one species, subject to an immense amount of variation, many of the larger forms of which seek their food, whenever conveniently situated, in the ocean, and run up the rivers like salmon to perpetuate their species; but it is probable that they do not make such lengthened journeys at sea as the salmon proper are supposed to do, but frequent the shallower water on the coast.

Even within the limits of a single species (so-called) no two are found to be exactly similar, but there is a tendency to diverge from the original type in such direction as to preserve and increase useful varieties—a law of variability by adaptation, which is destined to modify every organism so as to fit it for new conditions of existence. A notable instance of this occurs in the gillaroo trout of Ireland, which have developed *quasi*-gizzards to enable them to crush and digest the small fresh-water snails and shells found in certain lakes. It will be interesting to watch whether similar developments are found in any of the varieties in our lakes at the antipodes.

In short, my theory is that, whatever variety we liberate of the ordinary species of trout, it will develope into a *Salmo novæ-zealandiæ*, suited to the water in which it is liberated, and corresponding with trout in similar latitudes in the Northern Hemisphere more closely than with the varieties found in the more northern latitudes of our Mother-country. I do not think that these fish will retain the characteristics of the variety found in the environment from which they were taken, and consider that the results already obtained in New Zealand have proved this.

VII. Salmo irideus.

Turning to a more subtle family, the *Salmo irideus*, or rainbow trout, which we have successfully introduced into several of our rivers in the colony, there is considerable controversy as to what this variety really is. The progeny of ova taken from the *Salmo gardneri*, or steel-head, of British Columbia, are apparently identical with the progeny of the rainbow trout, and it is commonly believed by some of the experts that they are the same fish, and that the rainbow trout when it takes to sea-going habits developes into the steel-head. It will be very interesting to see whether this proves to be the case in New Zealand.

Personally, I am inclined to think that this species, in common with the rest of the trout on the Pacific Slope, is more allied to the char family than the trout. Its spawning habits are not like those of the trout, and in its play when hooked it is like a salmon. It lacks many of the shy habits of the trout, and is certainly the best sporting fish we have yet introduced. I do not think there is any probability of this variety crossing with the brown trout in our rivers, and I doubt their thriving well together.

There seems to be a marked divergence in species between the forms of salmon and trout indigenous to the Atlantic and Pacific Oceans.

VIII. Salmo salvelini.

The Char family proper are a beautiful, but more delicate, variety of Salmonoid, shorter lived, and most of their forms requiring deeper and colder water than the trout. We have introduced the American brook char (*Salvelinus fontinalis*), but have not been very successful with these fish. The only stream I know which is well stocked is the Tahuna-atara Stream, between Rotorua and Taupo, which is full of them, and contains no brown trout. They are evidently very difficult to establish, and attempts to do so have proved a failure in most places, both in England and on the Continent, though in enclosed private waters they have been successfully propagated and are easily handled. My experience with them in the Tahuna-atara was that they were fairly easily caught with a small spinning bait, like a "halcyon spinner," but that they did not rise well at the fly. When caught they made a few strong rushes, and then gave in without a long fight. For the table they are extremely rich and well flavoured, running, in that stream, up to about 6 lb. in weight, and averaging about 2 lb.

I consider that it would be worth while trying to import the saibling (*Salmo salvelinus*) from Europe, and introduce it into our lakes. It is a lively and delicate fish, and it is probable that the *S. alpinus* and *S. umbla* are varieties of the same fish, and that we may develope a beautiful variety of our own in some of the clear, deep lakes of New Zealand.

A few eggs of the *S. alpinus* arrived and were hatched out at Masterton some years ago, but the young fish died, and for the present we have lost the breed.

IX. Salmo carpio (Trutta lacustris carpioni).

Some years ago we imported and reared to maturity some of a very fine variety of deep-lake trout, the *Salmo carpio*, or carp trout, of Lago di Garda, in northern Italy, a kind much valued as a table fish by the Italians. This fish has proved very difficult to introduce into any waters where it has been tried, and, unfortunately, owing to a want of knowledge of its habits, we have lost the breed.

The *Salmo carpio* live at a great depth, and the best chance would have been to have liberated the young fish in one of the deep lakes in the South Island and let them take their chance. The shallow ponds of our hatcheries were unsuitable to them. Dr. Bettoni, of Brescia, promised to supply us with a further consignment from the Italian Government hatchery at Peschiera if we required them, and, if possible, another attempt should be made to introduce this fine fish. It is not a sporting fish, being caught trolling at a great depth, but is a very valuable fish to net for market, and one of the most interesting of the varieties of *Salmonidæ* found in deep lakes.

COREGONI.

The *Coregonus albus*, or whitefish, of America is a most valuable fish from a table and food-supply point of view, and, though no good for sport, should suit our lakes well. Several successful importations of ova have been made, and it is more than probable that these fish are now in Lake Rotoiti, in the Nelson Provincial District. The whitefish fisheries in America are large and of great value, and I think we should persevere in attempts to introduce the *Coregoni* until a planked whitefish becomes a recognised delicacy in the hostelries adjoining our magnificent lakes. Once established in any lake, we could easily transport them to the other lakes of the colony.

CONCLUSION.

The subjects on which I have ventured briefly to touch in the short space of time at my disposal are, I think, interesting ones, which might with advantage be enlarged upon *ad infinitum*.

I wish you to picture to yourselves the position of these Islands, far out in the southern Pacific, with ocean surroundings differing widely from those on the British coast. Then study, analyse, and make notes on the results already obtained from the introduction of various forms of *Salmonidæ* into entirely new environments—results which closely resemble those obtained in our sister-colony, Tasmania, and are of great interest in helping to solve problems in the scientific world. They seem to me to prove the truth of the theories I have advanced, many of which are practically those held by Dr. Francis Day, to whose works I am much indebted in writing this paper. This will, I think, give us a clearer conception of the scope of one branch of the work of acclimatisation and the far-reaching benefits we may hope to obtain if we strive conscientiously to people our waters with new forms of life, valuable not only from a sporting point of view and as an attraction to tourists, but best suited to the wants of the inhabitants of this fair land of our adoption.

Art. XXVI.—*Description of a New Ophiurid.*

By H. Farquhar.

Communicated by the Secretary.

[*Read before the Wellington Philosophical Society, 12th March, 1901.*]

Amphiura aster, n. sp.

A number of specimens of what I believe to be a new species of *Amphiura* have been placed in my hands by Mr. A. Haylock. They were found by Mr. Percy Allen at Timaru, in the sand at low water.

Diameter of the disc, 10 mm.; length of arm, about 136 mm.; width of arm near the disc, without spines, 1 mm. The disc is pentagonal, constricted in the interbrachial spaces, covered above and below with small rounded irregular scales. Near the centre of the disc the scales do not usually overlap, and around the radial shields they are larger and longer than elsewhere; below they are more regular than above. Radial shields large, long, and swollen, broader without than within, separated by a wedge of scales, meeting or almost meeting without. A pair of short, blunt, rounded mouth papillæ at the apex of the mouth-angle, and one, spiniform, tapering, and pointed, on each side. Mouth-shields rather small, shield-shaped; madreporic shield large, swollen, and oval. Side mouth-shields much broader without than within, meeting within. Arms long and slender, tapering evenly to very fine extremities. First under arm-plate small, squarish, rounded within; second and third longer than broad, and narrower than those beyond, which are squarish, with rounded angles. Side arm-plates small, with strong spine-ridges, meeting neither above nor below. Upper arm-plates oval, broader than long; the first two or three are absent in all specimens examined by me (12), except a young one, in which they are small and disconnected, evidently disappearing; sometimes those near the base of the arms are split in two longitudinally. Arm-spines subequal, somewhat flattened, six or seven near the disc, five further out, and four towards the tips of the arms. Tentacle pores very large. Two very small tentacle scales to each pore near the disc and one beyond. Colour of dried specimens pale-yellowish, sometimes tinged with red or brown; arms sometimes banded with grey.

Type specimens in the Canterbury Museum.

Art. XXVII.—*Our Migratory Birds.*

By Captain F. W. Hutton, F.R.S.

[*Presidential Address to the Philosophical Institute of Canterbury, 3rd April, 1901.*]

In the Northern Hemisphere the migration of birds in the autumn and spring is so common an occurrence that it has been known from time immemorial, but it is only of late years that the migrations have been followed in detail.

All the migrating-birds of the Northern Hemisphere breed in their most northern district and fly south before the cold of winter comes on. The land- and water-birds do not fly far, only into warmer or subtropical regions; but the shore-birds, such as the curlews, plovers, sandpipers—known as the *Limnicolæ*—wander much further, and travel down the shores of the Pacific and Atlantic Oceans, often crossing the equator into the Southern Hemisphere before halting. One such stream leaves eastern Siberia and, passing through China and Japan—where it picks up the southern snipe and the red-capped dotterel—continues to fly through the Malayan Archipelago into Australia and Tasmania, those birds which do not die on the way returning annually to their breeding-ground in Siberia and Kamtchatka. This statement may seem at first startling, or even incredible, but we must remember that a bird could easily travel from Kamtchatka to Tasmania in a month; so that, after the breeding-season was over in the Northern Hemisphere, there would be ample time for globe-trotting if the bird felt so inclined.

In the Southern Hemisphere a corresponding migration occurs: swifts, swallows, cuckoos, and quail migrate in Australia and Tasmania; while in South America swallows, humming-birds, and several others, including some shore-birds, after breeding in Patagonia, travel annually to Paraguay and Brazil. However, as the area of land in the temperate and cold zones in the Southern Hemisphere is small, these migrations are insignificant when compared with those of the Northern Hemisphere, and have attracted but little attention.

Stragglers from these migrating flocks often lose their way and turn up in unexpected places, while non-migratory birds sometimes get blown out to sea by gales of wind and become involuntary stragglers.

In addition to these there are some birds which may be called wanderers, or occasional wanderers—that is, birds which at irregular intervals become restless and trek* in numbers to some other district, which rarely lies north or south of the land which they have left. These excursions are well known in the Northern Hemisphere, and even in New Zealand we occasionally see wandering flocks of parrakeets. These stragglers and wanderers must be carefully distinguished from the true migrants which voluntarily perform two journeys a year with great punctuality.

The first notice that New Zealand participated in these southerly migrations was by the Rev. W. Colenso, who stated, in 1842,† that our shining cuckoo (*Chalcococcyx lucidus*) was migratory. Now, at the time this statement was made the furthest distance across the sea which migratory birds were known to fly was from Norway to Scotland and across the eastern Mediterranean from Egypt to the Greek islands, in each case a distance of about three hundred miles, which necessitates some eleven hours of continuous flying. When, therefore, it was said that the shining cuckoo, or bronze cuckoo, of New Zealand traversed more than three times that distance of ocean it is no wonder that the statement was received with incredulity, and it was thought that colonial naturalists had made a mistake. This appeared to be the more probable because until quite lately New Zealand was thought to be an oceanic island—that is, an island which had never been connected with the mainland—and oceanic islands have no migratory birds. The only exception to this rule is, perhaps, Bermuda, for, according to Dr. A. R. Wallace, this island has "several regular migrants."‡ But he does not distinguish clearly between migrants and stragglers, and appears to think that all these birds have been blown out to sea, and have not come voluntarily, in which case they cannot be true migrants.

But, however this may be, Dr. Wallace had somewhat changed his opinion about New Zealand in 1880, when he published his "Island Life," for in that book he calls it an "anomalous island," without explaining his meaning of the term, and says nothing about our migratory birds.

In his "Geographical Distribution of Animals," published in 1876, Dr. Wallace says, "Resident ornithologists believe that *Zosterops cærulescens* has found its way to New Zealand within the last few years, and that the two cuckoos now migrate annually, the one from Australia, the other from some part of Polynesia, distances of more than a thousand miles. These facts seem, however, to have been accepted on

*A useful word, meaning a voluntary movement without any intention of returning.

† "Tasmanian Journal," vol. ii., p. 227.

‡ "Island Life," p. 258.

insufficient evidence, and to be in themselves extremely improbable. It is observed that the cuckoos appear annually in certain districts and again disappear, but their course does not seem to have been traced; still less have they been actually seen arriving or departing across the ocean. In a country which has still such wide tracts of unsettled land it is very possible that the birds in question may only move from one part of the islands to another."* As this opinion has never been recalled, or even modified, it seems desirable to set out more fully than has yet been done the evidence for the regular migration of birds to and from New Zealand, as it is a question of considerable importance.

But first let me enumerate some cases of stragglers which have managed to cross the Tasman Sea and reach New Zealand. Of the shore-birds, or waders, we have the red-capped dotterel (*A. ruficapilla*), the Australian curlew (*Numenius cyanopus*), the little whimbrel (*Mesoscolopax minutus*), the grey sandpiper (*Heteractitis brevipes*), and the greenshank (*Glottis nebularius*), a specimen of which has been for many years in the Otago Museum.† There is also the Australian snipe (*Gallinago australis*) and the grey phalarope (*Crymophilus fulicarius*). Of swimming-birds we have only two reported cases of the tree-duck (*Dendrocygna eytoni*) and one of the Australian darter (*Plotus novæ-hollandiæ*).

Of truly land-birds there are the Australian kestrel (*C. cenchroides*), the yellow wattle-bird (*Acanthocæra carunculata*), the tree-martin (*Petrochelidon nigricans*), the Australian roller (*Eurystomus pacificus*), and the white-backed swift (*Micropus pacificus*). Possibly there may be a few others, but their cases are not fully proved.

That stragglers of swimming-birds are so few is not surprising, for they can alight on the sea, and, after resting, can rise again and regain the land from which they were blown. Such is not the case with birds whose feet are not webbed; they must fly on or be drowned. Possibly some of the perching-birds may rest for a time on steamers or sailing-vessels, but this would not be possible for the wading-birds. The kestrel and the swift have been seen only once; but the tree-martin and the roller have been shot several times in New Zealand.

None of these birds have been seen to arrive across the ocean, and we know them to be stragglers only because they are very rare with us but common in Australia. None of them have been known to breed here, and they are often single birds; from which it follows that they have not been

* "Geographical Distribution of Animals," vol. i., p. 452.
† It was bought by me in the market in 1874.

long in New Zealand, perhaps less than a year before they were seen.

The case of the white-eye (*Zosterops cærulescens*), alluded to by Mr. Wallace, is rather different. The date of its first occurrence in Otago is doubtful, but in 1856 it appeared on both sides of Cook Strait in considerable numbers. Before then it was unknown, both to the Europeans and the Maoris, the latter calling it "tauhau," which means "a stranger." In 1860–61 it had spread all over the South Island and the southern parts of the North Island, but it did not reach Auckland until 1865. It has also spread to the Chatham Islands, Snares, Auckland Islands, and Campbell Island. Evidently it is a new arrival, for the restless habits of the bird forbid us from thinking that it had remained for many years in Otago without spreading northwards. I should call the white-eye a wanderer, and not a straggler, for, unlike the others, it crossed the ocean in sufficiently large numbers to establish itself both in New Zealand and afterwards in the outlying islands. Several others of our birds—especially some of the herons, rails, and ducks—are also found in Australia; and these, we must assume, were at one time wanderers like the white-eye. They also, at different times, crossed over the sea and became naturalised; but long before the settlement of the country by Europeans.

These facts show us that the passage across the Tasman Sea is possible, even for some small land-birds. The distance as the crow flies is about a thousand miles, and it would take a bird twenty-four to thirty-six hours to accomplish the distance, flying at its ordinary speed.

We have next to see what is the evidence for thinking that some of our birds are regular migrants; and I will take first the shore-birds. Of the living stream, already mentioned, which passes every year through the Malay Archipelago to Australia, a small branch, consisting of three or four species, leaves New Guinea for New Zealand. Of these the godwit (*Limosa novæ-zealandiæ*) is the best-known case. These birds breed in eastern Siberia from June to the end of July, and then leave. In September, and again in April, they are found in China, some of them passing the winter in the Island of Formosa. Others arrive in August or September in Australia, Fiji, New Caledonia, and the New Hebrides from the north, and depart again northwards early in May. Stragglers go to Samoa and Tonga. In New Zealand many birds arrive during October, November, and December, spread as far south as Stewart Island, and leave at the end of March or the beginning of April. Some also visit the Chatham Islands; but they are not known to breed either in New Zealand or in Australia. In New Zealand they arrive in small parties, which evade observation, but they leave the North Cape district in large flocks, which have several times been seen to depart. This evidence of migration is sufficiently strong, but in addition we have that of the change of plumage. The godwit is one of those birds which have different plumages in summer and in winter. In the Siberian summer, during breeding-time, the birds have their summer plumage; but in New Zealand they are nearly always in their winter plumage, although it is summer with us. A few exceptions in summer plumage have been noticed, and it is probable that these are birds which remained behind when the great April exodus took place.

The turnstone (*Arenaria interpres*) also breeds in the Northern Hemisphere, but not so far north as the godwit, and it is found in its breeding-dress in India and Ceylon. In early autumn it leaves its more northern breeding-grounds, and some pass through the Malay Archipelago and New Guinea to Australia and Tasmania. In New Zealand it arrives in November and leaves in March or April, almost all the birds being in winter plumage. But, as in the last case, a few remain and take on their summer plumage, although it has never been known to breed here. Stragglers occasionally spread from Fiji through eastern Polynesia, but there is no regular migration eastward of Fiji. The evidence in this case is not so good as in the last, because the birds are not so numerous, and they have never been seen to leave New Zealand.

The knot (*Tringa canutus*) is another northern bird which, after breeding in Siberia, travels southwards across the equator. Its summer plumage is very different from its winter plumage, which it assumes in September and retains until May. In Canterbury, New Zealand, it appears in November and leaves in about April, thus remaining all through our summer. Generally the birds are in their winter plumage, but there are two specimens in the Canterbury Museum in summer plumage. One of these was shot on the 2nd April and the other in November, 1899, the latter being in company with others in which the summer plumage is just beginning to show. They were shot at Lake Ellesmere. Mr. John Gould also mentions a bird from Queensland, shot on the 2nd September, 1861, as changing into summer plumage. It seems, therefore, that some birds have changed the seasons for moulting and put on their breeding-dress in our summer, and I think it probable that these birds breed in New Zealand, although they are not known to remain here through the winter.

The brown-eared sandpiper (*Heteropygia acuminata*) also breeds in Siberia and Alaska, and, from the former country, passes through Japan and China to the Malay Archipelago, where it spreads into Australia, New Caledonia, and New Zealand. In Australia it is distinctly migratory, while in Tonga it is only a straggler, as it does not visit the islands every year. In New Zealand it is doubtful under which heading it should be placed, for our information about its habits is too scanty, and we do not at present know whether it is or is not an annual visitor to us.

The spotted plover (*Charadrius dominicus*)* is another Siberian bird which migrates regularly to Australia, has spread over Polynesia, and, according to Dr. Graffe, has become a resident at Tongatabu. In the Northern Hemisphere it takes on its summer plumage in April, and changes into the winter plumage in August or September. It is a common bird in New Caledonia and Fiji, and Mr. E. L. Layard says that in the former island he found, on the 20th April, 1877, a female followed by a couple of chicks a few days old. But he also says the old birds attain their full breeding-plumage in May, which is the same time as in the Northern Hemisphere. It would seem from this that the breeding of the bird in the island was what might be called "accidental," and, as the birds have not been long enough to change the time of breeding or of moulting, it is probable that all are migrants, but that some delay moving northwards until they have attained the breeding-plumage.

Something the same probably happens in Australia, as Mr. Gould says that the uniform black under-surface, which is the complete breeding-plumage, is seldom seen there. And all the specimens in the British Museum from the Malay Archipelago, Australia, and Polynesia are in the winter plumage.

In New Zealand the bird is rare, having been only recorded a few times in the North Island, while for the first time in history it made its appearance in the South Island last summer. Mr. W. W. Smith says that he has seen a good many in the Ashburton River bed, the first he had noticed for eighteen years. There is a specimen in the Canterbury Museum which was shot at Lake Ellesmere in November, 1900; and I saw another specimen which had been shot at the Bluff, in Southland. Two specimens shot near Auckland early in December, 1880, were in winter plumage, but showing signs of being about to put on their summer dress.† The specimen in the Canterbury Museum is in winter plumage, as also is the one shot at the Bluff; and Mr. Smith says that the plumage of the birds in the Ashburton

* This is called *C. fulvus* by many authors.
† Trans. N.Z. Inst., vol. xiv., p. 265.

River bed varied but slightly. But Sir W. Buller has received a specimen from Mr. C. H. Robson which had partially assumed the summer plumage. Mr. Robson also found a pair breeding at Portland Island on the 9th January, and, as he says that the birds undergo little or no change of plumage from winter to summer* (which is a mistake), I presume that the birds he saw were also in the winter or non-breeding plumage. This is very remarkable, for with introduced European birds, such as the starling, linnet, and redpole, the change of plumage goes with the breeding-season, as it did in Europe; both, on coming into the Southern Hemisphere, have changed together.

We cannot, therefore, think that the birds breeding at Portland Island were true residents, for if they had been long in New Zealand it is probable that they would have acquired their summer plumage in the breeding-season.

This concludes the list of migratory shore-birds. It is a very short one in comparison with that of Australia; but if only one species migrated regularly to an island so far away from the mainland as New Zealand it would still be very remarkable.

I will now proceed to examine the evidence for the migration of our two cuckoos.

The shining cuckoo, or bronze cuckoo (*Chalcococcyx lucidus*), appears in the northern parts of New Zealand regularly in the latter half of September, and early in October it is found in Wellington and in the South Island. It breeds in New Zealand, and during the first and second weeks in January all the old birds leave the southern portions of the country, but they do not leave the north until the end of January, or perhaps later. Some, at least, of the young birds leave considerably later than their parents, as they have been shot in the South Island in April. The times of appearance and departure of the old birds are wonderfully regular in both Islands. In the Chatham Islands the birds come and go at about the same dates as in New Zealand. Here we have distinct evidence that the birds travel from the north to the south, and then back again to the north. They have not been seen to leave the Islands, but it is impossible that they could remain during the winter and yet escape the eyes and snares of the Maoris, for there are no "wide tracts of unsettled land" for them to go to, as Mr. Wallace suggests, either in New Zealand or in the Chatham Islands. Also, although the birds have not been seen to leave, Mr. T. H. Potts told me that he once saw the arrival of a shining cuckoo at the Chatham Islands. It was so tired when it

* Trans. N.Z. Inst., vol. xvi., p. 308.

landed that it allowed him to pick it up in his hands, although under ordinary circumstances it is a very shy bird. Also, Dr. E. P. Ramsay has in his collection a specimen which was taken at sea between New Zealand and Lord Howe Island.

Outside of New Zealand we have little information. The species is found in Norfolk Island, where it also breeds, but elsewhere it has only been obtained at Cape York, in North Queensland, where it is very rare; and it is probable that its winter home is in New Guinea.

Mr. E. L. Layard said that it occurred in New Caledonia, but according to the authorities of the British Museum his specimens belong to the allied species *C. plagosus*, which migrates from north to south in Australia, but does not come to New Zealand.

The long-tailed cuckoo (*Urodynamis taitensis*) arrives in New Zealand at the end of October or beginning of November, and leaves in January or February, but its movements are not so easily traced as those of the shining cuckoo, for it is generally silent in the day-time. As in the last case, the young birds linger longer than their parents, and are occasionally seen as late as the first week in April. These birds retain their young spotted plumage much longer than the young of the shining cuckoo, but no specimen showing the change into that of the adult has as yet been shot in New Zealand, and neither old nor young have been recorded from the Chatham Islands.

Mr. E. L. Layard says that this bird is very rare in New Caledonia. He only obtained four specimens, all of which were purchased in the streets. The first was on the 23rd March, 1879, the second on 15th March, 1881, and the other two on 15th April, 1881.* As these birds were in their immature plumage, he thinks that they were born in the island.

Through the kindness of His Excellency Sir G. O'Brien, Governor of Fiji, I have received from Mr. C. W. Woodford, Resident Commissioner of the British Solomon Islands, a letter in which he says that he obtained immature males of the long-tailed cuckoo in April and May, 1887, and that he has seen the bird several times in the Solomon Islands during the last three years, the last time being in May, 1900. He is of opinion that the bird is a migrant, but cannot say so positively. He also, like Mr. Layard, thinks that the birds must have been born on the islands in which they were found. But the hypothesis that the young birds leave New Zealand early in March, and, passing through New Caledonia, reach the Solomon Islands early in April, would fit the facts very well.

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* *Ibis*, 1882, p. 523.

The evidence is therefore strong that both our cuckoos leave New Zealand in the autumn and travel north-west to New Guinea and the Solomon Islands, but we still want evidence of the spring migration to the south.

We have also migrations on a minor scale confined to New Zealand, but very little notice has been taken of them up to the present. Both the wry-bill plover (*Anaryhnchus frontalis*) and the little sand plover (*Thinornis novæ-zealandiæ*) breed in the South Island and pass the winter in the North Island; while the pied stilt (*Himantopus picatus*) seems to perform some sort of migration, for it is found near Napier in the summer, but not in the winter. However, it breeds in both Islands, and its movements have not yet been made out.

The banded dotterel (*Ochthodromus bicinctus*) has been suspected of migrating from New Zealand to Tasmania in the autumn, for it is common in Tasmania in the winter and leaves in the spring. The species occurs all through eastern Australia, as well as in Lord Howe and Norfolk Islands. In New Zealand it breeds in August and September, and is equally abundant in the South Island all the year round, showing no signs of migrating, and, as Mr. Handly reports that it is also common in Marlborough throughout the year,* I think that it may be safely affirmed that it does not pass regularly to and fro between Tasmania and New Zealand.

There are several other birds which do not migrate in New Zealand, although they belong to genera, or even to species, which migrate in other parts of the world. The pectoral rail (*Hypotænidia philippensis*) does not migrate with us, although it does so in Australia, being a summer visitor to New South Wales and South Australia, arriving there in August and retiring northwards in February. The New Zealand snipe (*Gallinago aucklandica*) and the brown dotterel (*Ochthodromus obscurus*) do not migrate, and it was so formerly with our quail (*Coturnix novæ-zealandiæ*), although all these belong to genera which migrate in other parts of the world. In the cases of the New Zealand quail and snipe, their powers of flight were so much reduced that they were incapable of migration. But it is different with the pectoral rail and grey dotterel. These fly well, but have lost the migratory instinct.

Now, what is this migratory instinct? And what are the reasons which induce, or have induced, birds to migrate? The principal cause of the migration of birds in the Northern Hemisphere is, obviously, the food-supply, which for insect-eating birds differs much in the summer and winter. In the

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* Trans. N.Z. Inst., vol. xxviii., p. 363.

winter insects hybernate, and the birds have to go to warmer latitudes. But when the spring comes on the insects in high latitudes come out, and the birds go back again to feed upon them. As this is the breeding-season they naturally breed in high latitudes. There are, however, several migratory birds in the tropics which never go to cold climates, but regularly change their quarters twice a year; and most of these migrations may be due to the fruits of different trees ripening at different times. In North America there are some birds which do not return by the same route which they follow when flying south, and these deflections also seem to be due to different fruits, on which they feed, becoming ripe at different seasons of the year in different places.

But change in the food-supply is not an adequate explanation of all cases of migration. For example, swifts migrate in Central America, while swallows remain all through the year. Ducks certainly do not leave their winter quarters for want of food; and our godwit would find just as much food on the shores in winter as it does in summer. In New Guinea three or four species of bronze cuckoo are residents, and, if they can find food all the year round, so also could the migratory species which go to Tasmania and New Zealand; and certainly insects in New Zealand, even in summer, are much less plentiful than they are in New Guinea or Australia. Evidently our two migratory cuckoos are not attracted here by the abundance of insect life. It is probable that these migrations may be due to the habit of resorting each year to the same place to breed, a habit which is common to many birds, whether migratory or not. Probably they like the site of their old nest, and have grown accustomed to it; it has protected their young in former years, and they have found sufficient food in the neighbourhood. They do not like new experiments, and year after year they return to build their nests in the same places that they did before. Instances are known of this taking place although the surroundings of the nest had been greatly altered by cultivation; thus showing that the return to the ancient breeding-place had become an instinct. No doubt this love of home must be taken into account, as well as the food-supply. It is this that explains the two cuckoos coming to New Zealand; while in the case of the *Limnicolæ* we must suppose that they return annually to the feeding-ground of their forefathers, and that this also has become an instinct. How strong this migrating instinct is we can judge from the fact that swallows not unfrequently leave their late broods of young ones to perish in their nests while they fly south.

The shore-birds retain the same specific characters, no matter where they wander, because all breed together in the north. But the case of the bronze cuckoos is different. These mix together in New Guinea in the winter, but separate to breed, and have, through this, become differentiated into different species. This is another illustration of the effects of isolation in forming species by preserving variations, for we cannot suppose that the slight differences in colour between the species are special adaptations to their surroundings; and they cannot be recognition marks, as the birds separate long before they begin to pair.

As a rule the migratory birds in the Northern Hemisphere follow the land, either the shore-line or the interior, according to their habits. But in their movements some have to cross the Mediterranean Sea, which blocks the way. This they do in three streams—one crosses the Straits of Gibraltar, another passes through Sicily and Malta to Tripoli, and the third goes by the islands of the Ægean Sea to Egypt. There are also other cases of trans-oceanic migrations. Skylarks, field-fares, and redwings pass backwards and forwards between Norway and Britain. Other birds cross the North Sea; others the English Channel; and, of course, many shore-birds must pass from island to island in the Malay Archipelago. But the boldest flight of all is to New Zealand and the Chatham Islands, probably from New Caledonia, a distance of a thousand miles or more. Why should they do this? How do they know that they will find land after so long and weary a flight? They are not blown out to sea, but go voluntarily, and they must know that there is land ahead of them. How did they acquire this knowledge?

Stragglers which have lost their way from a migrating flock and gone to some other country do not start new lines of migration. Birds never fly to sea at random and, having discovered new land, come back and tell their comrades of it. If this were the case we should find that oceanic islands, like the Azores and Madeira, were visited by migratory birds. These wanderers have no tradition behind them of the new route, and they cannot travel it again. Stragglers either perish or, if sufficiently numerous, establish themselves in the new country as residents.

We have examples of this in the swallow, which is resident in Tonga, and the spotted plover, which has established itself in New Caledonia and in Tonga. In New Zealand, also, the spotted plover has been known to breed, and, if undisturbed, might perhaps establish itself with us. *Heteractitis incanus* migrates annually from Alaska to Mexico, and has sent stragglers to Hawaii and southern Polynesia, and has become a resident in Fiji.

In all these cases the stragglers do not return. They either die out or establish themselves in the new locality.

The reason is obvious. As these islands have never formed part of a continent they never could have been either the breeding-places or the feeding-ground of migratory birds. No birds visit them instinctively, and if any bird happens to wander to one of them it has no hereditary instinct directing it how to return. This is why oceanic islands have no migratory birds.

The Polynesian whimbrel (*Numenius tahitiensis*) must breed in some of the Polynesian islands, for it is not known elsewhere, except as a straggler in British North-west America. It is closely related to the American whimbrel, and no doubt it is descended from some stragglers of that species which, long ago, found their way to the Hawaiian islands.

The only possible explanation of oversea migration seems to be that the birds are following old land-lines. The shore-birds follow the old shore-line; the land-birds follow the old land. Migration must have commenced when the two lands were contiguous, or nearly so, so that in no part of the course was an island so far off as to be invisible from those next to it. Gradually the land sank, but the force of habit kept up the migration. During the life of each bird the changes would be too small to be perceptible, and it would only be after many generations that the birds would find themselves flying over a trackless ocean. That migration is really an instinct we know from the fact that in the Northern Hemisphere the birds start on their flight to the south before there is any real necessity for it. The young cuckoos, which, of course, have never seen their parents, do not leave until two months after the old ones have gone, and, as they have none to lead them, their southern flight must be due to inherited memory.

But how do they find their way? What is the sense which directs them during their flight? This is a question which it is at present impossible to answer. Nevertheless, it is a matter of fact that they do find their way. The faculty, whatever it may be, is not an uncommon one in the animal kingdom. We see it exercised to a small extent by bees and ants and many other insects. Sea-snakes and turtles return to the same place to breed, although during their absence from the land they must have swum many miles in many different directions. Penguins, petrels, and other sea-birds have the same faculty; as also have seals, several of which perform long oceanic migrations. It is also well known that some domesticated animals can return to their homes after having been taken long distances. And savages, after following their quarry for several hours, or even for days, can always find their way home again through dense forest.

But this faculty is not unerring, even with migratory birds, as is shown by the number of stragglers which have lost their way. Most of these no doubt perish at sea, for they have often been known to take refuge on ships; and perhaps none regain their route after having once lost it.

There still remains one more question to ask. Why should some of the shore-birds and cuckoos migrate to us and not swallows, which are certainly quite as capable of undertaking the journey? Possibly the geological history of birds may help us to answer this question.

Remains of several kinds of *Limnicolæ*—three sandpipers and two rails—have been described from the Upper Cretaceous rocks of North America, so that they are among the oldest of carinate birds. In the gypsum of Montmartre, in France—which belongs to the Oligocene period—a godwit (*Limosa*) has been found, together with a few land-birds, one of which is a cuckoo. The first known swift (*Cypselus*) is from the Miocene, and we do not find swallows or martins (*Hirundo*) until the Pleistocene. Now, is this association of our two principal migratory birds — the godwit and the cuckoo—in the Montmartre gypsum, and the absence of the remains of swifts and swallows from all Oligocene rocks, merely a coincidence, or are the facts connected? Is it because swifts and swallows did not live with cuckoos and godwits in Oligocene times that they do not now accompany them in their migrations to New Zealand?

No doubt negative palæontological evidence must be used with great caution, but it seems to me probable that the godwit and cuckoo migrated to New Zealand at a time when no swallows were in existence, and that the original land bridge had been completely broken down before the first of the swallows arrived in Australia from Asia. I therefore suppose that migration to and from New Zealand commenced in the Eocene period, when the land stretched away to the north-west nearly to New Guinea—a time when, although New Zealand was not actually joined to the mainland, it must have approached pretty close to it.

In conclusion, I may perhaps be able to make some useful and practical deduction from this slight investigation. Can we introduce swallows and other insect-eating migratory birds into New Zealand with success?

It will be evident from what has been said that the naturalisation in New Zealand of migratory birds is impossible unless they abandon their migrating habits, for we cannot give them a new instinct and teach them how to cross the sea. Small flocks of the tree-martin of Australia have been seen several times in New Zealand, and no doubt they also often came before there were any settlers to record their appearance; yet the species has not become naturalised, nor has it established a regular migration, and, we may feel sure, will never do so. They have to leave the Islands in the winter for want of food, and they never return. However much we may try to introduce swallows, we shall never succeed until we can induce flies to remain out all the winter. It is the same with all insect-eating birds—like nightingales, which cannot support themselves in the winter in the absence of insect life. There are non-migrating insect-eating birds, like the hedge-sparrow and the robin, which are able to eke out an existence on seeds when no insects are about, and of these the hedge-sparrow has succeeded with us. But, in my opinion, it is idle to attempt to introduce into New Zealand any bird that has inherited strong migratory instincts. About twenty-eight years ago some thirty lapwings or peewits (*Vanellus cristatus*) were turned out at Auckland, and they were never seen again. They could hardly have died for want of food, for that is abundant; they must have flown out to sea, making, as they thought, for their old breeding-grounds in England, and all, no doubt, perished. So, I am afraid, it always will be, and attempts to introduce migratory birds into New Zealand will always end in failure.

II.—BOTANY.

Art. XXVIII.—*An Inquiry into the Seedling Forms of New Zealand Phanerogams and their Development.*

By L. Cockayne.

[*Read before the Philosophical Institute of Canterbury, 7th November, 1900.*]

Plates X.–XII.

Part IV.*

No. 360. **Pittosporum rigidum,** Hook. f. Plate X., figs. 1, 2, 3. (Continued from Trans. N.Z. Inst., vol. xxxi., p. 362.)

In the paper quoted above the seedling form of this species of *Pittosporum* is described as far as the development of the 5th leaf from seedlings which germinated early in the spring of 1898, and which are consequently now—28th August, 1900—about two years old. Some of the young plants are still growing in the flower-pot in which the seed was sown, and have been kept since their germination in an unheated greenhouse. Others were transferred into separate pots some six months ago, since which time they have been kept plunged in moist sand in the shade-house, a structure consisting of a wooden frame-work, span-roofed, and covered with white-calico blinds. Within this shade-house the air is usually more moist, the illumination much more feeble, the changes of temperature less extreme, and the wind less felt than in the open—indeed, the œcological conditions cannot be very different from those of certain forests, where the foliage is not extremely dense. The greenhouse as compared with the shade-house is hotter, moister, much more brightly illuminated, and its atmosphere is quite still. With regard to the plants in question, those of the greenhouse and those of the shade-house exhibit no differences of any moment. Most have produced one or two lateral shoots, which are given off from the stem at about an angle of 45°. The tallest plants are 9 cm. in height. Their stems are covered with numer-

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* For Part III. see Trans. N.Z. Inst., vol. xxxii., art. xvi.

ous white hairs pressed close to the surface, and through which the very dark-purple bark can be seen. Those internodes nearest to the central portion of the stem are about 4 mm. in length, while those more adjacent to the apex are of greater length. Although the majority of the leaves do not vary to any great extent from those previously described as "deeply toothed or pinnatifid," and figured in pl. xxx., fig. 4, of the above-mentioned paper, yet some few show considerable reduction of form. Such (fig. 1) are quite entire except for a few obscure marginal teeth, and approximate closely to the typical adult form of leaf. One exceptional seedling has nearly all its leaves of this latter type. Between the broad pinnatifid leaves (fig. 2) and the narrow almost entire leaves intermediate forms occur, whose laminæ are 11 mm. in length, 4 mm. broad for their basal half, and 1·10 mm. broad for the apical half. Such a leaf resembles a juvenile leaf in its lower and an adult leaf in its upper half. On page 363, *l.c.*, I pointed out some of the differences between the early seedling and the adult leaves, at the same time suggesting that the reduction, &c., of the latter had been caused by the direct action of the environment on the plant in a state of nature. During a recent botanical excursion in the Waimakariri district I made some observations which seem directly confirmatory of the above-mentioned suggestion. The following extract from my note-book describes a particular example, and was written at the place of observation, a small patch of "bush" and its immediate environs on the right-hand bank of the River Waimakariri, just opposite the mouth of its tributary the River Hawdon, and where the eastern and western climatic regions* merge into one another. "*Pittosporum rigidum.*—Seedlings of this are most plentiful under the beech-trees. They seem very similar to those raised artificially. Under the shade of the beech-trees the adult plants are of a loose habit, with erect twiggy branches scarcely interlacing, but in the open, only a few metres away, the whole plant forms a hard mass of rigid divaricating branches so closely interwoven that when one branch is pulled downwards the whole shrub is moved." From the above we see that within the shelter of the forest, with its accompanying conditions of more equable temperature, moister atmosphere, much less bright illumination, rather wetter ground, and, above all, comparative freedom from wind, the adult plant is to all intents and purposes of the juvenile form, and so distinct in appearance from the plant growing under xerophytic conditions in the open that it could easily be mis-

* Cockayne, "A Sketch of the Plant Geography of the Waimakariri River Basin" (Trans. N.Z. Inst., vol. xxxii., 1899, pp. 117 and 131).

taken for a distinct species; and yet the individual of the forest and the one of the open might have been actually produced from seed not only from the same parent, but even from the same capsule. It is very difficult to estimate what part is here played by environment and what by heredity; at any rate, it seems to me that so long as the forest should present the same conditions, then so long would *P. rigidum* keep the juvenile form. And, further, were the xerophytic conditions absent, which state of affairs a change in climate could bring about, then the xerophilous form—*i.e.*, the common form of the plant—would cease to be produced, though there seems no doubt that this form is hereditary, and thus the juvenile form, resembling most likely in many respects the ancestral form of the plant, be the sole survivor. On the other hand, a change of climate might banish the forests, and allow only the xerophilous form to exist.*

No. 783. **Stellaria roughii,** Hook. f. Plate X., fig. 4.

The seed was collected on the 3rd April, 1899, from one individual growing on a shingle-slip on the Mount Torlesse Range, at an altitude of 1,000 m. It was sown on the 9th September, 1899, and began to germinate on the 11th November, 1899, the germination continuing at intervals until June, 1900.

Description of Seedling.

Root very long and of very rapid growth; in a plant with the hypocotyl just visible above the soil it is 10·5 mm. long, and in a plant 5·5 mm. tall it is 31 mm. long; soft and succulent at first, but soon becoming extremely flexible; pale in colour, slightly wavy.

Hypocotyl greenish even when underground, afterwards pale-green, sometimes marked with brown on its upper portion; 4 mm. long before the cotyledons have emerged from the soil, finally 6 mm. in height above the soil; soft and succulent at first, but soon becoming so elastic that when bent to the ground it springs back into position; rarely quite straight and erect, often semiprostrate, terete, glabrous.

Cotyledons continue increasing in size for some time after they have opened out to the light, greenish even when underground, becoming finally pale-green; when fully grown 7 mm. (including petiole) in length by 1·5 mm. in breadth, linear-spathulate, obtuse or rarely subacute, entire, glabrous; petioles equalling lamina in length, semiterete, swollen and connate at the base.

* This idea is worked out at greater length further on in this paper when treating of the differences between Chatham Island seedlings and those of the same species in New Zealand.

Leaves opposite, rather succulent, in early stage of development vertical, with concave upper surfaces pressed tightly together, thus affording great protection to the growing-point of the epicotyl. As development proceeds the laminæ open out gradually and become horizontal, while at the same time the petioles increase very considerably in length.

1st pair of leaves (fig. 4)—in plant 15 mm. tall—oblong-spathulate, glabrous, entire, rounded at apex, of rather glaucous green; laminæ 3 mm. × 2·75 mm., tapering into the petiole; petioles almost equal in length to lamina, 1 mm. in breadth, flat on upper surface, rounded on under-surface, which is more or less deeply stained with purple, sheathing just above their swollen connate purple bases.

2nd pair of leaves similar in most respects to 1st pair, but paler in colour and stained with purple near base; laminæ almost rotund, petioles two-thirds the length of lamina, and midrib more evident than in 1st pair.

Stem very juicy, slender, and very elastic, quite glabrous, pale yellowish-green stained with purple; 1st internode 4 mm. long, 2nd internode 2·5 mm. long.

The adult form of *Stellaria roughii* has sessile, linear, succulent leaves, with an acuminate apex, and of an average size of about 17 mm. × 3 mm. These are indeed very different in shape from the long-stalked leaves of the seedling, with their almost orbicular blades. The adult plant grows in nature on "shingle-slips,"* which are often so unstable that when one moves the stones so as to take up a plant carefully the *débris* from above fills up the hole almost as fast as it is being made. Of soil strictly speaking there is little or none, and that little, when present, is merely coarse sand with a modicum of particles of clay. At a varying distance below the shingle, depending in large measure on the length of time which must have elapsed since the melting of the winter's snow, is a considerable amount of moisture. The seed from the plant, which is most likely a biennial, will fall under the shelter of its leaves. Here the young plants will be protected from excessive sunshine and wind, and, aided by a rapid root-growth, will soon be able to acquire the all-important water-supply. A transverse section of a seedling leaf shows that it is not ill provided even at an early age to resist excessive transpiration. There is a compact palisade and a rather close spongy parenchyma. On the under-surface the epidermis is 2-layered, the cell contents of the inner layer are often stained red, and on both surfaces is a well-developed cuticle. The petiolate rotund juvenile leaves, and the sessile linear adult leaves, suggest comparison with the often-quoted example originally described by Goebel

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* Cockayne, *l.c.*, pp. 129, 130.

of *Campanula rotundifolia,* with its stalked cordate shade leaves, which are at the same time hereditary, and its sessile lanceolate leaves, which are an adaptation to excess of light; and it may well be that the sessile linear leaves of our plant are due to the strong illumination it must often experience in its exposed station.

The elastic stem, pale glaucous-green leaves, and early succulence of the seedling show how hereditary are some of the most striking peculiarities of shingle-slip plants. The colour of the leaves, for instance, is the forerunner of that curious grey colour, almost identical with that of the shingle, which nearly all the true shingle-slip plants possess.

When the cultivated seedlings have had the growing-point of the stem removed there has always been a rapid response in the growth of shoots from the axils of the cotyledons. This in a state of nature would be of great benefit to the plant; and damage to the growing-point, to which I should imagine wild seedlings are very liable, would be distinctly an assistance rather than a harm to the plant, by encouraging spreading growth.

Nos. 813 and 966. **Gaya lyallii**, Baker, var. **ribifolia**,* T. Kirk. Plate X., figs. 5–10, and Plate XII., fig. 46.

The seed of No. 813 was collected near the foot of Mount Torlesse on the 31st March, 1899, at an altitude of 730 m., and that of No. 966 in the Trelissick Basin, at about the same altitude, towards the end of April, 1900. I possess no exact details as to the sowing and germination of No. 813. A part of the seed germinated in the spring of 1899; a few more plants appeared in the autumn of the same year; and, finally, in the spring of 1900 about ten more seeds germinated. No. 966 was sown on the 21st August, 1900; it commenced to germinate on the 17th September, 1900, and by the 11th October there were in the pot more than thirty plants of different sizes and germination was still proceeding, while by the 1st November the tallest plant was 3 cm. in height, and its 1st leaf was fully developed.

Description of Seedling.

Early development: By the time the cotyledons enclosed in the seed-coat, and usually also in the remains of the carpel, are just bursting through the ground the root and hypocotyl have developed considerably, and are almost indistinguishable except for the dense mass of very short hairs on the former.

* This form was first called attention to by Baron Von Mueller in his "Vegetation of the Chatham Islands," Melbourne, 1864, p. 11: "A curious variety of *Sida lyallii*, with small deeply incised leaves, collected by Mr. Travers and Dr. Haast in Middle Island, may be distinguished as var. *ribifolia*."

At this stage the root and hypocotyl are together 11·5 mm. in length, and the root is 1·5 mm. in diameter. Next the hypocotyl grows upwards, and by the time it has risen arching out of the soil to a height of 5 mm. the green base of the cotyledons is appearing above the ground. The part of the hypocotyl which is arched downwards rapidly becomes straight, and the cotyledons enclosed entirely or partly by the seed-coat, and often by the remains of the carpel also, are raised with their laminæ closely pressed together and horizontal. The cotyledons grow rapidly in length and width, only the tip remaining enclosed in the seed-coat, which finally is cast off. Then the cotyledons open out, becoming horizontal or having their apices pointing downwards and their bases almost touching or sometimes even overlapping. As development proceeds the petioles lengthen considerably, until they finally become half the length of the laminæ, the bases of which are now 6 mm. or more apart. By this time the plants are twenty-four days old, and have roots 5·5 cm. in length, with cotyledons (lamina) 11 mm. × 10 mm., petioles 5·6 mm., and the 1st leaf is 8 mm. in length, with its lamina equalling the petiole and just unfolding.

Root of great length, deeply descending; lateral rootlets not numerous.

Hypocotyl at first tender, succulent, green and occasionally marked with pink, soon becoming stout and woody, terete, glabrous except for a few short hairs above, smooth, finally 16 mm. long and much thickened at the base.

Cotyledons (when fully grown) variable in size and shape, sometimes not of equal size on same plant; lamina 9 mm. × 9 mm. or thereabouts, rotund or obovate-rotund, often cuneate at the base; sometimes quite entire, but usually lobed or irregularly crenate on upper third of margin, pale-green, glabrous; nerves five; venation much reticulating; apex rounded; petioles spreading, 5 mm. in length, channelled on upper surface.

Before the cotyledons have emerged from the seed-coat they have their upper surfaces pressed closely together; the apical portions are folded together upon themselves, and bent so as to be closely enclosed by the conduplicately folded lower three-quarters of the lamina. This remains of the folding of the apical portion of the lamina may be seen in the fully expanded cotyledons, where towards the apex of the one is a slight depression, and towards the apex of the other a still more slight protuberance. Lord Avebury explains that this folding of the cotyledons in certain of the *Malvaceæ* causes the obscure lobes on the cotyledons.*

* "A Contribution to our Knowledge of Seedlings," London, 1892, vol. i., pp. 40, 41, and 245, figs. 79, 80, 81, and 35.

1st leaf subcordate, irregularly and deeply crenate, almost lobed, ciliated with short hairs, also a few hairs on the petiole; remainder of leaf glabrous, pale apple-green on both surfaces, palmately 5-nerved, with the veins much reticulating; petiole three-quarters the length of lamina, channelled.

Later leaves up to 6th leaf broadly cordate, sometimes almost rotund, with cordate base; more or less lobed, sometimes almost trilobed; lobes irregularly crenate, ciliated; remainder of leaf as in description of 1st leaf.

Stipules inserted on stem on inner side of petiole, subulate, often stained pink; at first very soft and succulent, protecting young bud, afterwards smaller through drying, finally deciduous.

Stem of slow development, with early internodes very short (1st internode is 2 mm. long by time 1st leaf is 11 mm. long), terete, pale-green marked with purple, furnished with a few remote stellate hairs. In plant about eight months old the stem, exclusive of the now woody hypocotyl, is 14 mm. in length, still soft and succulent, green deeply stained with brownish-purple; later internodes considerably larger than the earlier ones; stellate hairs more numerous on upper portion than on lower portion of stem; from the lower internodes all the leaves have fallen, a few shrivelled stipules still persisting; the leaves above have all been developed since the winter.

Besides the above-described artificially raised seedlings, I have one which was collected at the base of Mount Torlesse in April, 1898, and which has been kept since that time in the shade-house. It is now 16 cm. tall, with three main stems, a few short side branches, and about fourteen leaves. The largest leaf is (lamina) 2·5 cm. × 2·6 cm., ovate, with cordate base; margin lobed and crenate; deepest lobes 5 mm. in depth; apex obtuse. The other leaves are smaller and more approaching reniform in outline, being considerably less drawn out at the apex. The stems of recent growth are twiggy and slender, with internodes ± 15 mm. in length. All last season's leaves fell off in the autumn or during the winter, notwithstanding the climate of the shade-house, a much milder one than that of the natural station of the plant.

There are two quite distinct forms of *Gaya lyallii*, one—*G. lyallii* proper—being confined, so far as I know, to regions in the South Island of New Zealand exposed to the great western rainfall; and the other form—*i.e.*, the one now under consideration—being found without the limit of the above rainfall in the eastern lower mountain region, where it grows chiefly at the base or on the slopes of river-terraces or near the outskirts of the *Fagus* forest. The adult leaves of *Gaya* *ribifolia*—I append only the varietal name, partly for sake of brevity and partly because it seems to me a perfectly distinct species, as Mr. D. Petrie suggested to me so long ago as January, 1893—vary considerably and are of two types: First, those which come close to the seedling leaves and are deeply lobed, sometimes of greater breadth than length and with the apex rounded and little drawn out; second, those of an ovate outline, with an apex much more acuminate, and with the lobes less deeply cut into the leaf than in the seedling forms, a leaf much resembling that of *Gaya lyallii*. In specimens from the Kaikoura Mountains the leaves are lobed much less than in my Canterbury specimens, and their apices are still more acuminate. All the adult leaves of *Gaya ribifolia* are covered on the under-surface with a mat of stellate hairs (Plate XII., fig. 46), which gives a whitish colour to that surface of the leaf, and almost hides the reticulating veins. The western plant, on the contrary, is bright apple-green on both surfaces, the stellate hairs being confined mainly to the principal veins. The individual hairs, moreover, are usually about half the length of those on the eastern plant. This difference in colour enables a thicket of either form of plant to be identified at a glance, even when the observer is quite a distance away. The western plant has its adult leaves not lobed, but only irregularly toothed, and the apex is always much drawn out.

I have not up to the present critically studied *Gaya lyallii* in the seedling form, but reversion leaves of that species are almost identical with some of the seedling leaves of *G. ribifolia* above described, and this shows that the two forms are very closely related; while possibly the more glabrous western form may be the ancestor of the tomentose eastern form, whose tomentum is clearly an adaptation to the drier character of its station. It is œcologically of extreme interest that a character seemingly so trivial as a slight variation in hairiness of leaf has led to these two species not having intermingled, although they approach in places to within only three or four miles from one another at most; and it shows, moreover, how an apparently unimportant character may govern the climatic distribution of a plant.* It may also be pointed out that both forms thrive equally well side by side in lowland gardens where the rainfall is slight, and that the characters of each, so far as I have been able to ascertain, remain unchanged.

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* In a struggle for existence between these two plants it seems probable that each in its own domain would wipe out the other, unless the invader possessed a special power of rapid adaptation to the new conditions.

The seeds of *Gaya ribifolia* are ripe about the end of April, the plant having bloomed at the end of January and the beginning of February. They are almost invariably attacked by the larva of some insect, so that sometimes it is almost impossible to procure good seed. The carpels when ripe fall from the trees, under which quantities of seedling plants are often to be found. This leads to the occurrence of the plants usually in small clumps, with the trees close together, for, under ordinary circumstances, a seed will not get far from its parent tree, nor, if it did so, would it grow so easily and thrive as under the friendly shade. The western plant, on the other hand, forms much larger colonies, since those of its seeds which fall away from the protection of the parent have a much better chance to germinate in the moister western climate. The large cotyledons will be of great service in providing a food-supply for the quick growth of the root. One of the seedling plants had three cotyledons, and it is worthy of remark that this one developed more rapidly than did some others with normal cotyledons which germinated at the same time.

According to Sir Julius von Haast, Mr. T. Kirk,* and others, *Gaya lyallii* is said to be deciduous at above 3,000 ft., and an evergreen at below that altitude. I have always much doubted that statement, but cannot as yet entirely disprove it. A tree of *Gaya lyallii* in my garden regularly loses its leaves, though some do not fall at times before the end of winter. *Gaya ribifolia* in the garden of Dr. A. Dendy, on the Port Hills, where it enjoys a much milder winter than in the lower mountain region, also loses its leaves. A plant in Mr. S. D. Barker's garden, originally from the Kaikoura Mountains, loses its leaves, and also seems to come into leaf later than the common type. Seedling plants in both greenhouse and shade-house are certainly deciduous. I fancy the idea of the plant remaining evergreen must have arisen from observers having seen trees late in autumn or early in winter still more or less leafy, but it may be possible that in the West Coast Sounds and similar regions the plant may be evergreen. However, this is for future observers to decide.

Plagianthus betulinus, A. Cunn. Plate X., figs. 11, 12, 13, 14, 15.

The young plants from which the description below was drawn up were growing under a parent tree, where the seed had fallen, in the Christchurch Botanic Garden, and were kindly given me for the purposes of this paper by Mr. A. L. Taylor. The leaves figured of the semi-shrubby form of this

* "Handbook," pp. 30, 31; "Forest Flora," p. 279.

plant are in part from the above-mentioned parent tree and in part from a young tree about eight years of age growing in my garden.

Description of Seedling.

Root appears to be of medium length and of rapid growth, but in all plants examined was broken.

Hypocotyl 30 mm. long—probably owing to being "drawn up," for the seedlings were crowded amongst grass, &c.—terete, white, hairy above.

Cotyledons more or less rotund; upper part of margin deeply crenate or lobed, ciliated; lamina 8 mm. × 7 mm.; petiole semierect, hairy, 3 mm. long.

Early leaves (figs. 12, 14) somewhat variable in size, but all of one type; ovate, often more or less truncate at base, or sometimes subcordate; lamina ± 19 mm. × ± 16 mm., lobed or bicrenate, bright yellowish-green on upper paler on under surface, palmately 5-nerved, with ultimate veins much reticulating, ciliated on margin, and with a few stellate hairs on veins, especially on those of under-surface; margin of crenations often stained with purple; petiole almost half as long again as lamina, slender, channelled above, but not deeply.

Stipules at first quite enclosing young bud, finally deciduous; linear, 3 mm. × 1 mm., inserted on stem at upper side of base of petiole.

Stem erect, with erect branches, and exhibiting no sign of a second shrubby stage, even in seedlings 12 cm. tall; terete, brown, hoary in places, with numerous stellate hairs; internodes ± 10 mm. long.

Further development: After remaining in the erect form for a certain time, and reaching a certain height (but of this I can as yet give no definite information), the plant assumes a semi-shrubby habit. The branches which are now developed are long, twiggy, and flexuous, hanging downwards and interlacing one with the other, their apices at the same time often bending upwards. The leaves produced on these branches are very much reduced in size, and in many cases occur in fascicles on very short reduced branches. In shape they present all kinds of gradations, from very small rounded often cuneate leaves, toothed or lobed (figs. 13, 15), to forms approaching the ovate or ovate-lanceolate acuminate adult type of leaf.* Finally, after several years usually, the plant undergoes a third change, when it assumes a true arboreal habit, its branches no longer interlacing and weeping, but growing upright, at first in a rather fastigiate manner, and in this final stage resembling, so far as erect habit is concerned and type of leaf, the first stage of development.

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* See also Kirk, *l.c.*, p. 207, and plate 103.

This passing of a plant through three stages, of which the first and the final are not very different, is a phenomenon of extreme interest, to which I have briefly called attention before.* In dealing with the Chatham Island form of *P. betulinus*—which I may here point out does not go through the semi-shrubby form at all — this matter is gone into at some length, and I propound a theory to account for this wonderful difference between two plants so closely related that botanists up to the present time have not accorded the Chatham Island plant even varietal rank.† I will here only point out that the semi-shrubby form much resembles in habit and general appearance the adult form of many New Zealand xerophilous shrubs of dry stations, and of some of which I have already treated.‡ In my garden a tree which I grew from seed, now about eight years of age, is shrubby below, with weeping interlacing twigs up to a height of 1·25 m.; above this for a height of 0·30 m. the plant is still shrubby, but the twigs are erect and not drooping, while the remaining 0·45 m. has assumed the final arboreal habit, with thicker hardly flexuous branches passing upwards from the stem at an angle of 45° or less, and with the leaves of the final shape, but not yet of so great size as in an older plant. This appearance of the semi-shrubby form below and of the tree form above persists for a long time, and may be seen in trees long after they have attained to their full development. I do not think that the semi-shrubby portion ever produces flowers, but this is a matter which deserves inquiry.§

No. 1072. **Plagianthus betulinus,** A. Cunn. (Chatham Islands var.). Plate XI., figs. 16–20.

The plants were grown from seed which ripened on a specimen with seemingly immature fruit kindly given to me by Mr. S. D. Barker, and collected by Mrs. Chudleigh in the Chatham Islands. The greater part of the description is drawn up from a number of living seedling and young plants sent to me from the Chatham Islands by Mr. F. A. D. Cox.

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* *l.c.*, p. 358.

† Kirk, "Student's Flora," 1899, p. 71. Mueller, *l.c.*, p. 10: "Leaves and calyces larger than the specimens in our museum." Buchanan, "On the Botany of the Chatham Islands" (Trans. N.Z. Inst., vol. viii., 1875, p. 334).

‡ *l.c.*, pp. 362, 385, 388, 390. It would perhaps be more correct to describe this semi-shrubby form as a transition between these extreme xerophilous forms and a low-growing tree of an ordinary erect habit.

§ Goebel states, "Organography of Plants," English edition, Oxford, 1900, p. 154, that the fixed juvenile forms of certain Gymnospermæ "are usually unable to produce sexual organs, although external conditions are quite favourable for this when they have attained an age and a size at which the normal plants are and have been for long sexually mature."

The seed was sown on the 20th August, 1900; it germinated on the 27th September, and by the 1st November the tallest plant was 2·25 cm. in height, with the lamina of its 1st leaf just opened out.

Description of Seedling.

Root slender, pale, very easily broken, about 25 mm. long in plant 16 mm. tall.

Hypocotyl 18 mm. long, glabrous and pale for lower quarter, green and hairy on upper three-quarters, with hairs projecting horizontally; terete, erect.

Cotyledons rotund, entire for lower half of margin, with remainder of margin lobed, in one instance merely crenate; ciliated with hairs similar to those on hypocotyl, palmately 5-nerved, with nerves near base rather obscure; green on upper and paler on under surface, horizontal or with apices bent slightly downwards; lamina 9 mm. × 9 mm., or not quite so broad; petiole channelled, but not deeply, on upper surface, rounded on under-surface, 3 mm. long, hairy.

Plants collected in Chatham Islands by Mr. Cox. The tallest examined was 15·5 cm. tall and the smallest 6·5 cm., with four persistent leaves and four leaf-scars, the lowest leaf therefore being the 5th seedling leaf.

Stem (in smallest plant) rather thicker at base than above, brown, slightly pubescent with stellate hairs, especially in youngest portion.

5th leaf shallowly 3-lobed, with the lobes deeply and coarsely crenate, petiolate; lamina 15 mm. × 15 mm. in broadest part, broadly ovate, truncate at base (fig. 17), bright pale-green, ciliated with short pale-coloured hairs, palmately 5-nerved, with ultimate veins much reticulating; petiole 12 mm. long, forming angle of 45° with stem, terete, pale, pubescent with stellate hairs.

Other leaves (figs. 18, 19, 20) very similar to above, but cordate at base, and often with hairs on upper surface.

Upper portion of stem green, stipules well developed, especially those at the growing-point, which are of full size much before the leaf is developed fully.

Stipules 3 mm. × 1·5 mm., linear, brown, acute, hairy, soon wither.

Leaves on older plants very similar to those already described, of average size of 16 mm. × 17 mm. in broadest part, truncate or cordate at base, often obscurely 3-lobed.

Later leaves on plant 15·5 cm. tall 30 mm. × 30 mm. in broadest part, cordate, tapering towards apex; petiole 30 mm. Other features as before (fig. 18).

The similarity of appearance in form between the seedling and adult leaves of *Plagianthus betulinus* of the Chatham

Islands was pointed out to me about a year ago by Mr. S. D. Barker, in whose garden I had the pleasure of seeing some seedling plants sent to him by Mrs. Chudleigh. Shortly afterwards I received from Mr. F. A. D. Cox the fine collection of young plants from which the above description was drawn up. Thinking that possibly, in common with *Pseudopanax chathamica*,* the Chatham Island form of *Plagianthus betulinus*, and perhaps other plants which pass through three stages in New Zealand proper, did not go through the three stages described above in this paper through which *P. betulinus* of New Zealand passes, I wrote to Mr. Cox for information on this point, so important in the life-history of the plant. The following is a copy of Mr. Cox's reply, under date of the 6th October, 1900: "*Plagianthus betulinus.*—This certainly does not pass through the stages you have mentioned; as far as I have observed branches and twigs are always upright, as in the mature form, and leaves always the same shape; the appearance you mention of apparently two distinct plants in regard to foliage, &c., is absent. *Sophora tetraptera* never alters its form; tiny seedlings have the leaves (of course, in a smaller form) identically the same as in the mature tree; the only Chatham Island plant that has two distinct forms of leaves—broad and narrow—on the same plant is *Dracophyllum scoparium*."†

If what Mr. Cox states is correct—and it is most unlikely that so accurate and keen an observer can be mistaken—then the question opened up as to the reason of this great difference in the life-history of a certain species according as it is indigenous to New Zealand or to the Chatham Islands is one of the greatest interest, but at the same time of the most extreme difficulty. The theory which I am about briefly to outline as an explanation of this phenomenon is the merest hypothesis, and put forward chiefly as a basis on which inquiries can be made, not in botany alone, but also in geology and zoology, so that, whether the theory be eventually sustained or shown to be false, its examination may lead to the publication of facts of considerable scientific importance.

According to the principles laid down in Part I.‡ of this series of papers, "a plant repeats in its ontogeny its phylogenetic development"§ more or less, and the later in the

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* Cockayne, Trans. N.Z. Inst., vol. xxxii., 1899, p. 89; and Kirk, "Student's Flora," p. 223.

† In what follows the heterophyllism of *D. scoparium* need not be taken into account, for I think it can be explained on quite local grounds, which it would be out of place to enter into here.

‡ *l.c.*, p. 356.

§ Strasburger, "A Text-book of Botany," London and New York, 1898, p. 46.

development of an individual a certain phase occurs, the more recently must the condition that the phase in question represents have been the fixed form of the species. Professor W. F. Ganong goes into this matter at some length and with great clearness.* "Of course, in any given generation the embryo,† apart from slight irritable responses to light, &c., is determined by heredity. But heredity is but the sum and resultant of past experiences, and hence in the present case is largely a study of past environments. This suggests an explanation which I believe to be the true one—*i.e.*, that the form of the adults, like that of any other character once acquired—it matters not for our present purpose how—as it becomes more and more fixed and intensified tends to work back into earlier and earlier stages in the ontogeny of the successive individuals, until finally a character adaptively acquired by the adults works back into the epicotyl and finally into the embryo itself." Further on he writes "of characters acquired by adaptation in the adults sweeping back into the later seedlings and wiping out earlier characters." According to the above that semi-shrubby form of *Plagianthus betulinus* of New Zealand, which remains for a long time in the ontogeny of that plant as a seemingly adult form, and, moreover, persists for a long time even after the real adult form has appeared, must have been the final form of the plant at no very distant date, geologically speaking. But it cannot have remained a fixed form for any great length of time, for it did not work back into the epicotyl, and so wipe out the earlier stage which so much resembles the final one. In the Chatham Island plant, on the other hand, the first seedling form being so little different from the final shows that the latter has endured for a very long time, nor, so far as the first form tells us, has ever undergone much change since it first became fixed. But the first seedling form of the Chatham Island and of the New Zealand plant are very similar, and so we can well conceive that a plant almost identical with the Chatham Island form was the ancestor of the New Zealand form. The same reasoning would apply to *Sophora tetraptera* (using the specific name in its widest sense), which is even a more instructive species. For one variety of that species not only goes through three forms in the course of its ontogeny, each much resembling in habit

* "Annals of Botany," 1898, vol. xii., "Contributions to a Knowledge of the Morphology and Œcology of the Cactaceæ: II. The Comparative Morphology of the Embryos and Seedlings," pp. 467, 468.

† "We may best speak of the stage where the embryo is lying in the seed as that of the ungerminated embryo, and that in which it has come out, turned green, spread its cotyledons, but before it shows the epicotyl, as that of the germinated embryo" (Ganong, *l.c.*, p. 431).

those of *P. betulinus*, but in certain dry regions of the South Island the intermediate shrubby, or I may call it the xerophilous form, undergoes no further change, and is considered by some botanists a distinct species.* On the contrary, the Chatham Island plant, and perhaps also one of the North Island varieties, passes through no xerophilous form. Here again, then, the Chatham Island plant resembles the ancestral form. There are few plants in New Zealand more xerophytic in structure than the various species of *Aciphylla*. The seedling forms of *A. squarrosa* and *A. colensoi* have, however, quite flaccid and grass-like leaves. In the Chatham Islands, Mr. Cox tells me, *Aciphylla traversii* has leaves sufficiently soft and flaccid for sheep to eat them greedily. Such an *Aciphylla* would probably much resemble the ancestor of the New Zealand forms. On the dry table-lands of the South Island of New Zealand, and in various parts of the North Island where the soil is poor and where the rainfall is low, the character of the vegetation is xerophytic, many of the shrubs showing, for instance, a common adaptation to the environment in their much divaricating interlaced wiry branches; in fact, they resemble very much indeed the semi-shrubby stage of *Hoheria, Plagianthus betulinus, Pennantia corymbosa*, and *Sophora tetraptera*. Xerophilous as these former shrubs are, a very slight change of environment, such as the shelter of a forest, will alter them in the most marked manner (see above regarding *Pittosporum rigidum*, and what follows *re Rubus pauperatus*). An extract from my note-book, taken in the "bush" at the lower gorge of the Waimakariri, is of interest in this connection: "Very worthy of note is a young plant of *Corokia cotoneaster*"—a most densely growing shrub under normal conditions—"assuming a semi-tree-like habit. At this stage the stem is erect, the branches pointing upwards and outwards, twisted and drooping at their extremities. It much more resembles the transitional form between the semi-shrubby stage of *P. betulinus* and the mature form of that plant than it does its own normal form as growing in the open."

If the early seedling form of a number of these xerophilous shrubs be examined it will be seen, as I have shown in some instances,† that they are at first erect, with a much more considerable leaf development than the adult, and altogether better adapted for more hygrophytic conditions. That is to say, the majority of the scrubby plants of river-terraces, stony flats, and the like, might well be descended from ancestors which lived in a moister climate. Dr. L. Diels‡ was the first

* *Sophora prostrata*, Buchanan.

† See, for instance, *l.c.*, pp. 91, 92, 93.

‡ "Vegetations—Biologie von Neu-Seeland," Leipzig, 1896, pp. 246, 247, and 296.

to offer a suggestion as to the causes which had led to the evolution of this xerophilous vegetation. In the first place, he considered its extreme xerophytic character to be not at all in accordance with its present environment, especially as far as climate was concerned. He therefore turned to the geological history of New Zealand, and based his conclusions on the theory of Captain F. W. Hutton*—viz., that a great elevation of the land took place during the Pliocene period, by which the Southern Alps would be raised to a height much greater than the present; and, to quote from Captain F. W. Hutton's latest utterance,† "All the islands were joined together, and the land stretched away to the east and south so as to include the Chatham and Auckland Islands, as well, perhaps, as Campbell and Macquarie Islands, whilst to the north it certainly extended to the Kermadecs, and perhaps much further. On the mountains of the South Island large glaciers were formed, and the torrential rivers running from them tore into disconnected fragments the Miocene marine rocks which obstructed their valleys." According to Diels this elevation of the mountains would lead to a much smaller rainfall on the then high table-lands and plains stretching to the mountains of the Chatham Islands in the east, and the consequence would be a steppe climate.‡

As a consequence of the extreme dryness of this region many of its plant inhabitants would migrate to wetter localities, while those that remained would become either modified so as to resist the gradually increasing drought or would perish. Those plants which became so adapted Diels calls "the descendants of the forest flora,"§ and he points out in support of his argument how Schenk and Warming have shown that lianes of the forest can become shrubs of the plain.‖ Captain F. W. Hutton also considers the above suggestion worthy of examination, for he writes (*l.c.*, p. 182): "It is possible that this large extension of land to the eastward may have produced desert- or steppe-like conditions in a portion of New Zealand, evidence of which some botanists think they find in our flora."

If we accept these views of Diels and Hutton, then three

* First propounded in Trans. N.Z. Inst., vol. v., p. 385; further elaborated Trans. N.Z. Inst., vol. viii., 1876, p. 383, *et seq.*, and in Annals and Mag. of Nat. Hist., ser. v., vol. xv., p. 77, *et seq.*

† "The Geological History of New Zealand" (Trans. N.Z. Inst., vol. xxxii., 1899, p. 182).

‡ *l.c.*, p. 296.

§ *l.c.*, p. 246, "Abkömmlinge der Waldflora." These include certain species of *Clematis*, *Pittosporum*, *Rubus*, *Carmichaelia*, *Notospartium*, *Aristotelia*, *Hymenanthera*, and *Corokia*.

‖ See also remarks in this paper *re Rubus pauperatus* and *Pittosporum rigidum*.

havens of refuge would be open to those forest-trees and other plants which could not tolerate the increasing dryness of climate, viz. : The region west of the Southern Alps and of the central ranges of the North Island, and which would then, as now, support a dense forest population; the warmer and moister regions of the North; and the eastern coast, part of which would include the then high lands of the Chatham Islands. These islands, having been in the Miocene period below the level of the sea, would possess no inhabitants to resist the invaders, consequently a purely Pliocene vegetation would there settle down and possibly undergo little change in the equable climate, as evidenced by early seedling forms of the present plants showing so great a resemblance to the present adult form. How long the connection between the Chathams and New Zealand existed, or whether the two lands were ever actually united or separated merely by a very narrow strait, geologists have not been able yet to determine. It seems clear, however, that when a subsidence of the land took place, then very soon the Chathams would be isolated sufficiently to receive very few plant immigrants, while yet steppe conditions would reign over much of eastern New Zealand. Finally, the subsidence continuing, New Zealand would sink, either in part or as a whole, to nearly 300 m. below its present level,* which would reduce the area very considerably, rendering many of the mountain passes of the South Island no barrier† to the intermixing of eastern and western plants, while in the North Island there would be less obstruction still. Between the plants of the forest and those of the desert the struggle must have been fierce, and the most extreme xerophytes must have perished or taken refuge in the most barren places, where, indeed, we find them at the present day, on shingle-slips, dry rocks, stony plains, river-beds, &c.‡ In this struggle those plants which had never become fully adapted to extreme xerophilytic conditions, such as *Plagianthus betulinus*, *Sophora tetraptera*, &c., and which possess great powers of adaptability by assuming quickly either a hygrophilous or a xerophilous form according to circumstances,§ would, I take it, be able in the struggle for existence finally to vanquish their Pliocene ancestors which would oppose them in the west or advance

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* Hutton, "On the Lower Gorge of the Waimakariri" (Trans. N.Z. Inst., vol. xvi., 1883, pp. 453, 454).

† Haast Pass, Arthur's Pass, Walker's Pass, Worseley Pass, Hurunui Pass, Amuri Pass, Cannibal Gorge, &c.

‡ Such plants are *Carmichaelia crassicaule*, *Raoulia eximia* and its allies, the plants of shingle-slips, *Ozothamnus coralloides*, *O. selago*, *O. microphyllus*, *O. depressus*, *Epilobium crassum*, *Hectorella cæspitosa*, &c.

§ Several examples are to be found in this and in my previous papers on New Zealand seedlings.

against them in the east. The very limited area in which the final struggle would take place would also much favour those better equipped for the fight. Also, the plants in question are not usually plants of the dense forest, but rather of its outskirts, where even at the present day in a region so wet as Westland the conditions are essentially favourable to semi-xerophilous vegetation.* Hybridization might also play a part, for in the third stage of these plants we have almost the ancestral stage reproduced, or, as I put it in a former paper, "reinstatement of a species."† On the Chatham Islands this struggle between eastern and western plants, between xerophytes and hygrophytes, can never have taken place, and the only struggle must have been between the Pliocene plants themselves, and any evolutionary changes would be owing to local conditions. That these conditions have had little effect seems proved by the fact that the seedlings of Chatham Island plants show so few changes during their development. Thus the present vegetation of the Chatham Islands may in large measure be almost the same as that which occupied New Zealand in the older Pliocene period.

Other facts seem to support the above view, such as the distribution of *Myosotidium nobile* and of the macrocephalous *Olearias*, &c., but I reserve the whole matter for fuller treatment.

I must not close this particular portion of my subject without expressing my very great obligation to Captain F. W. Hutton for much valuable advice and assistance in this matter.‡

No. 779. **Veronica odora,** Hook. f. Plate XI., figs. 21–26. (Syn. *V. buxifolia*, Benth., var. *odora*, T. Kirk, in Trans. N.Z. Inst., vol. xxviii., p. 524.)

The seed was collected on the 26th February, 1899, from plants growing on Mount Isabel, Hanmer Plains district, at an altitude of 970 m. It was sown on the 4th September, 1899, and commenced to germinate on the 1st November, 1899, but, although a large proportion of the seeds had germinated within four weeks or so from that date, some did not do so until the spring of 1900. The seeds were in part sown while still enclosed in their capsules This is a very useful method to employ when the capsules are removed from the plant before the seeds are fully developed, since seeds capable of germination may be thus often procured from plants grow-

* Cockayne, *l.c.*, p. 133.

† *l.c.*, p. 359.

‡ The author writes from the Chatham Islands, under date 9th January, 1901, as follows: "Since examining the vegetation here my views have become somewhat modified."—Ed.

ing in regions difficult of access, and which it might not be practicable to again visit when the seed was fully matured.* It is advisable, therefore, in many instances to collect immature fruits of *Veronica*, not removing the capsules from the inflorescence, even when so little developed that it might seem quite hopeless† for the seed to reach maturity. From seed germinating inside the capsule young plants will be developed in all respects similar to those from seed sown in the usual manner, except that the root will be coiled round and round within the capsule. In the case of the seedlings under consideration, one of the plants examined had its roots coiled up like a watch-spring, which, when unrolled, gave a measurement of 21 mm. The hypocotyl of this plant measured 3·5 mm. in length, and the cotyledons were 3 mm. × 2 mm. The root was of a brownish colour, and provided with numerous root-hairs.

Description of Seedling.

Hypocotyl very soft and juicy at first, pale-green, semi-translucent, glabrous, varying in length according to position with regard to light, those seedlings in shade of other plants, &c., having much longer hypocotyls than those more exposed to the light. The longest hypocotyl observed was 11 mm. long.

Plant described below 9 mm. tall, and having cotyledons and four pairs of leaves. A fairly typical seedling.

Cotyledons furnished with petioles connate at the base; laminæ 3 mm. × 2 mm., ovate-oblong, entire, obtuse; upper surface green; under-surface purple except at margin, round which is a narrow band of green; petioles 0·75 mm. long, channelled above, rounded on under-surface.

1st pair of leaves (fig. 21) soft, juicy, and rather thick, with petioles connate at base, very broadly ovate-rotund; laminæ 3 mm. × 2·5 mm., entire, acute or subacute; upper surface dull-green, furnished with numerous short white hairs; under-surface purple except towards margin, round which is a green belt; margin entire, ciliated with hairs similar to those on the upper surface.

2nd pair of leaves very similar in most respects to the 1st pair, but margin is not entire, having one tooth on each side. The leaf figured (fig. 22) is narrower than is usually the case.

3rd pair of leaves have petioles more erect—*i.e.*, given off from the stem at a more acute angle—than in 2nd pair of

* This plan of sowing is briefly referred to in a former paper, *l.c.*, p. 83.

† Mr. S. D. Barker tells me that he has also had good results from sowing seemingly unripe seed.

leaves, thus raising the horizontal laminæ so that they do not shade the leaves below, whose petioles, being given off at a wider angle, also help to throw the lower leaves out of the shade of the upper ones. (In older seedling plants the lowermost leaves have in addition their laminæ bent downwards towards the ground for the same purpose, while the very uppermost are on a level and almost horizontal. In the youngest plants the length of the lower internodes as compared with the very short apical ones serves the same purpose.)

Laminæ of 3rd pair of leaves (fig. 23) 3·15 mm. × 3 mm., broadly ovate; on each margin is one large tooth with a blunt swollen apex; petioles two-thirds the length of laminæ; other features of leaves as before.

4th pair of leaves similar in most respects to those previously described, but with the toothing still more strongly marked.

Stem terete, with two opposite rows of hairs on each internode similar to the leaf-hairs, those on the one internode alternating with those on the next above; 1st internode 2 mm. long, 2nd internode 1·9 mm. long, and so on, the internodes becoming much shorter towards the growing-point of the shoot.

Further development (as observed from older seedlings): The leaves continue for some time of the same type.

Anomalous seedling: One of the seedlings having cotyledons and three pairs of leaves; these latter are quite entire, and of same type as the 1st pair of leaves.

Plant with 18 pairs of leaves: In this plant, which may be taken as a typical seedling, the leaves from the 5th pair to the 9th pair (fig. 25) gradually increase in size, reaching a maximum of (lamina) 5·5 mm. by 3·75 mm., with petiole 1·75 mm., and having one or two teeth on each margin. The midrib is now quite prominent on the under-surface of the leaf, which in nearly every seedling (with hardly an exception) is dark-purple. The petioles are rather broad, channelled on upper surface, swollen and connate at base, where it is stained reddish-purple in a ring round the leaf-base. Commencing at about the 10th leaf and proceeding upwards, the leaves gradually decrease in size, and are much narrower than those below, otherwise they are as in the previously described leaves. The particular plant described above has developed a lateral shoot from the axil of the now withered cotyledon; all the leaves of this shoot are of the same type as the 1st pair of leaves. The internodes are short, ± 1 mm., and partly sheathed by the leaf-base.

Besides the Mount Isabel seedlings, I have also some older ones grown from seed collected from a plant in my garden, originally from Mount Maungatua, Taieri, Otago, which was kindly given to me some years ago by Mr. Henry J. Matthews, Chief Government Forester. The early seedling leaves are of the usual type, with entire margins. The later leaves are also of the same type as those described above, but usually wider (fig. 24). Plants 4 cm. tall have the leaves of the adult type oblong, sometimes oval, quite entire, coriaceous, almost glabrous, any hairs on upper third of margin most minute; lamina 5·5 mm. × 3·80 mm., obscurely keeled, tapering into petiole, not truncate; petiole 1 mm. long. The adult leaf of the parent is very similar but larger, with lamina 8 mm. × 5 mm., and with base truncate. Very probably had these young plants been growing in the open, and not in the greenhouse, the final leaves would have appeared at an earlier stage.

Mr. T. Kirk (*l.c.*, p. 524) included *V. odora*, Hook. f., as a variety of *V. buxifolia*, Benth., thus differing from Sir Joseph Hooker, who had previously, in the "Handbook of the New Zealand Flora," p. 210, given *V. odora* as a synonym of *V. buxifolia*. Whether the plant under discussion is identical with the Auckland and Campbell Island plant originally described and figured in the "Flora Antarctica," p. 62, tab. 41, under the name of *V. odora* I am not in a position to say; but I am certainly well acquainted with two quite distinct plants—viz., the one under consideration, which forms thickets at times in moist shady places in the lower subalpine region of the South Island, often in wet places taking the place of the ordinary mixed subalpine scrub, or when isolated is a bush 1 m. or less in height, of a ball-like aspect;* and the other a plant hardly branching, and certainly never forming a round bush, its main stem partly prostrate beneath the soil, and the ascending portion bearing a few short erect branches, and reaching at most a height of 0·5 m., or in many cases much less. Its leaves, too, are much thicker and more coriaceous than those of *V. odora*, and its spike very few-flowered. Also, it does not occur in the lower but only in the upper subalpine region, on wet grassy slopes. Of course, it is all a matter of opinion whether a systematic botanist would consider these two plants distinct species, but œcologically they are very distinct indeed, and from that point of view must be treated of separately. The two forms, so far as I know, are never found mixed together; so here we have another example of a slightly more xerophytic structure keeping two very closely allied forms distinct from one another as to their habitats.

I have pointed out elsewhere how greatly *V. odora* varies.†

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* Cockayne, *l.c.*, p. 121.

† "On the Burning and Reproduction of Subalpine Scrub" (Trans. N.Z. Inst., vol. xxxi., p. 417).

This variation chiefly concerns form of leaf, imbricating of leaves or the contrary, and length of internodes. Amongst a number of plants of which an exact measurement of leaf, &c., was taken by me the largest leaf measured 14·5 mm. × 5 mm. and the smallest 6 mm. × 4 mm., a difference of 8·5 mm. in length and of only 1 mm. in breadth. The proportion of length to width varied considerably in other cases; for instance, 2 : 1, 3 : 2, 3 : 1, and 5 : 3, &c. The longest internode was 4·75 mm. and the shortest 1·5 mm. Of sixteen plants examined, five had imbricating leaves and eleven had patent leaves, while only two had leaves of the same size and none had internodes of the same length. The leaves also varied very much in the degree of concavity of the upper surface or the degree of rounding or drawing out of the apical end. From the above it can be seen how great the variation is amongst individuals of *V. odora*. How far these individuals reproduce themselves "true" from seed, or, if they vary, how great is the proportion of variation in a certain direction, such as in the important œcological difference of patent or imbricating leaves, is a matter of considerable interest, and requires much careful and patient work. *V. traversii*, as I pointed out before,* does not individually produce itself "true" from seed, and the like is to be expected in all these variable *Veronicas*.

The seedling leaf-form of *V. odora* consists of, first, a very early appearing entire ciliated leaf, and, second, of a leaf more or less deeply toothed and ciliated. The first form much resembles that of *V. traversii* and some other *Veronicas*, but whether it be an approximation to the ancestral leaf-form of a certain section of *Veronica* cannot, with our present knowledge of seedling forms of this genus in New Zealand, be determined. The adult form of leaf is evidently an adaptation to its environment, the cold wet station of the plant being most likely physiologically dry. Cultivated plants grow in my garden in stations so dry as a sand-dune; one particular plant has occupied such a position now for eight years, and has received no artificial water-supply. The seedling leaves, on the other hand, are adapted for moister conditions. In the shade-house a plant from Mount Torlesse has produced for the past two years toothed ciliated leaves resembling a 2nd seedling leaf, while a few of the youngest leaves have at present entire ciliated leaves similar to the 1st seedling. A species with such capabilities for adaptation to a wet or a dry climate should easily conquer in the struggle for existence a closely allied species without such adaptive capabilities.

* *l.c.*, p. 377.

Veronica squalida, T. Kirk. Plate XI., figs. 36, 37.

The seed was given to me by Mr. A. L. Taylor, who gathered it from one plant in the Botanic Garden, Christchurch. This plant was originally sent to the above garden by Mr. T. Kirk at about the time when he first published the species. The seed was sown on the 6th June, 1899, and germinated on the 14th June, 1899.

Description of Seedling.

Early development: The hypocotyl emerges from the seed-coat and becomes developed considerably before the cotyledons appear. The cotyledons at this stage are arched downwards, enclosed in the seed-coat. The hypocotyl becomes slightly thickened at the base, and puts forth a great number of long minute hairs, which, together with the now descending root, fix the plant in position. Next the cotyledons open out horizontally. At this stage the cotyledons are sessile, oblong, 2·75 mm. × 1·75 mm., and the root is furnished with numbers of root-hairs, to which the particles of earth adhere in masses. The hypocotyl, at first white, is now green, and 2 mm. in length. By the 30th November, 1899—*i.e.*, in about five months and a half—the largest plants had attained to a height of 18 mm., and were furnished with three pairs of leaves; the cotyledons also were still present.

Plant described 18 mm. tall.

Root fibrous, with numerous lateral rootlets.

Hypocotyl stout, terete, almost glabrous.

Cotyledons ovate or ovate-oblong, entire, green, often much stained with purple (this purple staining is very common in *Veronica*), glabrous, with petioles connate and channelled above.

Leaves opposite, decussate, entire or with one or two teeth on each margin, ciliated with short hairs curved at the apex; lamina green on upper purple on under surface, and with purple margin, tapering into the petiole; midrib prominent on under surface; petioles half the length of lamina, channelled on upper surface, connate at base.

1st pair of leaves ovate, usually quite entire.

2nd pair of leaves (lamina) 9 mm. × 5 mm.; petiole 2 mm. long.

Succeeding leaves become more narrow, still usually with one or two teeth.

At a further stage of development the leaves become linear-obovate or linear-lanceolate, usually with one or two teeth towards apical end of leaf, dull-green above, often purple beneath, ciliated with very short hairs; lamina tapering into petiole, 2·2 cm. × 7 mm.; petiole 5 mm., rather broad and channelled above.

By the time a plant is 18 cm. tall and furnished with several branches most of the early leaves have fallen off, and those now being produced are of the adult linear type and almost sessile, with scabrid margin, and measuring 4·4 cm. × 5·5 mm.

The stem in these older seedlings is minutely pubescent, often much stained with purple; internodes ± 12 mm.

I have never seen the plant in its natural station. Mr. T. Kirk merely gives "Nelson—Matori and Wairoa Valley"* as the habitat, so I can say nothing as to the conditions under which it grows.† The leaf changes are of interest from the petiolate, ovate, toothed leaf, 9 mm. × 5 mm., to the narrow obovate leaf, and finally to the very distinct almost sessile linear, or, according to Kirk's description, "narrow linear-lanceolate," leaf, which is quite glabrous and entire, and 5·7 cm. × 6 mm. The early type of leaf (fig. 37) much resembles that of the same stage of *V. traversii.*

No. 692 bis. **Veronica armstrongii,** T. Kirk. Plate XI., figs. 27–35.

The seed was collected from a cultivated plant in my garden, and sown on the 1st September, 1899. Germination took place from the 12th September, 1899, until the 30th October of the same year, and even then seeds were still germinating.

Description of Seedling.

Early development: The primary root and hypocotyl emerge from the seed-coat, and when they together about equal the latter in length the root bends downwards with its extremity to the ground. The hypocotyl then lengthens considerably, and from its base a ring of short fixing-hairs are developed; then the root pushes into the ground and grows downwards rapidly, while at the same time the cotyledons escape from the half-decayed seed-coat and open out horizontally to the light. The cotyledons rapidly increase in size, and the 1st two leaves make their appearance. Both cotyledons and leaves increase in size, the latter becoming much more toothed, and their petioles increasing in length and protecting the 2nd pair of leaves, which are now making their appearance, but still quite hidden between the two erect petioles. These petioles lengthen and open out, becoming further apart as the 2nd pair of leaves develope, while at the same time the 1st internode slightly increases in length. As the blades of the 1st pair of leaves grow the teeth also

* *l.c.*, p. 528.

† I have also in my herbarium a plant which Mr. D. Petrie sent to me, collected at Whakatane, Auckland, which seems to be this species.

increase in size, until the leaf finally attains to the form shown in fig. 27. The 2nd pair of leaves are at first quite sessile and linear; as they become broader they are raised from between the protecting petioles of the 1st pair of leaves by their own petioles lengthening, which now, in like manner, protect the developing 3rd pair of leaves. At this stage the 2nd and 3rd internodes are hardly visible. After three months' growth the tallest seedling was 6 mm. above the ground, with two pairs of fully developed leaves, and the 3rd pair in process of development. After twelve months' growth a young plant is 2·8 cm. tall, with a root 6·8 cm. in length. This latter would probably have been longer had the pot been deeper. It has seventeen pairs of leaves, all of which are petiolate, very deeply toothed or pinnatifid, one lateral shoot from the axil of one of the 2nd pair of leaves, and three lateral shoots, with each one pair of leaves, from the axils of leaves near the apex of the main shoot. The leaf-blades are nearly all horizontal, but the upper ones point slightly upwards, and the lower ones are bent slightly downwards, in order to accommodate themselves to the light-supply.

Plant 6 mm. tall with two pairs of fully developed leaves.

Primary root 3 cm. long at least, pale-coloured, slender, with many lateral rootlets. It is very difficult to dig up a seedling without breaking the root.

Hypocotyl 4 mm. or 5 mm. in length, erect, stout, terete, glabrous, green or slightly tinged with red.

Cotyledons 4 mm. × 2 mm., ovate, entire, obtuse, glabrous, soft and rather succulent; petioles flattened above, half the length of lamina, inserted at about angle of 45°, connate at base.

1st pair of leaves variable in shape and size, 4 mm. or 5 mm. long × 2 mm. to 2·75 mm. broad, ovate or oblong-ovate, rounded or cuneate at base, fleshy, green, toothed rather deeply with one or two teeth on each side; petioles two-thirds the length of lamina, flattened and slightly channelled above, connate at base; midrib more or less raised on under-surface of leaf.

2nd pair of leaves very similar to 1st pair, but very deeply toothed with two or three teeth on each side, or almost pinnatifid.

Stem green, very soft and juicy, hardly developed except for 1st internode, bifariously pubescent; 1st internode 1 mm. in length or a little longer.

General description of a seedling leaf (figs. 28, 29, 35): From lanceolate to ovate or ovate-oblong in outline, often cuneate at base, usually very deeply toothed with one, two, or three teeth on each side, at times almost pinnatifid (fig. 35); acute, glabrous, usually bright-green on both surfaces of lamina, though often stained with purple, especially on teeth; petiole from half to three-quarters the length of lamina, flat on upper surface, connate and sheathing just at base, which is slightly swollen and often purple-stained.

Stem in plant one year old green, often stained with purple near nodes, terete, slightly hairy below with whitish hairs pressed upwards against the stem; hairs above in two opposite rows, those on one internode alternating with those on the next above; internodes often 1·5 mm. long, but variable in length.

Veronica armstrongii is a shrub reaching barely 1 m. in height. Its very much reduced leaves are so closely compressed to the stem above and so intimately united with the bark below that the plant appears at a cursory glance as if leafless. Diels* has called attention to our want of knowledge as to the morphological significance of these reduced leaves, and that it is important to determine whether they are leaf-blades or phyllodes. Certainly, so far as their appearance goes they might very well be the latter. But a study of the seedling form shows a great many transitional changes between petiolate deeply toothed leaves and such as are sessile and entire (see figs. 27–34). The toothing gradually becomes more and more shallow and the teeth fewer in number, until finally they are altogether wanting, and we have only an entire leaf such as is shown in fig. 33. Sometimes the last remaining tooth may be quite close to the leaf-base. Although I have not as yet seen gradations between leaves such as those in fig. 33 and adult leaves, yet I think the above shows fairly conclusively that the latter are reduced leaf-blades, quite sessile, and with a very wide leaf-base, and that there is no reason to think them to be phyllodes.

If we look upon the juvenile plant as the ancestral form, it seems very clear that this latter must have been an inhabitant of a region with a moist and equable climate, whose conditions we can imitate in some degree by bell-glass culture. The plant mentioned and figured in a previous paper† has been kept continuously under a bell-glass since the date mentioned—February, 1899—and is now—November, 1900—17·8 cm. tall, and its thickest branch 4·75 mm. in diameter. The central portion of its three main branches are almost naked for a distance of 3·7 cm., but the lower third of the whole plant is one mass of very healthy green leafy shoots, the largest of which are 3·5 cm. in length, and the whole of whose leaves are of the deeply toothed almost pinnatifid

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* *l.c.*, p. 280.

† *l c.*, p. 396 and pl. xxix. For photograph of adult shoot see pl. xxviii.

juvenile type. In several places, even at a height of 10 cm. above the soil, adventitious roots have been developed, the longest of which is 13 mm.; but in every case as yet such have after a time withered at the apex, and in no instance have reached the soil.

I have never seen *V. armstrongii* in the wild state; it is probably a rare and local plant, occurring in the southern portions of the Canterbury Alps. Mr. T. Kirk's record of its occurrence in Nelson, Westland, and Otago * requires confirmation. The common whipcord *Veronica* of northern Canterbury and of southern Nelson is *V. lycopodioides.* † As to the Westland habitat, it is improbable that there are any *Veronicas* of the above-named type in that region. In my garden our plant still keeps its xerophytic structure, nor while growing in the open air has any part ever reverted to the seedling form. It also flowers freely year by year, and differs little, I should imagine, from the typical alpine form.

No. 844. **Rubus cissoides,** A. Cunn., var. **pauperatus,** T. Kirk. Plate XII., figs. 39, 40, 42, 43, 44, 45.

The seed was collected by Mr. F. Anson at Piraki, Banks Peninsula, from a plant growing as a liane just outside the forest. This plant was leafy in its upper part, but almost leafless elsewhere. Sown on the 1st September, 1899, one seed germinated on the 20th November, 1899, two more plants appeared by the end of the same month, while a fourth seed did not germinate until the 20th August, 1900—*i.e.*, till nearly a year from the date of sowing. So far as observed the seedlings grow at first with considerable rapidity. By the 2nd December, 1899, the oldest seedling was 10 mm. tall, with the 1st foliage leaf in process of development but not unfolded. By the 19th June, 1900, its height was 1·5 cm., and there were six leaves fully developed, while by the 1st November, 1900, there were nine leaves almost fully developed, and it had increased 6 mm. in height. It will be noted that the stem-growth is very slow, its length at this point being exceeded by that of several of the petioles.

Description of Seedling.

Primary root (in plant with 1st leaf at an early stage of development) 14 mm. long, white, fleshy, stout, with very few lateral rootlets.

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* *l.c.*, p. 521.

† I am referring to the plant usually so named by botanists in New Zealand; whether it be Hooker's species is another matter. The plant in question is especially abundant on some parts of Peveril Peak, Canterbury, where it forms quite a large proportion of the subalpine scrub.

Hypocotyl 5 mm. long, terete, thickest at base, pinkish, especially towards cotyledons.

Cotyledons oblong, petiolate, bright-green or purplish-red throughout, obtuse, entire, with margin ciliated with glandular hairs; lamina 4 mm. × 3 mm., horizontal, bent almost at right angles to the nearly vertical petiole; petiole 1·15 mm. long, semi-erect or nearly vertical, channelled on upper surface, connate and slightly swollen at base.

Plant with nine leaves: Remains of cotyledons and 1st leaf show the lowest leaf to be the second.

2nd leaf (fig. 39) 5·5 mm. × 3·25 mm., ovate in outline, bright reddish-purple on both surfaces, coarsely and deeply toothed so as to be almost pinnatifid or lobed, and each tooth ending in a swollen apiculus, ciliated and sparsely hairy on both surfaces with simple and also with glandular hairs; midrib swollen on under-surface of leaf; petiole half the length of lamina, channelled above.

3rd leaf 6 mm. × 3·75 mm., similar in other respects to 2nd leaf.

4th leaf 12 mm. × 5 mm., very similar in all other respects to 2nd leaf, but with four teeth on one side and three on the other; lamina 7·5 mm. × 5 mm.; petiole 5 mm. long.

5th leaf similar to 4th leaf, but with longer petiole.

6th leaf lanceolate, horizontal, with apex sloping towards ground, subtruncate at base, 5-toothed on each side; lamina 10 mm. × 6 mm.; petiole 8 mm. long, sheathing at base, deeply and narrowly channelled down upper surface, inserted on stem at angle of 45°; edge of channel very thick.

8th leaf lanceolate, subcordate, very dark-purple, almost black on upper surface, much paler and rather grey beneath, irregular and deeply serrate; lamina 2·12 cm. × 8·3 mm.; petiole 3·2 cm. long; margin ciliated with long white and also with glandular hairs, sheathing at base; midrib, veins, and swollen apiculi of teeth pink.

9th leaf (in process of development): Lamina almost opened out, 12 mm. × 3 mm.; petiole 2·4 cm., with two prickles.

Stipules inserted at upper end of sheath, linear or almost filiform, ciliated, often bent downwards.

Stem of slow development, partly enclosed by sheathing leaf-bases; internodes 1 mm. long or a little more.

From the above description it will be seen that there are two distinct forms of seedling leaves, the first ovate or cordate-ovate, with a very deeply cut lamina and petioles shorter or only a little longer than the lamina; the second lanceolate or narrow-lanceolate, extremely dark in colour, not so deeply toothed as the first type of seedling leaf, but of much greater size and with the petiole always longer than the lamina.

The first seedling leaf-form much resembles the early seedling leaf of *Rubus australis*, var. *glaber*, whereas the second form is like the reduced lamina of an adult leaf (*cf.* figs. 40 and 44).

The difference in appearance between *R. cissoides* when a liane of the forest and when it forms a round mass of intertwining branches and midribs in the open is quite as striking as that of *Pittosporum rigidum*, described earlier in this paper; but there is this great difference: that the forest form of *Pittosporum rigidum* is the early seedling form still maintained, whereas the forest form of the *Rubus* in question more resembles the second seedling stage of the latter. In both, however, the form in the open is a direct adaptation to xerophytic conditions, though whether this form is hereditary in our plant I am not in a position to determine. This in large measure arises from the fact that, so far as I know, the extreme xerophilous form has never been observed in flower or in fruit. In order to verify my own observations I wrote to Messrs. T. F. Cheeseman and D. Petrie,* inquiring if they had ever seen this particular form of the plant in fruit, &c., and both these botanists, of most wide experience with regard to New Zealand plants, replied that they had never seen the almost leafless form in flower or fruit. Mr. Cheeseman qualified his information with the remark that he saw no reason why it should not flower. That is indeed very true, since poor soil, as every observant gardener knows, causes early flowering, while, on the other hand, it is a proved physiological fact that a moist atmosphere will hinder the development of the reproductive organs in plants.† Here, then, is quite a case to the contrary: the plant of the moist wood produces fruit regularly, the plant of the barren wind-swept slope rarely or never does so.

The forest liane climbs over tall shrubs or low-growing trees. It is well furnished with leaves, which are pinnately trifoliate, with the leaflets equal in size, or the terminal one is often the largest. The margin varies from coarsely and deeply toothed (fig. 42) to merely waved. The leaf-surface is usually bright-green and shiny, and always quite glabrous. The leaflets are from broad to narrow lanceolate in shape, rounded at the base, and articulated to the usually rather long channelled petiolule, that of the terminal leaflet being much the longer. Petioles, petiolules, and midribs may be quite unarmed in the most extreme cases, or furnished with few or many pale-coloured prickles. Such leaves may measure

* Mr. S. D. Barker also informs me he has never seen flowers, &c., on this plant.

† Schimper, A. F. W., "Pflanzen-Geographie," Jena, 1898, pp. 30, 31.

± 17 cm. in length, with leaflets 6·5 cm. × 15 mm., or the leaflets may be broader or more narrow.

When the plant is growing in the open we find a very different state of affairs. Then very often the leaf-blades are entirely wanting, and the leaf consists only of very long and prickly midribs. Often, however, there is a very small lamina at the apex of the midrib (figs. 43, 44, 45), especially in parts of the plant which are most sheltered. Such laminæ offer every gradation in size according to their position with regard to excessive light, wind, &c., between large ones such as described above and those of 2 cm. × 3 mm., or even of much smaller size. On the midribs are many more prickles than on those of the forest liane. These prickles are usually from two to four in number, close together, and situated on the under-surface and sides of the midrib, but never on the stem, each prickle measuring about 2 mm. to 2·25 mm. in length, and with a stout base 3 mm. or more long. They are of a straw-yellow colour, straight or curved, and so numerous as, with their peculiar colour, to give a distinct character to the plant.

The plant itself growing in these dry situations—volcanic hills, river-terraces, &c.—forms a round mass of intertwining, long, flexible shoots, having often a height of 61 cm., with a diameter of 84 cm., or the dimensions may be very much greater. So elastic is such a bush that when one treads hard down upon it the twigs spring back at once into their former position. This elasticity is exhibited at quite an early age in seedling stems and petioles. From out of the round twiggy mass of the plant erect shoots often arise, quite tender and soft, and with rudimentary leaves. Such are usually killed at a very early stage by the wind and sun. This destruction of the growing-point of the young shoots may account for the non-flowering of the plant, for flower-buds may not develope properly in the dense parts of the twiggy mass, and when exposed to the external climatic conditions are too tender, and so destroyed. In many instances the above-mentioned leaves bend down into the plant for shelter. On this account the lateral leaflets are often bent downwards at an angle to the midrib, which tends to fasten the twigs together, and so to consolidate the whole mass of the plant.

Several other species of *Rubus* in New Zealand have the habit of this plant when growing under xerophytic conditions, so assuming the form of shrubs rather than of lianes. Indeed, it is quite easy to see how from such a manner of life, where the climbing habit, suited as it is only for very special conditions, is no longer possible, a shrub could be evolved from a

* "Beiträge zur Biologie der Lianen," Jena, 1892, pp. 60, 162.

liane, as described by Schenk* and Warming, and I think we may safely conclude with Diels* that a number of our xerophilous shrubs have thus descended from forest plants, and in certain cases from lianes.

The prickles are developed to a much greater extent in the xerophilous than in the hygrophilous form of our plant, although they are clearly an adaptation for climbing, as was first shown by Kerner.† Afterwards, in the xerophyte, they become of still greater use by binding into a wind-resisting whole the numerous branches. The fallaciousness of Wallace's‡ idea that such prickles were a protection against snails has been ably exposed by Mr. G. M. Thomson.§ In the seedling the prickles did not appear until quite late (the 8th leaf) in its development; but in the xerophilous form they increase to a great extent, the conditions of its existence being seemingly better suited for their appearance than are those more sunless and damper ones to which the liane is exposed.

No. 768. **Ligusticum filifolium,** Hook. f. Plate XII., figs. 38, 41.

The seed was collected on Jack's Pass, Hanmer Plains district, at beginning of February, 1899. It was sown on the 6th September, 1899, and germinated on the 1st August, 1900. The young plants continued to make their appearance until the middle of September, 1900.

Description of Seedling.

Early development: The cotyledons remain within the seed-coat, and still surrounded by the walls of the mericarp, absorbing nutriment until they are pulled out of the ground and out of the pericarp by the lengthening of the hypocotyl, and of their own peduncles more especially. Within the seed-coat their upper flat surfaces are pressed together, absorbing nutriment especially with their apices. Emerging from the soil in a low arch, the short hypocotyl has become stout, and offers good support for the petioles to pull their leaf-blades out of their coverings. The cotyledons are at first very narrow, with their laminæ green, flat, and a little broader than the longer filiform petioles, which are of reddish colour, faintly channelled above and swollen at the base. At this stage the cotyledons are sometimes bent or twisted. By the time the cotyledons have reached a size of (laminæ) 19 mm. × 2 mm., and petioles 16 mm. in length, these latter have spread out

* *l.c.*, p. 247.

† "Pflanzenleben," Leipzig, 1887, p. 637. Here a figure of the reduced leaves is given, the plant being designated *Rubus squarrosus*.

‡ "Darwinism," London and New York, 1889, 2nd ed., p. 433.

§ "Nature," vol. 42, 1890, p. 222.

laterally, and are at junction of lamina 10 mm. apart. At this stage from between the cotyledons the 1st leaf is in course of development, not erect, but arching laterally, and with the two side leaflets closely pressed together near its apex. Following the development of the leaf, the petiole grows much more rapidly than the lamina. This at a very early stage of development is about the same length as the petiole, its lateral leaflets pressed closely together. As development proceeds and the petiole lengthens it becomes curved at its upper end, often forming an arch, the lamina being bent inwards and downwards like the numeral "2" (fig. 38), and with the apex of its terminal leaflet approached more or less near to the base of the petiole. Growth proceeding, the petiole gradually straightens, until by the time the lamina has expanded it is quite straight. After growth of forty-four days the cotyledons attained a length (including petiole) of 3·6 cm., and the 1st leaf a length of 2·31 cm., with lamina 6 mm. and petiole 2·25 cm. While this development of cotyledons and leaf is proceeding, the root, in an early stage pale and translucent, has now become a deeply descending thick tap-root containing an abundance of food-material, which has been here stored up at the expense of rapid growth and development of stem and leaves. After about two and a half months' growth the roots are out of the bottom of the pot, 9·2 cm. in depth, in which the seed was sown, and are from 1 mm. to 1·5 mm. in diameter above. The 2nd leaf issues from the protecting sheath at the base of the 1st leaf, and undergoes the same process of development as the 1st leaf.

Root very long and tapering, finally extremely thick and stout, with numerous lateral rootlets.

Hypocotyl 3 mm. above ground in largest plants, short, stout, glabrous, very pale yellowish-green, often stained with purple.

Cotyledons linear or extremely narrow linear-lanceolate, sometimes falcate, green on both surfaces, entire, subacute or obtuse, glabrous, $\pm$ 4·5 cm. in length, with lamina tapering into and about equalling petiole; lamina 2 mm. broad; petiole brownish or brownish-red, very obscurely channelled, connate, and forming a short sheath at base.

1st and 2nd leaves radical, $\pm$ 4·8 cm. long, ternate or palmately trifid, glabrous, green on both surfaces or sometimes stained purple; leaflets and segments narrow-obovate, lanceolate or linear-lanceolate, entire or with from one to three teeth at apical end, 14 mm. $\times$ 5 mm. or of considerably smaller size, acute, 1-nerved.

Ligusticum filifolium grows on shingle-slips, usually on such as occur in the dry lower mountain region of the South Island of New Zealand, although specimens may be occasionally met with on the alpine shingle-slips at an altitude of 1,200 m. It is also found in the shade of the small patches of *Fagus cliffortioides* so often met with on the slopes of river-terraces.

The adult leaves are usually divided into segments very much narrower than those of the seedling. There are, however, certainly two forms of this plant so far as the leaves are concerned, the one with quite filiform leaves and the other with the leaf-segments 12 mm. × 3 mm., or even broader. The form growing under the shade of the beech-trees has usually the leaf-segments broader than the form of the open. As to what the effect of shade is on the narrow-leaved form I cannot yet state. Moreover, the broad- and narrow-leaved forms may be two separate species. The rapid development of the root in thickness is of great benefit to the young plant. Possibly, too, the slow germination of the seeds may have an œcological meaning.

EXPLANATION OF PLATES X.–XII.

PLATE X.

Fig. 1. Seedling leaf of *Pittosporum rigidum*, closely approaching the adult xerophilous leaf form ; × 4.
Fig. 2. Early seedling leaf form of *Pittosporum rigidum ;* × 4.
Fig. 3. Leaf of seedling *Pittosporum rigidum*, resembling fig. 1 above and fig. 2 below ; × 4
Fig. 4. Early seedling leaf of *Stellaria roughii ;* × 6.
Fig. 5. Cotyledon of *Gaya ribifolia.*
Fig. 6. Early seedling leaf of *Gaya ribifolia.*
Fig. 7. Seedling of *Gaya ribifolia*, with cotyledons and 1st leaf.
Fig. 8. Early seedling leaf of *Gaya ribifolia.*
Fig. 9. Later seedling leaf of *Gaya ribifolia.*
Fig. 10. Leaf from one-year-old plant of *Gaya ribifolia.*
Fig. 11. Seedling plant of *Plagianthus betulinus ;* early leaves have fallen off.
Fig. 12. Leaf from young plant of *Plagianthus betulinus.*
Fig. 13. Leaf from semi-shrubby form of *Plagianthus betulinus.*
Fig. 14. Leaf from young plant of *Plagianthus betulinus.*
Fig. 15. Leaf from semi-shrubby form of *Plagianthus betulinus.*

PLATE XI.

Fig. 16. Seedling of *Plagianthus betulinus*, Chatham Island var., showing cotyledons, hypocotyl, and primary root.
Fig. 17. Early seedling leaf of *Plagianthus betulinus*, Chatham Island var.
Fig. 18. Leaf from young plant of *Plagianthus betulinus*, Chatham Island var.
Fig. 19. } Fig. 20. } Leaves from young plant of *Plagianthus betulinus*, Chatham Island var.
Fig. 21. 1st seedling leaf of *Veronica odora ;* × 4.
Fig. 22. 2nd seedling leaf of *Veronica odora ;* × 4.
Fig. 23. 3rd seedling leaf of *Veronica odora ;* × 4.

Plate XI.—*continued.*

Fig. 24. Later seedling leaf of *Veronica odora*, of Maungatua.
Fig. 25. 8th seedling leaf of *Veronica odora*; × 4.
Fig. 26. Much-toothed leaf of *Veronica odora*; × 4.
Fig. 27., Fig. 28., Fig. 29. Early seedling leaves of *Veronica armstrongii*; × 6.
Fig. 30. Entire and rather anomalous seedling leaf of *Veronica armstrongii*; × 6.
Fig. 31., Fig. 32., Fig. 33., Fig. 34. Later seedling leaves of *Veronica armstrongii*, showing transition between typical seedling and adult leaves; × 6.
Fig. 35. Very deeply cut seedling leaf of *Veronica armstrongii*; × 6.
Fig. 36. 2nd seedling leaf of *Veronica squalida*; × 4.
Fig. 37. 3rd seedling leaf of *Veronica squalida*; × 4.

Plate XII.

Fig. 38. Seedling of *Ligusticum filifolium*, with cotyledons and 1st two leaves.
Fig. 39. 2nd seedling leaf of *Rubus cissoides*, var. *pauperatus*; × 4.
Fig. 40. 8th seedling leaf of *Rubus cissoides*, var. *pauperatus*.
Fig. 41. Early seedling form of *Ligusticum filifolium*, showing 1st leaf in process of development.
Fig. 42. Adult leaf of *Rubus cissoides*, var. *pauperatus*, as found on liane form, or in sheltered portion of xerophilous form.
Fig. 43., Fig. 44., Fig. 45. Reduced leaf-blades of *Rubus cissoides*, var. *pauperatus*.
Fig. 46. Stellate hair from leaf of *Gaya ribifolia*.

Art. XXIX.—*Note on the Occurrence of the Genera* Gunnera *and* Myosotis *in Chatham Islands.*

By L. Cockayne.

[*Read before the Philosophical Institute of Canterbury, 27th February, 1901.*]

The genera *Gunnera* and *Myosotis* have not been recorded as occurring in the Chatham Islands so far as I can ascertain, notwithstanding there is a specimen of the latter, collected by Mr. H. H. Travers, in the herbarium of the Christchurch Museum. It therefore may be of interest to note that I met with both during my recent botanical excursion to Chatham Islands.

Gunnera monoica, Raoul, I found growing on the high land some two miles east of the Ngaio. One patch was on wet peaty ground, and another occupied the margin of a neighbouring swamp.

A species of *Myosotis*, possibly *M. spathulata*, Forst., was shown to me by Mr. F. Arthur D. Cox, growing in the shade of a small patch of forest on Whangamarino. The individual plants were by no means numerous. I collected a second plant growing in stony *débris* at the foot of the Te Awatapu Waterfall. It is just possible that this latter plant is distinct from the former.

Art. XXX.—*A List of the Seaweeds of Norfolk Island.*

By R. M. Laing, B.Sc.

[*Read before the Philosophical Institute of Canterbury, 4th July, 1900.*]

Owing to the kindness of my father, Mr. W. Laing, who has sent me a large number of dried specimens, I have been enabled to examine the seaweeds of this interesting little island, and the list appended to this paper probably includes nearly all the more conspicuous forms to be found there. Hitherto the Algæ of the island have not been examined, although the flowering-plants are fairly well known. In the "Phycologia Australica" (Harv.) several species, picked up apparently by casual collectors, are mentioned as occurring in Norfolk Island. All of these with one exception I have found in my collection.

As the island is surrounded by high cliffs, and there are few rock-pools, it does not afford any good collecting-grounds, and the number of species occurring there seems to be small, and of these nearly all are found on the northern coast of Australia. Though the flowering-plants show a distinct New Zealand connection, no trace of this appears among the seaweeds. In the following list there appear only two species which are apparently endemic. This is the more remarkable as it is stated that about a quarter of the flowering-plants are endemic.* In a word, the seaweeds of Norfolk Island are completely Australian in their affinities, and show no definite relationship to New Zealand or the South Sea Islands.

I have to thank Major Reinbold for his kind assistance in the identification of the majority of the species. I have still one or two which I have not yet been able to determine.

Species marked with an asterisk have been previously recorded from Norfolk Island.

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* Cheeseman, Trans. N.Z. Inst., vol. xx., p. 161.

1. *Codium muelleri*, Kütz., Tab. Phyc., vol. vi., tab. 95.
2. *Chætomorpha ærea*, Dillw.
3. *Sargassum godeffroyi*, Grun.
4. **S. spinifex*, C. Ag.
5. *S. amaliæ*, Grun.
6. *S. binderi*, Sond.
7. *S. cervicorne*, Grev. = *S. binderi*, Grun.; "forma *angustifolia* α., foliis subintegerrimis" (Sonder, Alg. Trop. Austr.).
8. *S. merrifieldiæ*(?), J. Ag. The material is not quite complete.
9. *Hormosira banksii*, Harv., var. *sieberi*, Harv., Ner. Austr. I have only seen some dwarfed fragmentary specimens.
10. *Zonaria diesingiana*, J. Ag.
11. *Padina pavonia*, Gaill. (including v., Grunow, *P. gymnospora*, Kg., and perhaps *P. d'urvillei*, Borg.).
12. *Halyseris plagiogramma*, Mont.
13. **Plocamium hamatum*, J. Ag. An endemic species.
14. *Gelidium rigidum*, Vahl. (Grev.).
15. *Pterocladia capillacea*, Bornet. In the absence of fruit there may be a little doubt about this identification.
16. *Spyridia filamentosa*, Wulf. (Harv.).
17. *Peyssonellia rubra*, Grev. (J. Ag.).
18. *Desmia ambigua*, Grev. (Harv.). This is probably only a form of *D. (Chondrococcus) hornemanni*, Mert.
19. **Galaxaura obtusata*, Lmx.
20. *Griffithsia thyrsigera*, Harv. On *Sargassum*.
21. *Leveillia jungermannioides*, Mert. (Harv.). On *Sargassum*.
22. *Laurencia concinna*, Mont. In the form of *L. calliptera*, Kg., tab. xv., 69.
23. *L. heteroclada*, Harv.
24. *L. dendroidea*, J. Ag.
25. *L. flagellifera*(?), J. Ag. (not of Keutzing). The materials are badly preserved.
26. *Liagora rugosa*, Zan., var. *vieillardii*, Grun. Syn., *L. fragilis*, Kg., not of Zan.
27. *Amansia robinsoni*, J. Ag. (Analecta Alg., pt. i., p. 174.) An endemic species.
28. **Corallina micrarthrodia*, Lmx.
29. **Amphiroa anceps*, Lmx. Close to *A. dilata*, Decne, and *A. bowerbankii*, Harv.
30. **Melobesia pustulata*, Lmx. On *Laurencia*.

In addition to the above there is a *Caulerpa* coming close to *C. chemnitzia*, but in the absence of the most recent literature I am unable to identify it with certainty; a coralline not yet sufficiently examined; and a species of *Cystophora* which may be new.

I have deposited specimens of most of the above in the Canterbury Museum.

ADDENDUM.

4th May, 1901.

The following additional species appear in "Meeres Algen von den Norfolk Inseln," by Major Th. Reinbold (Nuovo Notarisia, series xi., October, 1900):—

31. *Sargassum godeffroyi*, Grun., Alg. Fidji-Tonga-Samoa, i., p. 4.
32. *Sargassum leptopodum*, J. Ag., Spec. Sarg. Austr., p. 115, t. 30. (Determination not quite certain.)
33. *Sargassum stenophyllum*, J. Ag., Spec. Sarg. Austr., p. 104, t. 29.
34. *Griffithsia thyrsigera*, Harv., Trans. Irish Acad., vol. 22, n. 291.
35. *Corallina cuvieri*, Lmx., J. Ag., Spec. ii., p. 572.

ART. XXXI.—*On the Occurrence of* Cordyline terminalis *in New Zealand.*

By the Rev. Canon WALSH.

[*Read before the Auckland Institute, 9th July, 1900.*]

ABOUT twelve or fourteen years ago the late Miss M. A. Clarke, of Waimate North, showed me two specimens of a *Cordyline* which I had never seen before, and which she had growing at "Grove Cottage." She informed me that she had found them in a long-deserted native cultivation in the neighbourhood, and that they were specimens of a ti (*Cordyline*) which the Maoris had in former times been in the habit of cultivating for food, but which of late years had fallen into disuse and practically disappeared from the district. Of the two specimens she kindly gave me one, which I planted in my garden, and on her death, which occurred not long after, I took charge of the other. Both of these, though removed more than once to make room for encroaching vegetation, are now in a flourishing condition, and one of them has made very strong growth.

Although the plant was evidently a rare one, I had no idea that the specimens were almost the last survivals of a variety that is practically extinct so far as New Zealand is concerned, or that, indeed, it possessed any interest beyond that which would naturally surround a relic of old Maori times. My ideas on the subject were changed, however, by a visit I received from Mr. D. Petrie, F.L.S., Chief Inspector under the Auckland Board of Education, who has made some valuable contributions to the botany of the country. Mr. Petrie had never seen a growing specimen of the plant, but, after a careful examination, he was of opinion that it was identical with a species some specimens of which had been recently discovered by Mr. Reid at Ahipara, and which had been described by Mr. T. F. Cheeseman, F.L.S., Curator of the Auckland Museum.* For this species the late Mr. T. Kirk, F.L.S., had proposed the name of *C. cheesemanii*, supposing it to be a new species, although Mr. Cheeseman himself considered it to be identical with *C. terminalis*, a plant largely cultivated throughout the Polynesian islands, especially in Fiji and Samoa, for the sake of its edible root, but which had not hitherto been observed in New Zealand. On the advice of Mr. Petrie, I communicated with Mr. Cheeseman on the subject, at the same time sending him a fresh leaf from one of the plants. On examination Mr. Cheeseman told me that the species appeared to be the same as that of the Ahipara specimens, as well as that of the Kermadec Islands, a plant of which he had growing in his garden at Remuera, obtained by himself ten years before; and, further, that he had no hesitation in pronouncing it to be identical with the Polynesian variety, as he had suspected all along; and, as its appearance in New Zealand had not yet been accounted for, he recommended me to collect all available information on the subject from the old settlers and Maoris in the district in which the specimens had been found.

For some time all my efforts in this direction were unavailing. Most of the information I was able to obtain was either vague or otherwise unsatisfactory. The old settlers generally remembered that in the early days a certain species of ti (*Cordyline*) had been cultivated by the Maoris, but most of them confused it with the ti rauriki (*C. pumilio*), a wild species which was commonly eaten but never cultivated. The Maoris were still more unsatisfactory. The younger generation plainly knew nothing at all about the matter, while in the case of the elders my limited knowledge of the language prevented my following them into the region of mythical romance into which the lapse of time seemed to have relegated the subject.

The first reliable information I received was from Mr. J. B. Clarke, of Waimate North, who remembered that forty

* Trans. N.Z. Inst., vol. xxix., p. 346.

or fifty years ago it was to be found in many of the native settlements about that district. He was quite familiar with the cooked article, as the Maori nurses and other retainers of the mission families used often to bring small quantities as presents to the children. His attention was first drawn to the growing plant about thirty-five years ago by a Maori youth with whom he was out cattle-hunting, who pointed out some three or four specimens in an enclosure at the settlement of Te Matire, near Lake Omapere, informing him at the same time that "That was the ti which the Maoris cultivated for food." Mr. Clarke recognised my plants as being identical with these. This information was corroborated by the Maoris —Hone Peti, Heremaia Pirika, and Miriam —— —all of whom identified the plant from my specimens, and gave me a good deal of information about its habits and uses, from which I have been able to construct the following account:—

The plant was known among the Maoris as the "ti pore," and was one of two varieties of *Cordyline* used for food, the other, the *C. pumilio*, being called the "ti rauriki" (= small or narrow-leaved). The former—viz., that under consideration—was only found in cultivation, while the latter is largely distributed in a wild state. The signification of the name is uncertain. The qualification "pore" literally means "cut off close," as in the case of short-cropped hair, and may have reference to the practice of cutting off the top to propagate the plant; or possibly it may have been used to distinguish this from the taller or true varieties. Within the memory of living men the ti pore was grown in most of the settlements about the north, though probably from the fact that it was a slow-growing plant, taking several years to mature, and at best yielding but a comparatively small return, it was never cultivated in very large quantities.

In appearance and habit the ti pore is quite distinct from any other species of *Cordyline* found in New Zealand. A short slender stem, with a tolerably smooth bark, showing a ring for every leaf fallen off, is surmounted by a handsome head of soft glossy leaves, from 1½ ft. to 2 ft. long by 3 in. or 4 in. wide, each leaf being set on a fine stalk and bending over in a graceful curve. In older and well-grown plants the trunk forks off about 3 ft. or 4 ft. from the ground, and the top divides into several heads. This, I am informed, is the case with one of Mr. Reid's specimens at Ahipara, and the same thing may be observed in the Sydney and Brisbane botanical gardens on those obtained from the Polynesian islands. The root was by far the most important part of the plant from the Maori point of view. It is a mass of greenish-white pulpy fibre, of such a consistency as to be easily cut through with a sharp spade. In shape it is a very elongated cone, with an irregular outline and a lumpy and corrugated surface, and furnished at occasional intervals with thin wiry feeders set on at right angles to the axis. In size the root is out of all proportion to the rest of the plant. On one that I transplanted it was nearly 3 ft. long, with a principal diameter at the upper third of from 3 in. to 4 in., and tapering to a fine point at the lower end. Soil and situation, of course, greatly influence the growth, and the Maoris inform me that on rich alluvial bottoms the roots often attained such large dimensions that it was necessary to quarter them down the middle in order to reduce them to a convenient size for cooking.

The propagation of the ti pore was very easy and simple. The usual plan was to cut off and replant the stalk with a small portion of the root attached in the same manner as is done with the taro. Advantage was also taken of the offsets which often spring up from the foot of the old stocks, especially when any injury has happened to the top. So far as I have been able to learn, the ti pore does not seed in New Zealand.

To prepare the root for food it was finely pounded with a wooden club on a flat stone, in the same manner as the fern-root, until the fibre was quite broken up, after which it was steamed in the *haangi*, or native oven, for from twelve to twenty-four hours. The substance then presented the appearance of a glutinous mass, and the taste is described as of a sugary sweetness far beyond that of the ti rauriki, but, like that root, with a slightly bitter after-flavour. The cooked article was highly esteemed not only for its agreeable taste, but for its nutritive and keeping qualities, especially in time of war, when it was a question of provisioning the pa or carrying food on the war-path. It is probable, however, that owing to the slow growth of the plant it was most generally used merely as a sweetmeat. In fact, the Maoris say that in old times the chewing of a piece of the prepared root when one had nothing else to do gave the same satisfaction as is now afforded by a pipe and tobacco.

The almost total disappearance within a couple of generations of a plant once so widely grown and so easily propagated is not so difficult to account for as might appear at first sight. In the first place, its tropical origin limited its culture to certain favoured spots within a comparatively small area of the northern peninsula, while the fact of its not reproducing itself from seed rendered its preservation dependent on continuous plantation. And as on the general introduction of European trade which took place during the second quarter of the century sugar and other ready-made delicacies of the pakeha could be obtained at a cost of much less labour than was necessary to produce the primitive sweetmeat, its cultivation would naturally be abandoned, and the few plants which remained in the deserted enclosures would be gradually exterminated as the number of cattle increased and the fences fell to decay. It is not surprising, therefore, that, although there are several men now living who can remember the general cultivation of the ti pore, the number of known survivals should be limited to the four specimens discovered by Mr. Reid at Ahipara and the two in my possession at Waimate North.

The question naturally arises as to the probable period at which the ti pore came to the country, and the circumstances under which it was brought in. That it was introduced by the Maoris is self-evident, from the fact that it has never been found in a wild state, and that it cannot reproduce itself in the New Zealand climate without artificial help. The approximate period of Maori history in which the introduction was effected is, however, still an open question, and one of much interest. In a letter to me on the subject, Mr. Cheeseman expressed it as his opinion that the Maoris brought the plant with them from Hawaiki on their original immigration, just as they brought the kumara (sweet potato), the taro (edible arum), the hue (calabash), and the aute (paper-mulberry), while at the same time he admitted that another view might possibly be taken—viz., that it might have been introduced by some of the Maori whalers in the early part of the century, who are known to have introduced the taro hoia (the large coarse variety), and to have attempted the introduction of the yam.

Now, had the introduction and distribution taken place within what may be called the Maori whaling period—or, roughly speaking, the first half of the century—it is scarcely probable that all recollection of an event of such general importance should have already died out. But, although I have made most careful inquiry of many of the older Maoris of the Bay of Islands, the great centre of New Zealand whaling operations, I have been unable to find any recollection whatever of the introduction of the plant, the invariable answer being that they knew nothing at all about it. The only exception was in the case of Hone Peti, who said that there used to be a song about the ti pore, the words and tenor of which he had, however, completely forgotten. This, if it be worth anything, would rather point to a remote origin. Moreover, the case of the ti pore and that of the taro hoia and the yam are scarcely parallel. These plants would appeal strongly to the utilitarian Maori as yielding a large quantity of food, easily grown and readily prepared, while the other would only afford a precarious supply of a fancy esculent, involving infinite labour in its preparation, and, after all, of quite insignificant value beside the easily acquired delicacies of the pakeha.

But what would be hardly worth troubling about under one set of circumstances might be extremely valuable under another; and it is quite conceivable that an article of food which would be comparatively valueless once the Maoris had become possessed of the potato, of wheat and maize, of the pumpkin and vegetable-marrow, and had the means of purchasing biscuit and flour and sugar and tobacco, would be worth cultivating at the cost of any trouble at a period when the list of garden produce was limited to the smaller varieties of the kumara and taro (taro Maori), the tasteless hue and the "greens" mentioned by the early navigators, and when the supply of vegetable food had to be eked out with the fern-root and other wild edibles of the bush. I think, therefore, that, in the absence of any evidence to the contrary, we may safely conclude that Mr. Cheeseman's theory is the correct one, and that the plant was brought by the Maoris in prehistoric times, and that most probably the introduction took place on their original immigration to the country.*

Art. XXXII.—*Notes on the Cultivated Food-plants of the Polynesians, with Special Reference to the Ti Pore* (Cordyline terminalis).

By T. F. Cheeseman, F.L.S.

[*Read before the Auckland Institute, 9th July, 1900.*]

I think the Institute is indebted to the Rev. Canon Walsh for the trouble he has taken in preparing his paper,† and in collecting evidence proving the former cultivation by the Maoris of the Ti pore, or *Cordyline terminalis*. I have no doubt whatever that he is perfectly correct in the conclusions he has arrived at—that the Ti pore was introduced by the Maoris when they first colonised New Zealand many generations ago, and to a limited extent was cultivated by them until the commencement of European settlement, but in the extreme northern portion of New Zealand only. As the subject is an interesting one, I am desirous of advancing some considerations respecting it which appear worthy of notice.

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* See *C.* sp., *ti tawhiti*, Hooker's Handbook of N.Z. Flora, p. 743 (Hector, 1865).

† See above, p. 301.

So far it has been believed that the cultivated plants of the Maoris, brought with them when their migration to New Zealand took place, were four only. First, the kumara, or sweet potato, which, up to the time of the introduction of the true potato, constituted their chief vegetable food, and is still largely grown; second, the taro, which fifty years ago was seen in every Maori cultivation of any size, but which has now fallen into almost total disuse; third, the hue, or gourd, which was grown for the double reason of providing a food somewhat similar to our pumpkin, and of preparing calabashes, or water-vessels, from the hardened rind of the fruit. Like the taro, it is now seldom cultivated. Lastly, there is the aute, or paper-mulberry, now apparently extinct, but which was abundant in Cook's time. In Polynesia the inner bark is used for the manufacture of cloth, but in New Zealand it seems to have been put to no other purpose than that of making fillets for adorning the hair of the chiefs.

These four plants have a very wide distribution. The sweet potato is now cultivated in all warm countries and many temperate ones. Its native country is unknown, but it is usually supposed to be of American origin, although on this supposition it is difficult to account for its undoubted presence in the Pacific islands and New Zealand long prior to the period of Cook's voyages, and at a still earlier date in China. The taro is considered to be truly native in India and Malaya, and possibly also in some of the Pacific islands, but it also is widely grown in most warm countries. The hue, or gourd, has been known in cultivation from time immemorial, and its native country is quite uncertain, although probably some part of tropical Asia or Africa. Although commonly grown in Polynesia, it does not seem to be truly wild there. As for the paper-mulberry, notwithstanding the fact that it is, or was, cultivated throughout Polynesia from Fiji to the Sandwich Islands, it is extremely doubtful whether it is truly native therein. Probably we shall have to look to China or Japan for its true home. From these facts it will be seen that the four plants brought by the Maoris to New Zealand are widely distributed species, cultivated for ages over a large part of the earth's surface.

The position occupied by the Polynesian races as tillers of the soil has hardly had sufficient attention given to it, although it may be doubted whether any people ignorant of the use of metals ever advanced so far as they have done. In the case of New Zealand, we are apt, at the present time, to think of Maori agriculture as being slovenly, careless, and without method. But it was not always so. Let any one read the account given by the first visitors to New Zealand—especially Cook—respecting the Maori cultivations of those days—the care that was taken to keep them free from weeds; the labour expended in conveying gravel to hill up the kumara plantations; the trouble taken to protect them from strong winds by means of temporary screens or fences; the months employed in building houses (often highly carved and decorated) in which to store their crops; the amount of patient care and selection required in raising new varieties, for it is not generally known that more than fifty varieties of the kumara alone were cultivated—when all this is considered it cannot be denied that the Maoris were patient, careful, and expert agriculturists.

And, putting on one side the disturbing effects due to the intrusion of Europeans, the same statement can be made about Polynesia generally. On the first arrival of European navigators there was every evidence of a long-continued cultivation of the soil, not, of course, in the same shape that was visible in New Zealand, for in a tropical climate the growth of vegetation is so rapid and the necessity for shading the soil so great that many cultivations, when seen from a distance, present more or less the appearance of a jungle, and an abandoned plantation reverts to the forest in a year or two. But as regards the extent to which the inhabitants were dependent on vegetable food, the number of different plants cultivated, the care given to their plantations, the assiduity with which new varieties were raised and propagated, the evidence is even more complete than in New Zealand.

For the purposes of this paper I will briefly allude to the chief plants cultivated for food in tropical Polynesia, passing by the four which have been conveyed to New Zealand, reference to which has already been made. In order of merit the banana will rank first, no doubt. Of late years several varieties have been introduced by Europeans; but at the time of Cook's first voyage Dr. Solander enumerated no less than twenty-three varieties as being in cultivation in Tahiti. Dr. Seemann, in the "Flora Vitiensis," gives the names of nineteen known in Fiji; and during a recent visit to Rarotonga I obtained a list of eighteen which were grown on that island before the arrival of Europeans. These numbers will give an idea of the extent to which the banana was cultivated before any foreign demand arose for the fruit. Yet, notwithstanding its great abundance, it is doubtful if the true banana is indigenous in any part of the Pacific. The evidence, such as it is, seems to point to its gradual introduction, ages ago and step by step, from tropical Asia or Malaya. I have been careful to say "true banana," because there are species of plantains, or cooking-bananas, such as *Musa felix*, which are undoubtedly indigenous in Polynesia. But these are not cultivated to any great extent, although the fruit is regularly collected from the immense groves which they often form in the mountain valleys.

Next to the banana comes the bread-fruit, which has a very similar history. In Tahiti Solander obtained evidence proving that twenty-one distinct kinds were in cultivation differing greatly from one another in the cutting of the leaves and shape and size of the fruit. Yet Tahitian legends expressly allude to its introduction from abroad. So also in Rarotonga, where it is said to have been introduced partly from Tahiti and partly from Samoa. In Fiji Seemann saw thirteen varieties in cultivation, but was unable to satisfy himself that it was indigenous. In all probability it has been brought from the Malay Archipelago in a similar way to the banana.

Taking the cocoanut palm next, we have a species which is now plentiful on all tropical shores, and whose native country is quite uncertain. In Polynesia, however, it has so much the appearance of a true native that it appears best to so consider it. Judging from the numerous legends relating to it, its cultivation must be nearly as old as the Polynesian race itself.

I have mentioned the taro among the New Zealand cultivated plants, but one or two allied species are also largely grown in Polynesia, especially the gigantic kape (*Alocasia macrorhiza*). How far either it or the true taro is indigenous in the Pacific islands it is almost impossible to say, from the readiness with which they establish themselves in swampy places or on the banks of streams, in a very short time presenting all the appearance of true natives. Both are often cultivated in artificial ponds or swamps, frequently of large size, and fed by runlets of water conducted from the nearest stream. The construction of these ponds must have involved a very large amount of labour, considering the imperfect tools employed.

Five or six species of yams are grown in Polynesia, in some of the islands to a very large extent. In Fiji their cultivation was of so much importance that the months received special names from the class of work that had to be done at those particular times in the yam plantations. Some of the species are doubtless indigenous, but others are almost certainly introduced, probably from tropical Asia or Malaya.

Passing several cultivated plants of minor importance, we will now take into consideration the one which Mr. Walsh has brought under your notice—the *Cordyline terminalis*, or the Ti pore of the Maoris. This is undoubtedly a true native of Polynesia, stretching from the Kermadec Islands in the south to the Sandwich Islands in the north, and in an east-and-west direction ranging from Tahiti to Fiji. It also extends to North Australia, and through the Solomon Islands, New

Guinea, and the Malay Archipelago as far north as India and Malacca. It is largely planted in most of the Pacific islands, mainly for the sake of the huge tuberous root, which often weighs from 10 lb. to 15 lb. This is usually wrapped up in leaves and baked on hot stones, and is often mixed with the root of the kape, or gigantic taro. It cooks slowly, and in Rarotonga I was told that the baking of a good-sized parcel often extends over a whole day. It has a sweetish, sugary taste, which has been compared to that of stick-liquorice. In the Sandwich Islands the roots were bruised and mixed with water and then fermented, forming an intoxicating drink, but this practice does not seem to have been known in the southern Pacific. The introduction of European foods and customs has largely interfered with the use of the Ti pore, but in the olden days it constituted a very appreciable portion of the diet of a Polynesian. It is therefore in every way probable that its introduction would be attempted when the Maoris colonised New Zealand.

So far as botanical inquiry has been made into the origin of the common food-plants of Polynesia, it certainly seems to point to the belief that most of them are introductions from abroad, coming in the majority of cases from the direction of the Malay Archipelago or eastern tropical Asia. And it appears to me that this view is in harmony with the traditional history and legends of the Polynesian race, although my limited knowledge of these causes me to make the statement with some little hesitation. The actual introduction of the plants must have taken place at some far remote period, in order to give time not only for their spread through most parts of the Pacific, but also to allow of the gradual selection of so many different local varieties, in itself a proof of long-continued cultivation. The question as to how they entered Polynesia—whether they simply passed step by step from one tribe to another along the chain of islands connecting Malaya with the southern Pacific, or whether they were brought by the Polynesians themselves on their gradual advance southwards—is a matter which cannot be dealt with here.

Before going further I wish to make another point perfectly clear, which is this: that the Polynesians were not only great cultivators, but that they regularly carried cultivated plants from one part of the Pacific to another. Of course, this statement follows naturally on the assumption that the cultivated plants are not indigenous, and it is also supported by many traditions. But it must also be true if we assume that the cultivated plants are natives of Polynesia. For, even on this hypothesis, we cannot state with any reasonable degree of probability that all the food-plants are natives of every one of the hundreds of islands on which they are cultivated from Fiji to Hawaii. Such a statement would not be supported by any of the known facts of botanical distribution. Under any tenable theory, there must have been numerous stations where some of them did not exist, and which were stocked by human agency.

During recent years the traditional history of the various parts of Polynesia has been closely scrutinised and compared. Of course, many points are still doubtful, and many questions of interest may never be solved; but sufficient has been established to warrant the statement that at one time the Polynesians regularly navigated the Pacific, between the Sandwich Islands in the north and New Zealand in the south. And, so far as the latter country is concerned, there is every reason for believing that for some centuries there was no infrequent communication between it and the central Pacific. Not only did Polynesians reach New Zealand, but they returned, bringing back with them a knowledge of the country and its productions. From such voyages the Polynesians learned the existence of the much-prized greenstone, and of the moa, so easily hunted and yielding such tempting food. And when it was at length resolved to colonise this country there can be no doubt that the "Arawa," "Tainui," and the other well-known canoes of Maori history which constituted the fleet carrying the immigrants, were steered by people who knew well what direction to take and what the duration of the voyage would probably be. It may be good painters' license to represent the Maoris arriving in New Zealand as a famished crew that had lost their way on the Pacific and were at death's door, as is the case in a well-known painting now exhibited in this city, but it may be doubted whether this was the usual result of these voyages.

As it can be considered as proved that the Polynesians, in colonising the various islands of the Pacific, stocked them with their special cultivated plants, or, at any rate, with those that were not actually indigenous, so when they came to attempt the greater task of peopling New Zealand there can be little doubt the same practice would be followed. We know that they succeeded in establishing the kumara, the taro, the hue, and the aute. Mr. Walsh has shown that in all probability they also brought the Ti pore. We are acquainted with their successes; of their failures we know nothing with certainty. But we can well imagine the attempts that they would make to acclimatise the banana, the bread-fruit, and possibly the cocoanut, and the disappointment they would feel in failing to establish the three staple food-plants of the Pacific.

Art. XXXIII.—*Some Recent Additions to the New Zealand Flora.*

By T. F. Cheeseman, F.L.S.

[*Read before the Auckland Institute, 15th October, 1900.*]

Caltha obtusa, n. sp.

Smaller than *C. novæ-zealandiæ*, seldom more than 2 in. high. Leaves smaller; blade broader, wide-ovate or almost rounded, coarsely dentate, notched at the apex, 2-lobed at the base; lobes turned upwards and appressed to the surface, toothed. Flowers white, ½ in. diameter; at first sessile amongst the uppermost leaves, but the scape elongates in fruit. Sepals 5, oblong, obtuse or subacute, broadest above the middle. Stamens 10–15. Carpels 5–8, narrow-ovate; style long, slender. Ripe fruit not seen.

North Island: *Herb. Colenso !* (probably from the Ruahine Range, but without locality or collector's name). South Island: Mountains at the head of the Broken River, Canterbury, 5,000 ft. – 6,000 ft., *T. F. C.;* Otago — Mount St. Bathan's and Dunstan Mountains, 5,000 ft.–6,000 ft., *Petrie !;* Black Peak, 6,000 ft., *Buchanan !*

The white flowers and blunt oblong sepals distinguish this at once from *C. novæ-zealandiæ*, but in a flowerless state it is easily mistaken for a dwarf form of that plant, although the leaves are always broader and coarsely dentate. The sepals are markedly different from the long, tapering, almost caudate sepals of *C. novæ-zealandiæ*. I have not been able to compare it with the Australian and Tasmanian *C. introloba*, which is said to have white flowers, but, judging from descriptions, it is amply distinct.

Chiloglottis formicifera, Fitzgerald, Austral. Orchids, i., 3 (1877).

A small delicate herb, 2 in.–3 in. high. Leaves 2, at the base of the stem, sessile, 1½ in.–2 in. long, linear-oblong or oblong-lanceolate, obtuse, thin and membranous; margins often undulate when fresh. Scape 2 in.–3 in. high, robust, 1-flowered, with a single sheathing bract towards the top. Dorsal sepal erect, linear-spathulate; lateral sepals about the same length, narrow linear-spathulate, acuminate. Petals linear-lanceolate, deflexed by the side of the ovary, rather longer than the sepals. Lip horizontal or ascending, contracted at the base into a long and narrow claw, above suddenly expanded into a short and broad spoon-shaped or rhomboid lamina, the tip of which is usually reflexed. Numerous glands occupy the median portion of the lamina, the largest of which is placed at the base, and projects with a kind of double head towards the column. Rows of smaller glands reach the tip of the lamina, and at the sides of the larger ones are smaller stalked calli. Column rather shorter than the upper sepal, broadly winged.

North Island: Vicinity of Kaitaia, Mongonui County, *R. H. Matthews!*

This is a most interesting and unexpected addition to our flora. Mr. Matthews's specimens agree in all respects with the beautiful plate in Fitzgerald's "Australian Orchids."

Art. XXXIV.—*Plant-acclimatisation in New Zealand.*

By George M. Thomson, F.L.S.

[*Read before the Otago Institute, 10th July, 1900.*]

A European botanist landing at any one of the principal ports of New Zealand would be at once struck with the distinctively British facies of the vegetation. Perhaps this impression would be most vividly produced at Lyttelton and Christchurch, and least of all at Dunedin, for here the comparatively good state of preservation of the native bush in and about our Town Belt, and the proximity of so much high uncultivated land, have left more of the indigenous vegetation than is to be seen in the neighbourhood of any other of our large towns. The causes which have led to the displacement of so much of the native flora as has disappeared, and to the naturalisation of so many foreign species of plants, are numerous and in many cases not easily traceable; the facts themselves are conspicuous enough, even though the explanations may not be forthcoming.

In bringing this subject before you I am not going to attempt at all to catalogue our introduced plants. That, I hope, will be done in the completest manner by Mr. Cheeseman in the Flora which he has now in preparation. What I desire to do is to suggest reasons for the great increase and aggressive character of some forms, and also for the failure of others to establish themselves under what seem at first sight equally favourable conditions. Why, for instance, should gorse and broom, cooksfoot grass and meadow poa (*Poa pratensis*), establish themselves so strongly as to become serious pests in many parts, while attempts to introduce many favourite flowers and to get them to grow as wild flowers always end in failure? This aspect of the subject has received but little attention hitherto, yet it is an extremely interesting point of view from which to consider it.

When we speak of plant acclimatisation, or, more correctly, naturalisation, in New Zealand we mean within historic times. Probably the ancestral forms of all existing species of plants in the country were introduced at one time or another from adjacent lands, as the relationship of our indigenous flora with that of Australia, of the antarctic region, of Polynesia, of South America, and of Eur-Asia is more or less distinctly traceable. But though we may in some cases almost infer the comparative age of some of our species from finding identical or slightly different forms in adjacent countries, we cannot arrive at any definite information on the subject. Very little is yet known about the fossil flora of these Islands, and until this has been studied very little light can be thrown on the origin of our flora. When, however, we limit our investigations to the species introduced within the epoch comprised within such times as the Islands have been known to Europeans we have in many cases perfectly definite information, and in regard to all have a certain amount of sure knowledge. A few plants were certainly introduced by the Maoris from the South Sea Islands—*e.g.*, the kumara (*Ipomœa chrysorrhiza*), the taro (*Calocasia antiquorum*), and the hue or gourd (*Cucurbita* sp.)—but these occur only on the site of former native settlements, and show no tendency to spread, and barely even to hold their ground.

The Rev. Richard Taylor, in "Te Ika a Maui," speaking of the occurrence of *Clianthus puniceus* in the neighbourhood of native pas, tells a story which was related to him about the reputed introduction of this plant. A French vessel was captured in the Bay of Islands, and many of the boxes were emptied on a small island in the Kerikeri River, and were found to contain nothing but seeds. A few years later the whole island was covered with *Clianthus*, the beauty of its flowers attracted attention, and the seeds were carried about to all parts by the natives. Taylor, who was an unscientific man, thinks there is some probability in the story. But species do not arise in this sudden manner from nowhere in particular. There are only two species of *Clianthus*—an Australian species (*C. dampierii*), known as Sturt's "desert pea," and the New Zealand *C. puniceus*. Their unique form and difference from all other genera of *Leguminosæ* point to considerable antiquity for the genus, and their diversity of detail from one another to a considerable age also for the species. The probability is that our species would either have become very rare or have altogether disappeared, as some other large conspicuous plants have done, had it not been that the natives sowed the seeds in the vicinity of their pas for the sake of the flowers, which they used to stick in their hair or their ears for ornament. Why I suggest the disappearance is that the plant is probably edible and nutritious, and there would seem to have been some form or forms of animal life introduced since the development of the species which was tending to exterminate it.

A case somewhat corresponding to this is actually furnished by the large forget-me-not, misnamed the Chatham Island lily (*Myosotidium nobile*). This handsome plant is much more nearly allied to Australian species of *Cynoglossum* than to any existing New Zealand genus. I think, therefore, that it must formerly have been spread over these Islands, but that it has died out, or, more probably, been eaten out by some more recent form of animal life, perhaps by moas, which were formerly enormously abundant, and were vegetable-feeders.

The real history of plant-naturalisation here dates from Cook's first visit to the Islands.

The modes by which the naturalised plants of any country are introduced may be considered under four heads—(1) The deliberate scattering of seeds in the open ground or in selected localities; (2) as escapes from cultivation in gardens, orchards, or fields; (3) accidental, along with other seeds, or with hay, straw, packing, &c., with introduced varieties of plants or animals, or in ballast of ships; and (4) by wind, birds, &c.

(1.) In regard to the first of these modes, the remarkable thing is not the number of species of plants which have been introduced and naturalised in this manner, but rather the smallness of the number of those which have so established themselves as compared with the number of those which it has been sought to introduce. Hooker records in the "Handbook of the New Zealand Flora," page 757, that "the late Mr. Bidwill habitually scattered Australian seeds during his extensive travels in New Zealand. If this be true, it is remarkable how few Australian plants have naturalised themselves in the Islands, considering both this circumstance and the extensive commerce between these countries." The same experience has accompanied very numerous attempts since Bidwill's time to introduce what were considered desirable species. I do not know that it is possible to point with certainty to a single species which has thus become established in this part of the colony. It is just possible that the watercress (*Nasturtium officinale*) was so introduced by the early settlers into the Canterbury Plains, though I have no information to that effect, while it is equally possible that its introduction was accidental. Similarly, it would appear* that the Cape water-lily (*Aponogeton distachyon*) was planted in the streams about Waimate by the early missionaries. Of course, the scattering of grass- and clover-seeds on burnt lands, on farms, and sheep-runs comes under this category, but, with these exceptions, I cannot suggest any other examples.

It must very frequently have been the case during the past fifty or sixty years that persons, from motives of sentiment, have sown broadcast the seeds of flowers which they admired or were familiar with in the neighbourhood of their early homes in the Old Country, and which they thought would thrive here on account of the similarity of soil and climate. This is particularly true of such flowers as violets, primroses, cowslips, bluebells, heaths, &c., and of fruits like the bilberry (or blaeberry) and cranberry. But these plants do not, as a rule, belong to what may be called aggressive species. They cannot always succeed even in growing in open competition against the indigenous vegetation, and they never make the slightest headway against many of the vigorous introduced forms. Even where individual plants become established, they nearly always fail to produce seed, and this is the chief reason why such species do not become naturalised. In their native countries their flowers are visited and fertilised by certain species of insects, and these are totally wanting here. Our indigenous insects are unable to fertilise them, and so they do not produce seed. There are no doubt other differences which affect their success in the struggle for existence. The rapidity of germination of their seeds, the subsequent rapidity of growth of the young plants, and many other factors, which have not been sufficiently looked into in this connection, all bear on this question. I have in past years sown quantities of the seeds of many flowering-plants of Great Britain along the wayside in one of the suburban roads leading through our Town Belt, but from none of them have plants appeared except from those of foxglove, whose strong coarse foliage enables it to hold its own against most of its neighbours. If the others have germinated they have nearly always been smothered by cocksfoot or other coarse grass. In gardens many of our European flowers seed now on account of the general prevalence of humble-bees, but many others remain unfertilised.

(2.) Escapes from cultivation are much more common, and a few of these have succeeded in establishing themselves. Those who have travelled to any extent in the colony will, no doubt, recall numerous instances of this. Jungles of scarlet

* Trans. N.Z. Inst., vol. ii., p. 143.

geranium, fennel, parsnip, and other garden plants are common in waste ground about Napier, Auckland, and other towns, particularly in the North Island. Such plants are either fertilised by hive-bees or by various kinds of flies, or are perfectly self-fertile. In the Bay of Islands and elsewhere in the North I have noticed the American aloe (*Agave americana*) and the common flag-lily (*Iris germanica*) growing on the sites of abandoned gardens. At Kerikeri I saw, in 1884, groves of wattles (probably *Acacia decurrens*, var. *dealbata*), and these apparently were spreading in all directions; and the late Mr. Kirk recorded in 1872* that *Robinia pseudacacia* was similarly establishing itself in a grove on the Auckland–Drury Railway.

In our own southern portion of the colony such garden escapes occur freely, though not to the same extent as in the warmer climate of the North Island; yet of late years they have increased from a new and recently introduced cause. Foxgloves, musk, monkey-flowers (*Mimulus luteus*, var.), mullein, and a few other flowers have run wild in many localities, but they do not show any tendency to become generally distributed. On the other hand, the great increase in number of our imported fruit-eating birds (blackbirds and thrushes) during the last twenty years has led to a remarkable increase and a much wider distribution of plants bearing succulent fruits. Thus, the elderberry has become a nuisance in our Town Belt, while to a less extent wild roses, brambles, raspberries, and gooseberries are spreading, and this always in the neighbourhood of bush- or scrub-covered land. Similarly, I find such plants as Cape fuchsia (*Leycesteria formosa*), holly, barberry, and mountain-ash (and the list might easily be extended) appearing not only in various parts of my garden, but also in places at some distance from it. In all the cases mentioned above it is noteworthy that the flowers are visited, and almost certainly fertilised, by bees and flies, and are not dependent on any specialised form of insect for their seeding. It may be accepted as a general rule that cultivated plants are not well fitted to compete unaided in the hard and complex struggle for existence against wild species. Hence we do not find them holding their own in the open, except in a few cases.

(3.) In regard to the introduction of naturalised plants by accidental means—viz., along with seeds, hay, straw, &c., in the soil surrounding other introduced plants, by animals, in ballast of ships, or in any other chance manner—this is certainly the source or mode in which by far the greatest number of such aliens have come to these Islands. Agricul-

* Trans. N.Z. Inst., vol. ii., p. 137.

tural seeds are especially responsible for the majority of our most common weeds, and I have given an example of this in the first paper read by me before this Institute.*

It is evidently the case that weeds of cultivation, such as chickweed, shepherd's purse, groundsel, &c., must have developed their special characteristics within comparatively recent times—that is to say, they have developed them *pari passu* with the development of cultivation of the land by the human race. This, from the naturalist's point of view, does not point to any great antiquity.

An examination of any list of the naturalised plants of a district—for example, that of the plants of Port Nicholson by the late Mr. Kirk,† or that of our own immediate neighbourhood issued a couple of years ago by the Dunedin Field Club—reveals certain interesting general facts. Thus all, or nearly all, are capable of self-fertilisation, if they are not habitually self-fertilised. If one looks at the weeds in any unkept bit of garden-ground at the present midwinter season (July), they will probably find some or all of the following species producing seed in abundance from flowers which never open and which are more or less imperfect in structure: Shepherd's purse (*Capsella bursa-pastoris*), winter-cress (*Barbarea vulgaris*), bitter-cress (*Cardamine hirsuta*), hedge-mustard (*Sisymbrium officinale*), wart-cress (*Senebiera didyma*), chickweed (*Stellaria media*), mouse-ear chickweed (*Cerastium glomeratum* and *C. triviale*), groundsel (*Senecio vulgaris*), sow-thistle (*Sonchus oleraceus*), spurge (*Euphorbia peplus*), and perhaps various others. This faculty of producing more or less imperfect self-fertilised flowers is almost an essential feature in all such plants, many of which are thus enabled to produce fruit at all seasons of the year, and almost independent of the weather. It is perhaps the most characteristic feature about them. Another point is that most of them produce very small and very numerous seeds; and still another, that a large proportion of them come to maturity very rapidly, and that their seeds germinate quickly. These characters are all retrogressive from one point of view—that is to say, the plants exhibiting them have tended to become less instead of more specialised in their development; but by this degradation of their reproductive organs they have really become better adapted for the peculiar conditions which are imposed upon them in their struggle with the gardener and agriculturist.

(4.) I am not aware that any plants naturalised within historic times have been introduced by means of either wind,

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* Trans. N.Z. Inst., vol. ix., p. 538.
† Trans. N.Z. Inst., vol., x., p. 362.

birds, or insects, though there is no inherent improbability in this mode of introduction. Many of us can recall the sultry day a few years ago when the sky was darkened and the sun became lurid from the dense smoke of Australian bush-fires, and it is quite clear that light seeds and spores might very easily be carried along at considerable elevations by a similar westerly wind. Many of our native species of flowering-plants are either identical with or closely allied to Australian forms, and this is particularly the case with such plants as the pappus-bearing composites—*e.g.*, *Celmisia longifolia*, *Craspedia fimbriata* and *C. alpina*—several species of *Erechtites*, &c., and the various species of *Epilobium* (*E. confertifolium*, *E. glabellum*, *E. junceum*, &c.), which have a tuft of hairs on the seeds.

Again, on the west coast of the North Island, and particularly on the peninsula north of Auckland, Australian birds have been met with which had managed to survive the long flight across the Tasman Sea. Such birds are probably weak from exhaustion on reaching the shore, and are killed by gulls or other enemies, those which survive dying in the course of time without reproducing their kind. Such birds may bring seeds in their crops or stomachs (though this is not very likely after such a long flight), or they may have seeds attached to their feet or their feathers. Both the cuckoos, too, come to us from across the seas—one from Australia and the other from the South Sea Islands; while migratory birds like the sandpipers, &c., travel vast distances from shore to shore. Yet, with all these possible modes of conveyance, we cannot point to a single instance of plant-naturalisation due to these agencies.

A large proportion of the plants which have succeeded in establishing themselves in this country belong to what Sir Joseph Hooker has called the "Scandinavian flora," the aggressive and colonising power of which has been dwelt upon by him, by Charles Darwin, and by A. R. Wallace. Darwin's explanation, it may be remembered, is that this power of colonising is due to the development of these plants in the most extensive land-area of the globe, where competition has been most severe and long continued. A discussion on this subject will be found in the chapters dealing with the flora of New Zealand in Wallace's "Island Life," and much additional information is also given in his "Darwinism."

There are one or two aspects of this question of plant-naturalisation which have not yet received much investigation, though they are very interesting.

Often when a species is first introduced into a country or district it exhibits most extraordinary vitality for a time, and then appears gradually to lose its exuberance of growth, and to assume a more normal rate of individual development. It is as if the restrictions which formerly kept it within certain limits had been removed, and it sprang with a bound to a height of vigour which it was not able to maintain, and then had gradually fallen back to a level at which it could maintain itself. Anglers recall the marvellous rapidity with which trout grew when they were first put into our streams. The food-supply was practically unlimited, and they increased most remarkably in size and weight. But succeeding generations have not been able to keep up the same phenomenal rate of growth, for not only is the food-supply diminished, but the young fish have to run the gauntlet of the old ones, which are their worst enemies. This factor does not, of course, enter to anything like the same extent into the relations of plants to one another, but it is to be taken into account in considering that well-established plants are most formidable rivals to the seedlings of their own kind round about them. A somewhat analogous case seems to be that of the humble-bees. During the first few years after their liberation in Canterbury these insects increased enormously in numbers, and bee-keepers frequently expressed the opinion that they would soon crowd the hive-bee out of existence. But, as far as I can make out, this rate of increase has not been maintained, and these insects are now by no means troublesome on account of their numbers.

The same phenomenon has been witnessed in the case of some plants. The marvellous growth of watercress in the streams of the Canterbury Plains, producing as it did stems of 12 ft. in length and ¾ in. in diameter, has often been adduced. But I do not think that this huge type of growth has been kept up to any extent, though I am open to correction on this point. As far as I have seen it about Christchurch, the plant seems to grow larger than the parent plants in Britain, but it does not attain its former recorded dimensions.

When the Oamaru district was first ploughed the common thistle (*Carduus lanceolatus*) took absolute possession of the soil. I remember walking in 1872 through many hundreds of acres on the Balruddery and Elderslie properties, between the Waiareka and Kakanui Rivers, and the only available track was on the dray-ruts, and even there the thistles were waist-deep, while on both sides they formed a wall 6 ft. or 7 ft. high. During the first year or two of their occupation not a blade of grass or other plant could show itself, but afterwards the ground seemed to become somewhat sick of thistles. Meanwhile the soil was enriched by the plentiful supply of vegetable matter which was produced on it and ultimately worked in again, the subsoil was penetrated by the roots, which decayed in it and thus helped to decompose and break it up, and on such soil 50 and 60 bushels of wheat were taken off per acre immediately after the thistle-crop.

No doubt numerous other cases of the same kind could be adduced, and it would be interesting to find out whether such individual development anywhere tends to be maintained, and, if so, whether it tends to the production of any permanent variety. I think it possible that the development in the past of such large species of plants as *Myosotidium nobile*, *Aciphylla squarrosa* and *A. colensoi*, *Ranunculus lyallii*, *Ligusticum latifolium*, and *Pleurophyllum criniferum*, all of which are giants as compared with their nearest relations, is due in great part to their isolation in these Islands, and the comparative absence of severe competition.

Another curious change which has been noticed as taking place is the adaptability of some of our indigenous plants to the changed conditions brought about by settlement. Some of the native species appear to be able to hold their own, and even to benefit by these altered circumstances. I have already recorded the fact that, with the increase of blackbirds and thrushes, many succulent-fruited plants have become widely dispersed. This is true of native as well as of introduced species. Fuchsias are increasing, not diminishing, in numbers in the Town Belt, and in my garden I find a species of *Coprosma* (*C. robusta*) and the common cabbage-tree (*Cordyline australis*) coming up where none were sown, and where I do not remember any growing naturally for some twenty-five years. The fruit of the latter is often eaten by starlings, and thus distributed. Again, some creeping plants furnished with rooting stems or underground stolons are able to spread in cultivated ground and in pasture. I have noticed three species particularly aggressive—viz., *Epilobium nummularifolium*, *Hydrocotyle asiatica*, and *H. muscosa*.*

Note.—In "Darwinism," p. 29, 2nd edition, 1889, Wallace quotes W. T. L. Travers, and, apparently on his authority, states that "the most noxious weed in New Zealand appears, however, to be the *Hypochœris radicata*, a coarse yellow-flowered composite not uncommon in our meadows and waste places. This has been introduced with grass-seeds from England, and is very destructive. It is stated that excellent pasture was in three years destroyed by this weed, which absolutely displaced every other plant on the ground. It grows in every kind of soil, and is said even to drive out the white-clover, which is

* The Rev. A. Don, Chinese missionary, states that *Raoulia australis* is greatly on the increase in the interior of Otago. It is one of the few plants which is not being eaten out by rabbits.

usually so powerful in taking possession of the soil." This is a rather overstated case. The *Hypochæris*, or cat's-ear, usually misnamed Cape-weed with us, is only troublesome where sheep cannot get at it. But on sheep-runs and farms on which sheep are fed the plant disappears, as these animals eat it down to the ground, and so completely eradicate it.

The following notes by Mr. D. Petrie are supplementary to the above paper:—

(1.) A leading fact which might have been emphasized more is that the spread of weeds is mainly due to useful plants—their competitors—being regularly checked and eaten down, while the weeds are mostly allowed to grow without check of any important nature. Almost all weeds found in our northern pastures owe their spread to this—*e.g.*, several buttercups, numerous docks, pennyroyal, *Holcus mollis* and *H. lanatus*, and many weedy grasses, various spurges, mallows, mulleins, and so forth. In many cases their spread is facilitated by the ready germination of their seeds, by the long time that the seeds retain their vitality in the soil, and by the readiness with which their earliest roots strike deep down into the soil, which allows the plants to establish themselves in hot, dry weather. Black medick (*Medicago lupulina*), meadow plantain (*Plantago lanceolata*), the docks and spurges, all start and thrive in hot, dry weather, when more superficial-rooting seedlings die off. The introduced speedwells and poor man's weather-glass (*Anagallis arvensis*) are much in the same case.

(2.) The decline of plants that have taken possession of a district for some years is no doubt due to temporary exhaustion of some element of plant-food needful for their vigorous growth. This principle lies at the base of the theory of the rotation of crops. In Central Otago. when I first knew it, *Carduus lanceolatus* was the prevailing weed on open downs and dry hill-slopes. Some years after *C. pauciflorus* completely replaced it, and this will, no doubt, be now giving way to something else. The doctrine that the Scandinavian plants possess extraordinary vigour, which is the cause of their aggressive character, seems to me very doubtful. In each single species particular advantages can generally be assigned that will readily explain their rapid spread. In the peninsula north of Auckland there are very large areas of land on which European weeds have but slightly established themselves, though the ground is frequently cleared of all native vegetation by fires. In these areas native plants mostly grow up with great readiness, especially species of *Leptospermum* and *Pomaderris*, *Haloragis tetragyna* and *H. minuta*, besides various cyperaceous plants. The pre-eminence in aggressive characters of North European plants is decided enough, but many non-European plants are now widely spread here, and are, indeed, very aggressive. I may instance *Modiola multiflora*, a North American malvaceous plant, an Australian *Plantago*, two species of *Erigeron*, and *Kyllinga*. The rat-tail grass, too, is no doubt introduced, and has been most aggressive, while the South African *Cyperus* (*minimus*?) is nearly as ubiquitous as sorrel.

(3.) The agency of birds in scattering seeds is most noticeable here (Auckland). The Cape gooseberry, the blackberry, and the inkweed (*Phytolacca*) are now spread over vast areas entirely through their agency.

(4.) Here, as in the South, a few native plants are spreading—*e.g.*, *Haloragis tetragyna*, *H. minuta*, *Aristotelia racemosa*, *Fuchsia excorticata*, *Pomaderris phylicifolia*, *Erechtites*, &c.; but the most aggressive plant of all is *Pteris aquilina*, which is rapidly overrunning much of the land that has been cleared of bush, and which permanently establishes itself before roots are sufficiently decayed to admit of ploughing.

(5.) I suppose our most abundant and most widespread introduced weed is *Hypochœris radicata*. This furnishes a good example of the mode in which an aggressive plant spreads. Its seeds germinate easily, the roots strike down to the moist layer promptly, the rosulate leaves keep neighbouring plants from encroaching on it when established, and the seeds when mature are wafted afar by the wind. Add to this that cattle and horses will not touch it, and its rapid and universal diffusion calls for no special constitutional vigour. The specific advantages thus assigned sufficiently account for its spread. I do not know of any reason for thinking its seeds possess long vitality, but in spite of this drawback it has advantages enough to fully explain its predominance. We found it on the topmost rock of Mount Hikurangi (5,500 ft.), on the east coast, where the wind must have brought it from many miles' distance. It was the only weed that we noticed on that mountain, a region which has never been reached by cattle, sheep, or horses, and has never been overrun by fire. Again, take the case of sorrel. It is widely spread by seeds, which are eaten but not injured or digested by grazing animals, and it spreads by underground runners with great quickness. It forms large tufts of foliage that keep off or smother competitors in grazed land. These facts seem to me enough to account for its spread without postulating any special constitutional vigour. Most other cases of aggressive plants are, I think, to be accounted for by special advantages of habit and growth, and these are matters that will well reward studious inquiry.

Art. XXXV.—*On the Regrowth of the Totara.*

By Joshua Rutland.

[*Read before the Wellington Philosophical Society, 16th October, 1900.*]

Of the four trees—kahikatea, matai, totara, and rimu—on which the sawmills of the Pelorus have been mainly dependent since the establishment of the timber industry in the district the totara was by far the scarcest, yielding probably not more than 1 per cent. of the sawn timber produced; yet of all the *Coniferæ* occurring in the Pelorus the totara was the most generally distributed. Dividing the land into three classes, hill-sides, level terraces, and alluvial flats, to the terraces and flats the kahikatea and matai chiefly belong, the former growing in the damper and swampy portions of the ground, the latter on drier soil. The rimu was restricted to the hills and terraces, the totara being scattered over the three descriptions of land without displaying a decided preference for any. On steep hill-sides, on the stony soil of the terraces, and on the rich alluvial land it attained dimensions which entitled it to be considered "king of the forest."

On the shores of the Pelorus Sound, where the vegetation was especially vigorous, keikei, supplejack, and other climbing plants converting the forest in many places into an almost impenetrable jungle, the totara was extremely scarce. In the Rai Valley, where, owing to the scarcity of climbers, the bush is comparatively open, the totara is most abundant. Along the summits of the ranges inland and bordering the Sound there still is in many places a narrow but almost continuous belt of the mountain totara, the *Podocarpus hallii* of the late Mr. T. Kirk.

Looking back to the sixties, on the abandoned Maori clearings, which occupied most of the alluvial land in the lower Pelorus Valley, there were numbers of young totara-trees from 12 in. to 15 in. in diameter down to mere rods, standing singly or in clumps, and forming a conspicuous and very attractive feature in the vegetation of the partly open land. Within the shade of the adjacent forest small totara-trees were scarce; in addition to the giants already referred to, trees of useful size and saplings were dotted about, generally singly and far apart.

In swampy places the kahikatea monopolized the ground, on the better-drained alluvial land matai predominated, and on the hilly land rimu occupied extensive areas; but, excepting the narrow belts of mountain totara, the young trees on the Maori clearings, and a few small clumps of larger growth in the Rai Valley, totaras nowhere congregated. Throughout the forest they stood generally solitary, surrounded by trees of different species.

On Mr. Farnell's property, in the Kaituna Valley, an explanation of this singular distribution may now be seen. Here, scattered over the grass land on hills and flats, are numbers of young totaras. Mr. A. T. Cavell, who kindly obtained the particulars of these trees for me, writes: "I visited Mr. Farnell as promised and saw the prolific growth of totara. It is really impossible to say how many to the acre, as, like young birch-trees, they grow in patches. In one place I saw about thirty nice young trees in a space 15 ft. square, while it is quite common to see three, four, and five in a bunch. They grow freely, and Mr. Farnell assured me that they transplant easily. The largest, near Mr. Farnell's house, measures 52½ in. in girth 6 in. from the ground. There are any number measuring from 25 in. to 45 in. in girth, and all of these, including the large one, are less than twenty years old. The large one is one of the dark-coloured species." In other parts of the district the same thing may be observed, but, cattle being generally kept on the farms, only a few of the totara seedlings escape destruction. During twenty years sheep alone have been depastured on Mr. Farnell's property.

Evidently the totara belongs to the open land, and not to the dense bush; hence its congregating on the ridges of hills, where it cannot be overshadowed by other trees, and its being most plentiful in the Rai, where the forest is comparatively open. From the appearance of the bush in one part of the Rai, large totaras standing amongst trees of much smaller growth, it occurred to me that the land had at some remote time been artificially cleared, and in writing on Maori matters I ventured to say that probably traces of human occupation would be found there. Since then the clearing of the land has brought to light ovens and other remains; thus from these forest giants historical data may be gathered.

Where the mixed bush escapes fire after the milling timber has been removed young kahikatea, matai, rimu, and totara come up in their proper places, but along with them quicker-growing trees, shrubs, and climbers also spring up in a much larger proportion. These are conditions fatal to the young totara, but apparently essential to the other species, which grow rapidly, running up into tall slender rods, and subsequently increase slowly in girth.

The abandoned pit-dwellings of the ancient Moriori inhabitants, with large forest-trees growing in and close around them, prove beyond question that much of the bush on the shores of the Pelorus Sound was a regrowth. Though nothing could have been more beautiful or more interesting to a botanist than the tall evergreen trees, draped with climbing plants and loaded with epiphytes, beneath whose shade nikau palms, tree-ferns, and other tropical forms enjoyed an almost continuous spring, commercially this regrowth was of little value. Even on the level land it did not yield more than 5,000 superficial feet of marketable timber per acre.

Of all the marketable timber-trees the totara is the only one that might be artificially produced on a large scale without a great expenditure. From what naturally takes place it seems only necessary, after the present crop of forest-trees has been felled and burned off, to sow the land broadcast with totara and grass seeds, excluding cattle, but allowing sheep to run over the ground in order to keep down other woody plants.

The totara forest might be reproduced by raising seedlings in nurseries and transplanting; but this would be a costly process. In England it has been proved that transplanting forest-trees shortens their existence. By sowing the land with seeds the New Forest was created in the eleventh century, and in the same way has been renewed ever since. In a very interesting article, dated Lyndhurst, 1892, the writer, who had evidently much information at his command, thus compares the effects of the two ways in which the English forests have been artificially produced: "There has been a great dispute as to whether the grand forests which have survived from the Middle Ages were sown or planted, but it is now pretty well settled that every tree has grown from seed in the place where it stands. There are, of course, plenty of planted forests, or woodlands, in England, but not ancient ones. The trees which William the Third planted at Hampton Court, at Bushey, and at Kensington are an example. They are now about two hundred years old, and their days are already numbered. They all show signs of age, and one by one they are dying. Planted trees, in fact, do not live more than about two hundred years, even when taken the best care of, and many of them decay much earlier. Trees grown from seed in the place where they stand, on the other hand, are everlasting, and, under fair conditions, never decay. The oaks, beeches, and birches which were sown in the New Forest in the eleventh century are as vigorous now as they were at a year old, and there is no reason why they should not be as vigorous eight hundred years hence. There are trees in the forest, indeed, which are much older than the forest. I went a few days ago to see the Knightwood oak, in a secluded part of the forest about three miles from here. It is an enormous tree, one of the largest in England, with a vast trunk branching at a height of 20 ft. into eight main boughs, each as large as a large tree, and spreading so far that they need to be supported on props. This tree is mentioned in 'Domesday Book' as being famous for its size and antiquity. Now, 'Domesday Book' was written in 1085–86, so that, allowing only two hundred years for the Knightwood oak to have attained a growth that made it famous then, it must now be more than a thousand years old, yet it is full of life and vigour, and to all appearance is sound at heart. It makes each year a good deal of dead wood owing to the enormous stretch and interlacing of its branches, but with a little skilful trimming it may flourish for centuries to come—always, of course, barring storms and lightning. Close to the Knightwood oak are several groups of gigantic beeches undoubtedly belonging to the same period with the oak, before the forest was laid out. These magnificent trees seemed to have formed a small plantation by themselves, and probably belonged to some religious house, or perhaps to the dwelling of some Saxon thane, the history of which is forgotten. They are not the only instances of the kind, for in several other parts of the forest are groups of trees, or distinctive plantations, which evidently belong to an age before the Conquest, and which were carefully preserved and planted in by William's men."

In the portion of Marlborough north of the Wairau River care is necessary to prevent the land taken from the forest being overrun with brambles, briars, St. John's wort, manuka, tawhinau, and other woody plants, none of which spread on the natural grass land of the adjacent Awatere district. Possibly the tendency of the forest country to revert to an arborescent vegetation might be turned to account. The low lands, to which the mixed bush was chiefly confined, cannot be spared for timber-growing, but there are within the forest country large areas of hilly land unsuitable for pasture now being overrun with fern and other troublesome plants owing to repeated fires. If this land could be replanted with useful trees without a great expenditure of labour it would be a positive gain.

Like our totara, many of the European and North American *Coniferæ* reappear after the forest has been destroyed by fire.

Probably some of those trees suitable to the situation and climate might be propagated by sowing the seed on the ash-covered ground after bush-fires. One of the Australian hakeas which I introduced from Nelson some years ago can be grown in this way.

Art. XXXVI.—*Descriptions of New Native Plants.*

By D. Petrie, M.A.

[*Read before the Auckland Institute, 25th February, 1901.*]

Danthonia planifolia, sp. nov.

Stems solitary, not tufted, 1 ft. high or less, having one or two young branches at the base, slender, glabrous, clothed below with the withered sheaths of old leaves, sparingly leafy. Leaves less than half as long as the culms, glabrous; the sheaths dilated, striate, pale-yellow; the blades flat, acute, in the cauline leaves much shorter than the sheath; ligule a band of longish slender hairs. Panicle ovate, open, about 2 in. in length; branches and pedicels silky. Spikelets few (6 to 12), rather large ($\frac{1}{2}$ in. long, $\frac{3}{8}$ in. wide), more or less tinged with purple, usually 4- or 5-flowered. Empty glumes nearly equal, about as long as the spikelets, acute, the lower faintly 3-nerved below, the middle nerve evident throughout, the upper 3- to 5-nerved. Flowering-glumes bifid; lobes membranous, acute, not awned, with a broad middle awn flattened and more or less twisted, a hairy band along the middle, and a fringe of fine hairs along the lower edges; pedicel silky; palea deeply bifid, with silky nerves and a fringe of long hairs along the lower edges.

Hab. Scrubby slopes leading up to the Clinton Saddle, between Lake Te Anau and Milford Sound, on the eastern side of the saddle (2,500 ft.).

I formerly regarded this grass as a variety of *Danthonia australis*, Buchanan, which it closely resembles in the size and structure of its spikelets. It differs from Buchanan's species in never forming tufts, in its flat leaves with dilated sheaths, in its more numerous spikelets, and in the very silky edges of the palea. I saw no plant with more than one culm, but, as the stems usually show one or two branchlets at the base, it is likely that more than one culm may be occasionally developed. The usual course of events is for the flowering-stem to fall off and a branch from the base to produce a new flowering-stem next season. The stems are fairly stout at the base, and are evidently several years old. The plant is of sparing occurrence in this habitat, and, as it is rather inconspicuous, is by no means easy to detect. In half an hour's hunting not more than twenty specimens were collected. It appears to have little economic value.

Deschampsia tenella, Petrie, var. **procera.**

This strongly marked variety differs from the type in the larger size of all its parts. The culms are stouter; the panicle shorter, more effuse, and fewer-flowered; and the spikelets are twice the usual size.

It was collected in open scrub and low bush near the head of the Clinton River, where the track to the Clinton Saddle diverges from the valley. The station is about 1,800 ft. above the sea.

Glyceria novæ-zealandiæ, sp. nov.

A tufted erect annual, 6 in. to 15 in. high, glabrous, and almost white when dry. Leaves strict, with broad loose striate sheaths and shorter involute striate blades, the topmost one equalling the panicle, which is partly enclosed in its sheath; ligule scarious, as long as broad, lobed, the middle lobe subacute. Panicle 3 in. to 6 in. long, contracted, the branches short and clustered. Spikelets pedicelled, the uppermost sessile, white and shining, $\frac{1}{4}$ in. long, mostly 4-flowered. Empty glumes unequal or nearly equal, one-half the length of the spikelet, glabrous; the lower narrow, acute, and 1-nerved; the upper broader, almost oblong in outline, obtuse or subacute or slightly lobed, 3-nerved; the middle nerve continued to the tip. Flowering-glumes stiff, glabrous or finely downy on the back below, oblong-ovate, suddenly contracted at the tip so as to leave a subacute median projection, 5-nerved, the middle nerve continued to the apex. Palea as long as the flowering-glume, stiff, bifid, the nerves pilose or almost glabrous.

Hab. Wet littoral stations on the south coast of Otago.

The present plant was distributed by the late Mr. T. Kirk, F.L.S., as *Poa walkeri*, sp. nov. In some respects it approaches *Poa*, but I am of opinion that it cannot be properly included in that genus. The spikelets differ widely from those of the other indigenous species of *Glyceria.*

Art. XXXVII.—*Notes on the New Zealand* Musci.

By Robert Brown.

[*Read before the Philosophical Institute of Canterbury, 27th February, 1901.*]

Plate XIII.

Genus **Conostomum.**

The genus *Conostomum* was created by Swartz to include the European species *C. boreale* and the New Zealand *C. australe*, which in the generic characters approach very closely those of *Bartramia*, the principal difference between them being the coherence of the teeth of the peristome at the apex in the former, while in the latter they are free. Many modern botanists place the species in *Philonitis*, a section of the genus *Bartramia*.

Mr. Wilson, in his "Bryologia Britannica," has kept them distinct, and so has Sir J. D. Hooker in his "Handbook of the Flora of New Zealand," which is the principal work there is on the bryology of New Zealand. I have therefore followed in the same lines in keeping the genera distinct, in order to facilitate reference to the above-named works.

This genus is a truly alpine one, the New Zealand species belonging to it being seldom found growing below 2,000 ft., and then only in cold, wet habitats.

The leaves of all the species but one treated in this paper are very distinctly arranged in five rows, as in *C. boreale*, leaving a furrow between each of the rows, which gives them a character so distinct that they can be at once distinguished from species of *Bartramia*.

I have seen no specimens of *C. pusillum*, but figures of it are given in the "Flora Novæ-Zealandiæ," which show that the leaves are very similar in their outline to the leaves of the other species belonging to this genus, which vary from each other principally either in their length or breadth. This species will be easily determined by the margins of the leaves being recurved and the double serration on them.

C. gracile of this paper unfortunately had the peristomes destroyed by insects, so that its true position could not be ascertained. It is placed provisionally in this genus in order that it might be recorded. Its habit appears to be that of a *Conostomum*.

C. minutum: Although neither the operculum nor the peristome of this species was found, its other characters are so distinctly those of a *Conostomum* that I have no doubt about placing it in the genus.

All the figures (Plate XIII.) are drawn to one scale.

C. australe, Swartz. Extended description.

Plants perennial, monœcious, growing in dense tufts $\frac{3}{4}$ in.–1 in. high, yellowish-green above, brown below. *Stems* stout, $\frac{3}{4}$ in. high, radiculose. *Innovations* irregular, $\frac{1}{4}$ in., fastigiate. *Leaves* densely imbricating, nearly erect, pentstichous, linear-lanceolate, acuminate, piliferous, concave; upper ones nine times longer than broad, with entire margins or slightly toothed, minutely serrated in the lower ones; nerve excurrent, keeled; unaltered when dry. *Areola* oblong. *Perichætial leaves* linear-lanceolate, acuminate, piliferous, shorter than the upper ones. *Fruit* acrocarpous. *Fruitstalk* flexuous, $\frac{3}{4}$ in. long. *Capsule* inclined, broadly ovate. *Mouth* small. *Peristome* single. *Teeth* 16, cohering at the apex. *Operculum* stout, oblique, conico-rostrate. *Calyptra* cucullate. *Antheridia* in the axils of upper stem leaves.

Hab. Mount Torlesse. Coll. by R. B., Jan., 1886.

C. macrocarpum, sp. nov.

Plants perennial, monœcious, growing in dense tufts 1 in.–1$\frac{1}{4}$ in. high, yellowish-green above, brown below. *Stems* about $\frac{3}{4}$ in. high, radiculose. *Innovations* irregular, $\frac{3}{16}$ in.–$\frac{1}{4}$ in., fastigiate. *Leaves* small, nearly erect, closely imbricating, pentstichous, ovate-lanceolate, acuminate, piliferous; margins slightly recurved and minutely serrated towards the apex; nerve stout, excurrent. *Areola* oblong. Leaves unaltered when dry. *Perichætial leaves* slightly broader than the upper ones, otherwise similar. *Fruit* acrocarpous. *Fruitstalk* $\frac{1}{2}$ in.–1 in. long, flexuous or inclined. *Capsule* oval, obliquely connected with the fruitstalk. *Mouth* small. *Peristome* single. *Teeth* 16, cohering at the apex. *Operculum* narrow, oblique, conico-rostrate, half the length of the capsule. *Calyptra* cucullate. *Antheridia* on short branches.

Hab. On damp ground, Mount Torlesse, Jan., 1886.

C. intermedium, sp. nov.

Plants perennial, monœcious, growing in dense tufts $\frac{1}{4}$ in. high, yellowish-green above, brown below. *Stems* $\frac{3}{16}$ in. *Innovations* $\frac{1}{8}$ in., fastigiate. *Leaves* small, nearly erect, pentstichous, closely imbricating, ovate-lanceolate, shortly piliferous, concave; margins serrated; nerve stout, excurrent. *Areola* oblong. Leaves unaltered when dry. *Perichætial leaves* linear-lanceolate, acuminate, piliferous. *Fruit* acrocarpous. *Fruitstalk* about 1 in. long, flexuous or inclined.

Capsule suberect, oval. *Mouth* small. *Peristome* single. *Teeth* 16, cohering at the apex. *Operculum* oblique, conico-rostrate, one-third the length of the capsule. *Calyptra* cucullate. *Antheridia* in the axils of the upper stem leaves.

Hab. On damp ground, Kelly's Hill, West Coast Road; altitude, 4,000 ft. Coll. by R. B., Nov., 1889.

C.(?) *gracile*, sp. nov.

Plants perennial, monœcious, growing in dense tufts $\frac{1}{2}$ in.–1 in. high, green above, brown below. *Stems* slender, radiculose, $\frac{1}{4}$ in.–$\frac{1}{2}$ in. *Innovations* fasciculate, very slender, fastigiate. *Leaves:* Upper loosely imbricating, erect, obscurely pentstichous, small, ovate-lanceolate, acuminate, piliferous; branch ones linear, acuminate; margins toothed on the upper half; nerve disappearing at the apex. *Areola* quadrilateral. Margins of leaves incurved and slightly twisted when dry. *Perichætial leaves* smaller, inner smallest, ovate-lanceolate, acuminate, piliferous. *Fruit* acrocarpous. *Fruit-stalk* flexuous, $\frac{3}{4}$ in. long, slender, curved at the apex. *Capsule* ovate, tapering to the small mouth, horizontal or inclined. *Operculum* oblique, conico-rostrate, one-third the length of the capsule. *Peristome* and *calyptra* not seen. *Antheridia* on short branches, close to the perichætium.

Hab. On wet ground, summit of Kelly's Hill; altitude, 4,000 ft. Coll. by R. B., Nov., 1889.

C. bellii, sp. nov.

Plants perennial, monœcious, growing in dense tufts $\frac{1}{2}$ in. high, yellowish-green above, dark-brown below. *Stems* $\frac{3}{8}$ in., radiculose. *Innovations* about $\frac{1}{8}$ in., fastigiate. *Leaves* nearly erect, closely imbricating, pentstichous, ovate-lanceolate, acuminate, piliferous; margins serrated towards the apex, and slightly recurved; nerve stout, excurrent. *Areola* oblong. Leaves unaltered when dry. *Perichætial leaves* ovate-lanceolate, acuminate. *Fruit* acrocarpous. *Fruitstalk* inclined, $\frac{3}{8}$ in. long, pale-red. *Capsule* ovate, small. *Operculum* conico-rostrate. *Peristome* single. *Teeth* 16, cohering at the apex. *Calyptra* not found.

Hab. On marshy ground, Lake Harris; February, 1895. Coll. by William Bell.

C. minutum, sp. nov.

Plants perennial, monœcious, growing in small dense tufts about $\frac{3}{8}$ in. high. *Stems* $\frac{1}{4}$ in., radiculose. *Innovations* $\frac{1}{8}$ in., fastigiate. *Leaves* ovate-lanceolate, acuminate, nearly erect, pentstichous, closely imbricating; margins serrated towards the apex; nerve excurrent. *Areola* oblong. Leaves unaltered when dry. *Perichætial leaves* slightly longer than the upper ones, ovate-lanceolate, acuminate, piliferous. *Fruit* acrocarpous. *Fruitstalk* inclined, slender, $\frac{1}{4}$ in. long. *Capsule* inclined, subrotund. *Operculum*, *peristome*, and *calyptra* not found.

Hab. On wet ground, Kelly's Hill. Coll. by R. B., Nov., 1889.

EXPLANATION OF PLATE XIII.

Conostomum australe, Swartz.

1. Capsule.
2. Perichætial leaves.
3. First leaf outside perichætial.
4. Upper leaves.
5. Middle stem leaves.

Conostomum macrocarpum, sp. nov.

1. Capsule.
2. Inner perichætial leaves.
3. Outer perichætial leaves.
4. First leaf outside perichætial.
5. Upper leaf.
6. Middle leaf.

Conostomum intermedium, sp. nov.

1. Capsule.
2. Perichætial.
3. First leaf outside perichætial.
4. Upper leaf.
5. Middle leaf.
6. Branch leaf.

Conostomum(?) gracile, sp. nov.

1. Capsule.
2. Perichætial leaves.
3. First leaf outside perichætial.
4. Upper leaves.
5. Middle leaves.
6. Branch leaf.

Conostomum bellii, sp. nov.

1. Capsule.
2. Perichætial leaves.
3. First leaf outside perichætial.
4. Upper leaf.
5. Middle leaf.
6. Branch leaf.

Conostomum minutum, sp. nov.

1. Capsule.
2. Perichætial leaves.
3. First leaf outside perichætial.
4. Upper leaves.
5. Middle leaf.
6. Branch leaf.

III.—GEOLOGY.

Art. XXXVIII.—*Notes on an Artesian-well System at the Base of the Port Hills.*

By S. Page, with Analyses by E. B. R. Prideaux, B.A.

[*Read before the Philosophical Institute of Canterbury, 27th February, 1901.*]

Last year it came to my knowledge through Mr. T. E. Cutler, of Gebbie's Valley School, that flowing artesian wells of considerable depth had been obtained inside Lyttelton Harbour, at and near Teddington; also that similar flowing wells, all more or less warm, existed on the other side of Gebbie's Pass.

The wells vary in depth from about 70 ft. to 290 ft.; in temperature from 65° to 84° Fahr. One or more rise as much as 20 ft. above the surface, and they extend in one direction as far as the ocean-beach and in the other from the north side of Gebbie's Valley round the foot-hills as far as Little River.

Seeing that the wells extended over such a considerable area, it was at first thought possible that the supply might be connected with the artesian system of the plains. If that was so, however, the presence of the wells at Teddington would tend to show that the alluvial system of the plains extended under the hills.

To test the point, samples were obtained from six representative wells, through the kindness of Mr. T. E. Cutler, and analyses of these by Mr. E. B. R. Prideaux are appended.

From Mr. Miller, of Gebbie's Valley, who sunk the greater part, if not all, of these wells, I learn that inside Lyttelton Harbour the wells pass through clay, freestone rock, sand, and in one case rubble, but no shingle. On the other side of the hills, in addition to sand and clay, waterworn shingle was constantly met with, in beds as much as 50 ft. in thickness. In one well, on the spit between Lake Ellesmere and the sea, no clay was found; sand and shingle only. In this case water was met with at 50 ft. and the flow did not improve to the extreme depth reached—212 ft. In other cases, where beds of clay were interposed, the flow increased with the depth.

Water was found indifferently in beds of sand, shingle, and rubble, and from the surface of rock.

It will be seen from the analyses that while the samples vary much amongst themselves, yet all contain very much larger proportions of chlorine and of total solids than does the water from the Christchurch artesian system. It is reasonable, therefore, to conclude that the source is a purely local one—the neighbouring hills—although the water is not by any means confined to hill deposits.

Qualitatively the waters are much alike, all containing carbonates, sulphates, calcium, and magnesium. The quantitative results only are appended :—

Sample No.	Locality.	Depth of Well, in Feet.	Temperature of Well.	Total Solids, in Grains per Gallon.	Chlorine, in Grains per Gallon.	Alb. Ammonia, in Parts per Million.	Free Ammonia, in Parts per Million.
1	Manson's, Teddington ..	177	..	68·4	22·54	0·014	0·02
2	Public House, Teddington	95	..	74·5	24·49	0·035	0 048
3	Grey's, Little River Road	194	..	32·0	13·13	0·04	0 035
4	Parkinson's, Little River Road	211	..	71·3	31·95	0·03	0·02
5	Frazer's, Kaituna Valley..	150	..	16·7	6 03	0·043	0·008
6	Near Rabbit Island Station	190	84° F.	28·0	8·16	0·048	0·008

Art. XXXIX.—*On the Occurrence of Crystallized Native Copper on Mine-timbers at Kawau Island.*

By W. H. Baker, B.Sc.

[*Read before the Auckland Institute, 13th August, 1900.*]

Owing to the increase in the price of copper attention has lately been turned to several abandoned copper-mines with the object of ascertaining if, by the use of more modern mining and metallurgical processes, these mines would now be remunerative. The Kawau Mine was one of these, since when it was abandoned some forty years ago there was still a large amount of copper-ore in sight.

It may be as well to describe this mine. It is of especial interest, since it is the first lode of copper-ore that was worked in New Zealand, the first operations dating from 1842. The lode was discovered in the south-west part of the island, and consisted of copper- and iron-pyrites, the surface portion being highly coloured with carbonates and oxides of copper. It is enclosed between green foliated slates on the foot-wall side and cherty slate on the hanging-wall. It strikes about north-east, and at the surface dips at about 70°, while lower down it becomes almost vertical. This lode was opened up by a shaft sunk on the foot-wall side, and was worked by a system of levels and stopes.

Owing to a question of ownership this shaft occupies a unique position, having been started on the beach below high-water mark. In consequence, the collar of the shaft had to be raised out of reach of the tide by means of a double box of planks made watertight by well-puddled clay. The shaft was worked successfully for a number of years, but about forty years ago operations were suspended. At this time the reef was about 15 ft. thick, and averaged 16 per cent. of copper. On this shaft being abandoned the sea very soon found ingress into the mine, and for years past the waves have washed over the mouth of the shaft for several hours every day.

During the present year it was decided to again open up this mine. The collar of the shaft was again built up, and the workings were drained by means of Cameron pumps. It was then found that large masses of native copper were adhering to the sets of timber in the shaft and to the floor-boards in the levels. These masses were generally found as excrescences growing from a nucleus, and varied in diameter from ½ in. to nearly 1 ft. When disclosed in the mine it had the peculiar red colour of pure copper, but on exposing it to the air it quickly became tarnished. I examined this copper both microscopically and chemically. Looking at it casually it appears as small imperfect crystals arranged radially from a centre, with numerous beautiful crystals branching from the main stems. Examined under the microscope it is seen to be composed of crystals of the isometric system, in which octahedral faces predominate, though I noticed some good examples of pentagonal dodecahedra. In one peculiar instance I found that one branch was composed of twinned octahedra, giving the edge of the branch a very regularly serrated appearance.

On examining chemically I found that the crystals were pure copper, but were coated on the outside with compounds of manganese and iron.

I looked for the cause of the tarnishing of these crystals in the presence of these impurities, and found that when the crystals were well washed in water freed from air they were not nearly so liable to become discoloured, but when allowed to dry just as they came from the mine a coating of oxide was formed which destroyed the lustre of the specimen. The reason of this probably is that the iron and manganese salts, which I found present in small quantities in the mine-water, formed a thin coating of these salts on the crystals. On bringing the copper to the surface this thin film, exposing a large surface to the air, would quickly oxidize to oxide of iron and manganese. These substances would then give up their oxygen to the copper, which would form a layer of black oxide of copper. This iron and manganese therefore appear to act as carriers of oxygen to the copper.

The explanation that one would naturally jump to with regard to these deposits is—(1) That the iron- and copper-pyrites have oxidized, producing sulphuric acid and soluble iron- and copper-sulphates ; (2) that iron has been present in the mine-timbers in the form of bolts and nails, and that this iron has replaced the copper in the soluble copper-sulphate, thus forming deposits of metallic copper. But, with regard to the presence of metallic iron, I ascertained that no bolts were used to suspend the frame-sets in the shaft, and the amount of iron present as nails would not by any means account for the large deposit of copper.

From the fact of the sea being in almost constant communication with the mine for so many years, it appeared that the sodium-chloride of the sea-water would affect the solution of the copper from the pyrites, as it was highly probable that during the oxidation of the copper-pyrites the sodium-chloride would cause a concurrent action, resulting in the formation of copper-chloride and copper-sulphate. To verify this I weighed out two equal portions of copper-pyrites and partly oxidized them under exactly similar conditions, and while still hot, and therefore still oxidizing, I plunged one into pure water and the other into a solution of common salt. In each case a blue solution of copper was obtained, but the brine-solution was found to contain 5 per cent. more copper than the other.

I was unable to obtain an accurate sample of the mine-water for quantitative analysis, but a sample I had showed the presence of sulphates and chlorides of sodium, copper, iron, and manganese, and from the above experiment it seems likely that the copper is present as chloride and sulphate of copper.

As previously stated, the metallic iron is not in sufficient quantity to account for the amount of copper produced ; but I think the following explanation accounts for the quantity and also for the crystalline form : As the mine-water was connected with the sea the solution of copper could not become very strong, as the salts of copper and the sea-water would diffuse into each other, thus weakening the copper-solution and at the same time tending to keep it at constant strength. The iron nails would then by the ordinary process replace the copper from the solution, forming metallic copper and a soluble salt of iron. Since the solution was very dilute, the deposition of copper would be very gradual, and the atoms of copper would be enabled to arrange themselves symmetrically, thus forming a regular crystalline mass. But when the iron was all dissolved deposition of the copper must still have taken place, and may be accounted for as follows, by considering the state of things in the mine: Here on the one hand we have the lode continually oxidizing and dissolving, and on the other hand the metallic copper previously formed by the iron, and these are separated by a dilute solution of an electrolyte.

There are then all the elements necessary for an electric current; it is, in fact, merely a large cell, in which the native copper acts as the positive plate and the lode acts as the negative. The conducting liquid is so dilute that almost all the copper-salt will be dissociated into its ions, the anion being pure copper and the kathion being Cl and SO_4. The anion will carry its load of positive electricity to the previously deposited copper nodule and deposit more copper, while the kathion will carry its negative electricity to the lode and there give up the Cl and SO_4. On account of the continual action of the liquid by the inrushing sea these gases will be dissolved or will react on the lode, and so a fresh surface of the lode will be presented, thus preventing polarisation. In this way the nodules of copper formed will be constantly increasing at the surface of the lode-matter. The deposition will be so gradual that, as before, the copper atoms will be symmetrically deposited, and will form constantly enlarging bunches of crystals of copper.

ART. XL.—*Notes on a Quartz Mica-diorite from Western Flanks of Moehau.*

By JAMES PARK, F.G.S.

[*Read before the Auckland Institute, 25th February, 1901.*]

THIS rock occurs on the coast eight miles north of Waiaro, a small stream flowing into the sea about five miles north of Cabbage Bay. A few detached boulders, some of enormous size, lie scattered along the sea-beach, and in 1897, during a geological reconnaissance of the country between Cabbage

Bay and Cape Colville, the presence of these led me to the discovery of the rock *in situ*. An examination of the neighbourhood showed that the boulders were shed from a massive dyke descending from the western flanks of Moehau. The dyke itself forms a bold precipitous spur or ridge, terminating somewhat abruptly before it reaches the sea, about half a mile north of Waitoitoi. It obviously owes its present exposure to the denudation of the Palæozoic slaty shales through which it has been erupted, and which flank it on both sides.

Under the microscope the essential mineral constituents are seen to be plagioclase feldspar, hornblende, and biotite, with quartz, apatite, chlorite, epidote, augite, and magnetite as associates. It is completely holocrystalline.

The feldspars are generally well developed and mostly idiomorphic. They occur principally as broad tabular crystals, many of them ranging from 4 mm. to 6 mm. long. By transmitted light they appear fresh, glassy, and transparent, except a few phenocrysts, which are slightly clouded with dust-like enclosures of a dark-grey colour, resembling minute microlites. The majority of the feldspar plates exhibit fine polysynthetic twinning on what is known as the "albite plan," but there are examples in each slide of combined twinning according to the albite and pericline plans. The polarisation colours are very bright, especially in thick plates. In one slide a phenocryst shows a zonal shell-structure, being apparently built up of plates of gradually diminishing size towards the centre. The successive layers exhibit different colours in polarised light, and some of them are clouded by lines of microlites zonally arranged. The finely developed twinning laminæ, brilliant interference colours, and large extinction angles all point to a feldspar of a basic character, probably calcareous labradorite or bytownite.

The hornblende occurs in irregular aggregates and imperfectly developed crystals, ranging from 0·01 mm. to 9 mm. long. The colour in transmitted light is pale-brown to greenish-brown. The pleochroism is very pronounced, and of the usual character in hornblende—*i.e.*, the α ray, nearly parallel to the clinodiagonal axis, is light-yellow; the β ray, coincident with the orthodiagonal, yellowish-green; and the r ray bluish-green. The absorption is $r > \beta > \alpha$. The basal pinacoids are the most strongly pleochroic, and show the parallelogram formed by the prismatic cleavage-cracks in a very marked degree. The extinction angle is about 16 degrees.

Some of the hornblendes show a narrow opaque border of magnetite, due to corrosion and resorption of edges before consolidation of the magma, but this feature is not common and never conspicuous. In one slide a hornblende phenocryst has a black border and a clear centre. Twins are not uncommon.

In one example the composition plane was inclined at an angle of 18 degrees to the orthopinacoid cleavage-cracks. A few plates show a fibrous structure, apparently due to aggregation of needles with approximately the same orientation. Between crossed nicols the needles do not extinguish at the same moment, and the result is a display of banded colours when the stage is rotated. The hornblendes are comparatively free from enclosures, but in the twin phenocryst mentioned above there is enclosed a well-developed plate of feldspar.

Biotite has been very abundant in the rock when fresh. It is now mostly altered to chlorite, being represented only by dark-brown irregular cloudy patches with frayed edges. The alteration shows initial encroachment along the cleavage-cracks. Enclosures of magnetite and quartz are common. The chlorite contains epidote, augite, and apatite as alteration products of biotite.

The quartzes occur in crystalline grains and interstitial, with coloured enclosures. The former may be of primary origin; the latter is undoubtedly of secondary generation. Fluid lacunæ are common, polarisation colours brilliant.

A chemical analysis of this rock by Mr. W. H. Baker, B.Sc., of the Thames School of Mines, gave the following results:—

SiO_2	60·21
Al_2O_3	12·28
FeO / Fe_2O_3	13·84
CaO	6·72
MgO	1·96
K_2O	1·32
Na_2O	2·55
H_2O	1·16
	100·04

The percentage of iron-oxides is abnormally high, and is due to the abundance of ferro-magnesian silicates. The silica is somewhat below the normal.

Locally the rock is known as granite, to which it bears a strong resemblance. It is a handsome and durable building-stone, very tough and hard, perhaps too hard for hand-dressing where the rate of wages is high, but with mechanical dressing-machines it should be produced at a rate to compete successfully with imported stone.

Art. XLI.—*Notes on a Hypersthene Andesite from Waihi Mine, Waihi.*

By James Park, F.G.S.

[*Read before the Auckland Institute, 15th October, 1900.*]

This rock was cut through in the south-east crosscut from No. 1 shaft, at the 300 ft. level of the mine, on the hanging-wall of the Martha lode, near the Grand Junction boundary-line. It approaches close to the surface of the old valley which existed to the east of the Martha Hill before the eruption of the rhyolites which cover the plains and wrap round the Rosemont, Amaranth, and Black Hills, and surround the Martha Hill on all sides, excepting the narrow neck of andesite on the north side, which connects it with the great andesitic area of the Hauraki Goldfields. It occurs as an undecomposed bar or core passing insensibly into the soft decomposed andesite or propylite enclosing the Martha and Empire lodes.

The colour of the rock is greyish-black; when wet, dense black. In hand specimens phenocrysts of feldspar and pyroxene are prominent. Fracture splintery, subconchoidal. Under the microscope the essential minerals are seen to be plagioclase and pyroxene, with numerous square and rod-shaped microliths set in a glassy base. The base is not abundant, is mostly clear, and dusted evenly with a black-brown or black dust, apparently magnetite.

The feldspars are fairly fresh and glassy, and occur both as short tabular phenocrysts, up to 5 mm. long, and as narrow laths. The former are well developed, and show very marked polysynthetic twinning, and sometimes zonal structure. The smaller feldspars are often irregular in form and not much twinned. The effects of corrosion by the cooling magma are clearly seen in the rounded angles and indentations of some of the feldspar plates. Binary twin crystals occur in each slide. Their straight extinction indicates orthoclase.

The indentations and cracks of the larger feldspar plates are filled with calcite and fine magnetite dust, which often shows oxidation to hæmatite. In some of the phenocrysts enclosures of colourless square-shaped microlites are common, in many cases zonally arranged.

Hypersthene is abundant and generally much decomposed, showing alteration into serpentinous products, quartz, and magnetite. In some cases the crystal is almost replaced by magnetite; in others—perhaps the more common

—a skeleton of magnetite outlines the original form and cleavage-cracks. The magnetite always shows alteration to hæmatite. A little enstatite is present in each slide.

There may be a little augite present, but it could not be distinctly identified, as the ferro-magnesian minerals are more or less altered into serpentinous matter.

Hornblende, much altered, occurs sparingly in well-developed crystals, showing the characteristic prismatic cleavage. In each slide there are several long prismatic and lozenge-shaped bodies, rendered almost opaque with magnetite dust. They may originally have been hornblende. In one slide a plate of one of the dark bodies, besides the magnetite dust which renders it almost opaque, contains enclosures of large grains of magnetite and a small idiomorphic crystal of plagioclase feldspar, and, embayed on the edge, a small grain of quartz.

Quartz occurs as hexagonal plates and interstitial. The former are rare and may be a primary generation.

There is much calcite present in the rock, and a little carbonate of iron and magnesia.

From the crosscut at the 300 ft. level, at a point immediately below No. 5 shaft, occurred a few small kernels of black greenish-grey rock enclosed in the decomposed andesite. Microscopic examination proved it to be the same rock as that just described from the south-east crosscut from No. 1 shaft, some 1,000 ft. distant, but more altered, with the result that calcite, hæmatite, and quartz are more abundant.

Art. XLII.—*Note on the Cave at Papatu, Ormondville, Hawke's Bay.*

By H. N. McLeod.

[*Read before the Wellington Philosophical Society, 28th August, 1900.*]

This cave is situated about a mile and a half from the railway-station at Ormondville, in the southern part of Hawke's Bay. While it is not a very large cave, it has several interesting points about it, and is worth a visit in passing.

There are two portions to the cave, which may be likened in shape to an ordinary iron pot, the handle representing a passage which opens out into a small blind gully, and the body of the pot representing the main cave.

To reach the main entrance it is necessary to ford the Manawatu River, a matter which is easy enough at this spot in ordinary times. The floor is almost on a level with the river, and the river-bank is steep and brush-covered. The entrance, though hidden from view by foliage, is quite large, being some 10 ft. high, while inside the roof would be 15 ft., and the measurement across about the same.

The roof and walls were hung and cased with stalactite formations, while the floor, but for places here and there, was under water. On a ledge near the roof on the right on entering are to be found what are described as petrified ferns and twigs. These, however, were simply covered with the same deposit which formed the stalactites.

The passage portion enters the main part at the top, and a primitive wooden ladder had been placed to assist the explorer, but at the time of my visit this had become useless, so it was necessary to return to outer air, scale the cliff-side, and find the entrance to the passage-way.

The gully in which it was situated was a blind one and small, and, instead of opening out into a larger waterway, it had its course barred, and the water which it led away passed into the cave, and so found its way into the Manawatu. It may be that the gully itself was formed by the falling-in of a considerable underground passage.

For the purpose of measurement a reel of cotton was used here, as well as to give a feeling of security, for I had to do the exploration without assistance, the owner of the property not being able to accompany me.

The entrance is exceedingly confined, and inside there was a strong draught, which made an unprotected light an impossibility. I had been warned that there was an awkward hole some distance on in the passage, so this added to the interest.

A little way in there was room enough to look round. The walls, roof, and floor were composed simply of shells; indeed, the land in this district consists largely of shell deposits. Through this shell water percolated, and the shell was quite crumbly and rotten.

Inside the passage, by the aid of a large stock of matches, a weta was secured; it was one of several which struck against me, and its body now rests in Mr. Hudson's collection.

Finding my way out, I returned to the main cave to secure what specimens could be obtained without playing the part of a vandal. This, however, has not been guarded against to the extent it should have been.

Some years ago there was read a paper in which it was asked whether plaques could not be made in some of our New Zealand caves similar to those produced in the South of Europe; and this it appears to me could easily be done with the water holding the necessary matter in solution, which drops from the roof and runs down the sides of the Papatu Cave.

IV.—CHEMISTRY AND PHYSICS.

Art. XLIII.—*Studies on the Chemistry of the New Zealand Flora.*

By T. H. Easterfield, Professor of Chemistry in Victoria College, and B. C. Aston, Chemist to the Department of Agriculture.

[*Read before the Wellington Philosophical Society, 24th July, 1900.*]

PART I. THE TUTU PLANT.

The standard to which the study of any branch of science attains in a community may be accurately gauged by the quantity and quality of the research work produced by the members of that community. It is therefore to be regretted that, whereas the biological sciences have attracted in New Zealand a large and enthusiastic body of workers, chemical research has been almost entirely neglected, except in so far as its application to the mineral resources of the colony might be expected to yield a direct financial return. In consequence of this indifference to the value of chemical investigation very little is known about the chemistry of our native plants, a subject of the greater importance since the flora of these Islands is so largely endemic. The field for investigation is wide, and much work must be done before our knowledge of the subject can be placed upon a satisfactory basis. The authors of the present paper, however, hope by their own researches, and even more by inducing others to carry on similar inquiries, to lay the foundation for a fairly complete knowledge of the characteristic constituents of the more important New Zealand plants. The tutu has been chosen for the first of these investigations because it is the most widely spread and the best known of the native poisonous plants. A great interest therefore attaches to it.

The poisonous nature of the tutu is well known; of the animals brought by Captain Cook,* both of the sheep and one of the goats appear to have died from the effects of the plant.† Of the cows brought by the early Canterbury settlers, two

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* Voyages.

† Lauder Lindsay, B. and F. Med. and Chir. Rev., No. 61, July, 1865.

were poisoned within a few days of landing.* The same newspaper warns settlers of the danger of this plant to freshly landed cattle.

Lauder Lindsay,† who visited New Zealand in 1861–62, in an interesting article entitled "The Toot Plant and Poison of New Zealand," says, "I was everywhere struck by the abundant evidences of the devastation produced amongst flocks and herds from their feeding on the toot plant. . . . In other words, he seemed a fortunate farmer or runholder who had not lost more than 25 per cent. of his stock from toot-poisoning, whilst in some instances the losses were so high as 75 per cent."

Other animals are also affected by the plant. An interesting account of the poisoning, with death in seven hours, of an elephant belonging to a travelling menagerie is given by Haast, the skeleton being now in the Colonial Museum, Wellington.‡

Birds are said to be unaffected by the seeds, but cases have come under the notice of the authors in which domestic fowls have been poisoned by eating the berries, the symptoms being typical of tutu-poisoning.

The number of recorded cases in which human beings have died from tutu-poisoning does not appear to be large. The authors have endeavoured to collect details of these fatal cases, and have in this connection issued a circular asking for the experience of every medical man in the colony. The following cases are taken in part from the replies already to hand:—

1. At Wakapu, Bay of Islands, 1835–36, twelve French sailors were poisoned; four are said to have died.§
2. Thomson, "Story of New Zealand," 1859, states that up till that date several children had died from eating the berries.
3. *Otago Colonist*, 25th October, 1861, records the case of two children being poisoned by the shoots; one died.
4. *Otago Daily Times*, 16th November, 1862; death of a young man from eating the shoots.
5. H. C. Field‖ records the death of a girl in 1854–55 from eating tutu-berries.
6. E. Cross‖ lost a son from eating the berries in January, 1860; symptoms very distressing.
7. Mr. Giles, ex-Coroner at Westport and Auckland,‖

* *Lyttelton Times*, vol. i., No. 1, 11th Jan., 1851.

† *Loc. cit.*

‡ "The Student," Feb., 1869; and Trans. N.Z. Inst., 1869, p. 399.

§ W. G. Mair, private communication; also Lauder Lindsay, *loc cit.*

‖ Private communication.

records two cases of poisoning from the berries. One case was fatal; in the other the memory was much impaired.

The authors have received accounts of the treatment of patients who have recovered. These include bleeding from the arteries and veins, emetics, stimulants, lime-water, ammonia, compulsory exercise, inhalation of chloroform followed by sedatives. The experience of stock-owners points to bleeding as the most certain and rapid method of affording relief.

BOTANICAL AFFINITIES OF TUTU.

The name "tutu" is applied to three distinct species of the monotypic natural order *Coriariæ*: *Coriaria ruscifolia*, L. (*C. sarmentosa*, Forst., *C. arborea* and *C. tutu*, Lindsay, tutu, pohou, and tupakihi of the Maori), is commonly known as the tree-toot; it is a handsome shrub, with glossy acuminate leaves, and grows to a height of from 20 ft.–25 ft. *C. thymifolia*, Humb. and Bonp. (tutu-papa or tutu-heu-heu of the Maori), seldom exceeds 3 ft. in height, and is known as the ground-toot. *C. angustissima*, Hook. f., is of comparatively rare occurrence. It is a small herbaceous upland annual, with a characteristic fern-like appearance.

C. thymifolia also occurs in South America, where it is known as the "ink-plant." The juice of the fruit is used in New Granada as an ink, under the name of "chanchi."* *C. ruscifolia* occurs, too, in China,† where a black stain prepared from it is used by shoemakers. *C. nepalensis*, the Himalayan species, is not known to be poisonous, and the fruit is eaten. *C. myrtifolia*, the European species, is highly toxic. It is known as "*gerberstrauch*" (dyers-bush) in Germany and "*redoul*" in France.

CHEMISTRY OF C. MYRTIFOLIA.

In 1863 M. Riban showed that *C. myrtifolia* contained a very poisonous constituent, which he called "coriamyrtin."‡ A. G. Perkin§ has recently shown that the same plant contains quercetin.

CHEMISTRY OF TUTU.

It is somewhat remarkable that the poisonous constituent of tutu has remained hitherto unisolated. Skey‖ has shown that ether removes from the seeds a highly poisonous green oil, which, he remarks, is or contains the poison. Hughes¶

* Jamieson, Proc. Linn. Soc., vol. 7, p. 120.
† Lauder Lindsay, *loc. cit.*
‡ "Comptes Rendus," 1863, p. 798, and 1866, p. 680.
§ "Journal of the Chemical Society," 77 (1900), p. 429.
‖ Trans. N.Z. Inst., 1869, 153, 399, 400.
¶ Trans. N.Z. Inst., 1870, 237.

showed that *C. ruscifolia* contained crystalline constituents soluble in alcohol or water, but did not identify them. He found that boiling with slaked lime destroyed the poisonous action of the drug. Christie* has examined the physiological effect of decoctions of the plant, and denies that lime destroys the poison.

The results of the examination of tutu recorded in the present paper may be summarised as follows:—

(1.) No alkaloids can be detected in the plant. This result confirms the previous work of Skey.†

(2.) All the New Zealand species of *Coriaria* contain a highly poisonous crystalline glucoside of the formula $C_{17}H_{20}O_7$, to which the authors give the name "tutin." It differs in many respects from any known chemical compound. In physiological action tutin closely resembles Riban's coriamyrtin, described above. A comparison of the two compounds is given below.

Tutin is present in both the seeds and leaves of the plants.‡ No other poisonous constituent has been detected.

(3.) The following well-known acids occur in the leaves of *C. ruscifolia* and *C. thymifolia*: Acetic, ellagic, gallic, and succinic. *C. angustissima* contains, in addition, a volatile crystalline acid, $C_8H_6O_4$.

(4.) The oil extracted by carbon-bisulphide from the seeds is a drying oil, and upon saponification yields salts of linoleic acid. The oil is not poisonous.

Experimental.

Coriaria thymifolia.

Eleven kilograms of the air-dried plant (root excluded) gathered at Dunedin at the time of flowering (January) were put through a chaff-cutter and boiled with successive quantities of water. The concentrated infusion was treated with a large volume of alcohol, which precipitated inorganic salts, ellagic acid, and a large quantity of black, tarry matter. The residue remaining after distilling off the alcohol from the supernatant liquid was extracted with ether. When the ether was distilled off the residue containing the characteristic glucoside tutin set to a semi-solid crystalline mass with a pungent odour.

Acetic acid was recognised by distilling the mass with steam. From the distillate a silver salt was prepared, which,

* N.Z. Med. Journ., July and October, 1890.

† Jurors' Reports and Awards, New Zealand Exhibition, 1865.

‡ The presence of the poison in the seeds and leaves is opposed to the view put forward by Manning (Lindsay, *loc. cit.*) that the seat of the poison is not the seed, but the "fur" on the fruitstalk.

after a single recrystallisation, gave Ag = 64·3 per cent. Calculated for $C_2H_3O_2Ag$, Ag = 64·7 per cent.

GALLIC ACID remained in quantity when the solution which had been distilled with steam was evaporated to the crystallising-point and the residue extracted with chloroform. It gave the usual colour reactions. After recrystallisation from water it was dried at 150° and gave—

C = 49·4 ; H = 3·5 per cent.
$C_7H_6O_5$ requires C = 49·0 ; H = 3·5 per cent.

QUERCETIN, or some isomeric compound, was present in the crude gallic acid. After purification by repeated recrystallisation from water it showed the usual colour reactions and dyeing properties, lost 2 mols. of water at 160°, and, on analysis, gave—

C = 59·2 ; H = 3·6 per cent.
$C_{15}H_{10}O_7$ requires C = 59·6 ; H = 3·2 per cent.

Quercetin has been definitely shown by Perkin to exist in *C. myrtifolia.**

The chloroform solution separated from the gallic acid was evaporated and the product dissolved in ether; the remaining acids were then removed by sodium-carbonate.

SUCCINIC ACID was identified in the alkaline solution. It was recognised by qualitative reactions, melting-point, and analysis of the silver salt.

C = 14·3 ; H = 1·25 ; Ag = 64·8 per cent.
$C_4H_4O_4Ag_2$ requires C = 14·4 ; H = 1·2 ; Ag = 65·0 per cent.

TUTIN.

The ethereal solution, from which all the acids had been removed, was evaporated, and yielded almost colourless crystals, which were repeatedly recrystallised from water and from alcohol. From water the substance separates in characteristic acicular forms, from alcohol in oblique-ended prisms. The compound is perceptibly volatile, may be slowly sublimed at 120°–130°, melts at 208°–209° (uncorr.), and has an intensely bitter taste. It contains no nitrogen, and after hydrolysis by dilute acids reduces Fehling's solution, and with phenylhydrazine gives an amorphous precipitate which is not phenylglucosazone. Strong sulphuric acid added to a few drops of a saturated aqueous solution of tutin gives a blood-red colouration.

Examination by Zeisel's method for methoxyl groups gave negative results. When evaporated to dryness with slaked lime solutions of tutin yield amorphous compounds amongst

* Trans. and Journal Chem. Soc., 1900, 77, 429.

which tutin can no longer be detected, even when the residue has been acidified.

Some preliminary experiments upon the toxic effect of tutin were carried out by Mr. J. A. Gilruth, Chief Government Veterinary Surgeon. The compound is very poisonous. A dose of 0·129 gram killed a pig weighing 17 kilograms in five hours; 0·01 gram killed a kitten weighing 1 kilogram in forty minutes; 0·001 gram given to a cat weighing 2 kilograms caused a fit in three hours and illness for the next twenty-four hours. The same cat subsequently succumbed to a dose of 0·003 gram.

A dose of about a milligram produced nausea, vomiting, and incapacity for work extending over twenty-four hours in a healthy, full-grown man.

Three preparations were analysed, (i.) and (ii.) from *C. thymifolia* and (iii.) from *C. ruscifolia* :—

(i.) 0·1299, dried at 120°–130°, gave 0·2899 CO_2 and 0·0691 H_2O. C = 60·78; H = 5·91.

(ii.) 0·1255, dried in desiccator, gave 0·2793 CO_2 and 0·0710 H_2O. C = 60·70; H = 6·20.

(iii.) 0·1264, dried at 120°–130°, gave 0·2825 CO_2 and 0·0658 H_2O. C = 60·95; H = 5·78.

$C_{17}H_{20}O_7$ requires C = 60·71; H = 5·95 per cent.

Molecular Weight Determinations.—Calculated for $C_{17}H_{20}O_7$. M = 336.

0·403 gram depressed the m.p. of 10 grams of acetic acid 0·47°. M = 332.

0·319 gram depressed the m.p. of 10 grams of acetic acid 0·38°. M = 325.

0·2448 gram depressed the m.p. of 8 grams of phenol 0·66° M = 333.

1·1173 grams raised the b.p. of 11·65 grams of alcohol 0·35°. M = 320.

Solubilities.—One hundred grams of water at 10°, of ether at 10°, and of alcohol at 16° dissolve 1·9, 1·5, and 8·2 grams of tutin respectively. It is very soluble in acetone, but dissolves only sparingly in chloroform, and is insoluble in benzine or carbon-disulphide.

The optical activity has been determined by Professor C. R. Marshall, of University College, Dundee, who reports as follows :—

$\alpha_D = +0{\cdot}37°$; $l = 2$ dcm.; $d = 0{\cdot}8$; $c = 2{\cdot}5$ per cent. in alcohol; whence $[\alpha]_D^{19\cdot5°} = +9{\cdot}25$.

Note on the Pharmacology of Tutin.—Professor Marshall has undertaken the pharmacology of tutin, and furnishes the following preliminary note :—

"Tutin, pharmacologically, is closely allied to coriamyrtin, and belongs to what is known as the picrotoxin group of substances. After preliminary depression it induces salivation, a fall in the frequency of the pulse, and increased respiratory activity, followed by convulsions, for the most part clonic and limited in the earlier stages to the fore part of the body. The effect is apparently due to an action on the medulla oblongata and basal ganglia of the brain. It differs from coriamyrtin in being less toxic and slower in its action. On this account the preliminary depression is more marked. Its connection with this substance, however, is close. Experiments suggest that it is broken up in the body into some substance, possibly coriamyrtin, which is the active convulsant factor. It ought to be stated that the coriamyrtin employed by me was obtained from Merck. After boiling for a short time with dilute hydrochloric acid (2 per cent.) it did not reduce copper-sulphate solution. It melted at 224° (uncorr.), and its solubility in physiological saline solution (0·6 per cent. NaCl) was less than 0·1 per cent. Riban's coriamyrtin melted at 220°, and was soluble in water to the extent of 1·44 per cent. at 22°."

SEEDS OF C. THYMIFOLIA.—A kilogram and a half of the seeds of *C. thymifolia* were pulverised and exhausted by carbon-disulphide, which removed 22·6 per cent. of a green drying oil. The seeds, freed from oil, yielded to water a small quantity of tutin, which was extracted with ether, and after recrystallisation melted at 208°–209°. The oil, upon saponification, yielded a liquid acid, which was probably linoleic acid, since its calcium and barium salts were readily soluble in ether.

Coriaria ruscifolia.

In the examination of this plant the juice expressed from the succulent asparagus-like shoots (gathered at Wellington early in October) was employed. It contained the same acids as the extracts of *C. thymifolia.* The yield of tutin was 0·03 per cent. Samples of the plant gathered later in the year from the same hillside contained a smaller percentage of the poison. The dried seeds of *C. ruscifolia,* on extraction with carbon-disulphide, yielded 22·8 per cent. of oil, which was very faintly toxic; 0·18 gram administered to a small kitten produced only very mild symptoms of tutu-poisoning. From the extracted seeds water removed a few crystals of a substance which gave the characteristic bitter taste and colour reaction of tutin.

Coriaria angustissima.

Only 1 kilogram of the dried plant was obtainable. It was collected at Dunedin early in January. Tutin was obtained from it, and identified by its melting-point. This species contains an acid which was not detected in the other two; when the aqueous extract of the plant was repeatedly shaken up with ether the latter extractions contained the acid in a comparatively pure condition. It crystallised from chloroform in silky yellowish needles, which were finally sublimed at 125° under diminished pressure. It was thus obtained in colourless iridescent plates, very readily soluble in water, alcohol, or ether. The acid has a characteristic smell, gives a transient violet colour with ferric chloride, and melts at 130° (uncorr.). On analysis—

0·1214 gave 0·2537 CO_2 and 0·0545 H_2O. C = 56·99; H = 4·99.

$C_8H_8O_4$ requires C = 57·10; H = 4·76 per cent.

Forty-two compounds of the empirical formula $C_8H_8O_4$ are already known. The *acid* from *C. angustissima* does not appear to be identical with any of these.

Coriamyrtin.

The physiological action of the New Zealand species of *Coriaria* and of the European species (*C. myrtifolia*) is so similar that a direct comparison of tutin with coriamyrtin, the glucoside isolated by Riban,* seemed desirable. A gram of coriamyrtin was obtained from Merck, of Darmstadt; the specimen melted at 225° (uncorr.),† and the melting-point was not altered by recrystallisation from alcohol. Like tutin,‡ the compound is somewhat volatile, sublimation commencing at about 150°. Analysis of the compound before and after crystallisation gave numbers agreeing closely with those obtained by Riban:—

0·1389 gave 0·3288 CO_2 and 0·0822 H_2O. C = 64·56; H = 6·57.

0·1263 gave 0·2976 CO_2 and 0·0734 H_2O. C = 64·25; H = 6·45.

Riban found (mean of three analyses) C = 64·07; H = 6·57.

$C_{30}H_{36}O_{10}$ (Riban) requires C = 64·75; H = 6·47 per cent.

$C_{21}H_{26}O_7$ requires C = 64·61; H = 6·66 per cent.

If the latter formula were correct, coriamyrtin would differ from tutin by C_4H_6 only, and its higher melting-point, lower volatility, and solubility suggest strongly that it is a higher member of the series to which tutin belongs. Molecular

* Bull. Soc. Chim., 1864 [ii.], 1, 87; 1867 [ii.], 7, 79.

† Riban gives 220°; Merck (Chem. Centr., 1899, i., 706) gives 229°.

‡ M. Riban has recently shown his continued interest in the subject by supplying us with a small quantity of the original sample of coriamyrtin, and providing us with copies of his valuable memoirs.

weight determinations, however, indicate that the true formula is smaller than either of the above, being probably half that assigned to coriamyrtin by Riban.

0·2478 gram raised the b.p. of 3·76 grams of acetone 0·46°. M = 255.

0·3196 gram raised the b.p. of 6·4 grams of acetone 0·33°. M = 265.

0·1732 gram depressed the m.p. of 8 grams of phenol 0·62°. M = 250.

0·2226 gram depressed the m.p. of 8 grams of phenol 0·80°. M = 250.

Calculated for $C_{15}H_{18}O_5$, M = 278; and for $C_{21}H_{26}O_7$, M = 390.

The conclusion that the real formula is $C_{15}H_{18}O_5$ harmonizes with the fact that, by the action of bromine, Riban obtained a crystalline derivative in which one-eighteenth of the hydrogen was replaced by the halogen. If, however, the compound is a glucoside, as its reactions suggest, the sugar which it yields upon hydrolysis cannot contain more than five atoms of oxygen, and the formula is remarkable in that it contains fewer oxygen-atoms than that of any glucoside hitherto described.

The appended table shows the chief differences between tutin and coriamyrtin :—

	Tutin, $C_{17}H_{20}O_7$.	Coriamyrtin, $C_{15}H_{18}O_5$ (E. and A.).
Solubility in 100 parts of water	1·8 at 10°	1·44 at 22° (Riban).
Solubility in 100 parts of alcohol	8·2 at 16°	2·00 at 22° "
Reaction with hydriodic acid followed by potash	Nil	Magenta* "
With concentrated sulphuric acid ...	Blood-red	Dirty-yellow.
Initial temperature of sublimation ...	About 120°	About 150°.
Melting-point ...	208°–209°	225°.
Optical activity ...	$[\alpha]_D^{19.5°} = 9.4$	$[\alpha]_J^{20°} = 24.5$.

The labours of the authors in the above investigation have been materially lightened owing to the assistance received from a number of gentlemen. In addition to those already mentioned, the authors desire to thank Sir James Hector for drawing attention to points in the literature of tutu which otherwise would have escaped notice; to Dr. Hocken, of Dunedin, for placing his fine library at the authors' disposal; to

* Reaction verified by the authors.

Mr. J. D. Ritchie, Secretary of the Department of Agriculture, and to Mr. H. J. Mathews, Chief Government Forester, for obtaining much of the raw material used in the investigation; to Mr. A. R. Young, M.R.C.V.S., for experimental assistance; and to numerous correspondents.

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Art. XLIV.—*Researches into the Action of Fusible Cutouts.*

By E. G. Brown, A.I.E.E.

[*Read before the Wellington Philosophical Society, 12th March, 1901.*]

Plate XIV.

The following is an account of the general results of researches (as yet incomplete) which I have been making into the behaviour of tin wires exposed to the heating effect of electric currents. These researches are the outcome of my experiences as fire underwriters' electrical inspector here, it having been borne upon me that the action of fusible cutouts (or fuses) was not at all satisfactory.

Since the underwriters have become responsible for the design of these fittings it appeared desirable to make a few experiments on the subject. These soon led to the conclusion that the tables at present in use (quoted in the rules I am working under as well as in all the electrical pocket-books I have seen, and due to Sir W. H. Preece,* and commonly called Preece's tables) are erroneous, the error with the larger wires being, according to my experiments, as much as 90 per cent., or probably more with very large wires, the error being that the fusing-currents are given too great. This appears an extraordinary statement, but I think I shall be able to show how it is that this error has hitherto escaped the notice of practical men. It will be also suggested, as the result of experiments, that tin is probably a thoroughly reliable material for the construction of fuses, under proper design, of course.

I found it necessary to establish the physical properties of the tin I was using, the more especially as practical men assured me that my wire was made of an alloy of tin and lead. Accordingly I submitted the fuse-wires A and B to a careful approximate analysis. Taking SnO_2 as 78·66 per cent. metal, I obtained, with both A and B, a percentage of tin of 99·5 per cent.; the impurities, roughly estimated as sulphides containing two-thirds of metal, gave 0·3 per cent. impurities with sample B, and about half this amount in the case of sample A. Sample A is certainly the purer of the two, and it will be noticed in the table of specific resistances that it has the higher conductivity—about 3 per cent. higher. It also has a higher fusing-point; but, still, the values of the fusing-currents observed were practically identical.

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* Proc. Roy. Soc., 1884, No. 231; 1887, December; 1888, April.

These results are sufficient to show that my metals are "commercial pure tin." It would have been interesting, no doubt, to have made a complete analysis of the metals; but for this purpose what is really required is the specific resistance and the fusing-temperature of the material, and to this I accordingly devoted my attention. Here sundry difficulties cropped up. The first determination of the specific resistance (ρ_0) gave a value about 25 per cent. less than that of Matthiessen, the English standard. My values will be seen to be of the order of $10{\cdot}6 \times 10^{-6}$ ohms per cubic centimetre at 0° C. for tin wire, confessedly impure, hard-drawn into wire of about 36 mils; Matthiessen gives the numeric as 13·19 for "tin, pressed." Matthiessen's value I find to be confirmed by Fleming;* my own value, approximately, by Kirchoff and Hausemann—10·67 at 15° C. (10·018 at 0° C., reducing by my formula for temp. coef.); Lorenz, at 0° C., 10·781 (taking mercury as 94·074); Becquerel (1846), given by Weiller (1885), 11·6 (cf. with mercury), 94·079; 10·71 (cf. with silver), 150. Tin pure; banca drawn into wire, 9·821.

A similar disagreement is apparent with regard to the temperature coefficient, the authorities I have been able to consult giving as follows (writing, instead of the usual formula, the coefficients for the temperature divided by 100, which gives handier numbers and is more convenient for my purposes):—

Matthiessen, $\left[1 + 0{\cdot}3628\left(\frac{t}{100}\right) + 0{\cdot}0636\left(\frac{t}{100}\right)^2\right]$, from 0° to 100°: calculated by myself from his conductivity coefficient at 0°, 50°, and 100° C.†

Fleming, about $\left[1 + 0{\cdot}4085\left(\frac{t}{100}\right) + 0{\cdot}0345\left(\frac{t}{100}\right)^2\right]$, from 0° to 200°: calculated from the curves given (*Elect.*: 3rd July, 1896, p. 30), P at 0° = 13·1; 100° = 18·9; 200° = 25·6.

Lorenz, $\left[1 + 0{\cdot}432\left(\frac{t}{100}\right)\right]$: calculated from values at 0° and 100° of conductivity.

Benoït (1873), $\left[1 + 0{\cdot}4028\left(\frac{t}{100}\right) + 0{\cdot}05826\left(\frac{t}{100}\right)^2\right]$.

My own value for fuse-wire A (annealed) is—

$$\left[1 + 0{\cdot}421\left(\frac{t}{100}\right) + 0{\cdot}0398\left(\frac{t}{100}\right)\right],$$

the curve fitting the equation very well indeed. My value, however, is dependent upon the thermometer errors very largely, especially the quadratic term. Since 0° and 100° are the fiducial points, it is better to take the change of resistance for this range. Thus we have—

* Friday Evening Discourse, Roy. Inst., 5th June, 1896.

† Trans. R.S L., 1862.

Matthiessen	...	·4264	Change in resistance of 1 unit betwen 0° and 100° C.
Fleming	...	·443	
Lorenz	...	·432	
Benoït	...	·460	
My own value	...	·4478*	

Matthiessen's value for the temperature coefficient is usually given as 0·00365 per degree at ordinary temperatures. This value, as may be seen by differentiating the formula I have given, is the rate of change of ρ_0 at 15° C.

Further research is evidently required to set up a standard for "pure tin." I am at present engaged in testing some samples of commercial tin, some results for which will be found in a table printed herewith.

To add to the confusion, I find that at a temperature beween 170° and 190° the resistance of a sample of tin (hard-drawn sample A) increases 3·6 per cent., the highest temperature reached being 200·7° C. Upon reheating to 214·8° a further small increase (0·6 per cent.) occurred, making a total of 4·2 per cent. on two "annealings."

Upon another sample the effect of fusing the wire (laid flat on asbestos) was tried. The resistance at 15° C. increased 5·1 per cent. It will be observed, however, that commercial tin does not vary much in the different samples I have tested. This will be noted as a point of great importance in estimating the reliability of tin as a fuse material, other essential points being thermal conductivity, emissivity, and fusing-points. I have not yet examined either of the former two quantities very closely; but, as far as sundry fusing-tests indicate, the change in thermal conductivity is very small after "annealing" the hard-drawn wire. As to emissivity, I hope to have something to say about this later on, meanwhile I include figures showing the effect on the fusing-current for one or two sizes of wire of shellacking and of thoroughly oxidizing the surface of the wire (by dabbing with nitric acid). It will be seen that a 10-per-cent. margin would about cover the effect of shellac or white oxide with these sizes. This is another point to be noted with regard to reliability.

As to fusing-points, a table is given of sundry samples, but the results are, owing to uncertainty in temperature standards, not absolute. Callendar and Griffiths give the fusing-point as 231·68° C. Still, the comparison shows that the variation which we may expect is very small. The standard thermometer has been sent to Kew.

The foregoing leads to the conclusion that there is no standard to which I can refer my wire for comparison with that used by Sir W. Preece. The only way in which the

* Thermometer errors included; correct value probably less.

two can be compared is by the values of the fusing-currents themselves. Here there is some slight difficulty, owing to an alteration of the values assigned to the fusing-currents in the ratio of 1,800·6 to 1,642 between the years 1887 and 1888. This is referred to as a verification of the "dimensions of the currents as detailed in my paper read on the 22nd December, 1887," but whether it is a recalibration of standards, the result of further tests, or a recalculation of means does not appear. I have taken it that the means have been recalculated.

(1.) Diameter of Fuse-wire.	(2.) Fusing-currents calculated from Sir W. Preece's Formula.	(3.) Fusing-currents observed by Sir W. Preece.	(4.) From My Experiments.
8	...	...	1·43
10	1·64	2 55	2·0
14	2·8	3·244	3·1
18	4·0	4·095	4·1
20	4·65	4·675	4·65
26	7·0	6·570	6·2
30	8·5	8·656	7·25
33	9·9	9·430	8·1
36	11·25	11·60	8·85
40	13	13·14	9·9
50	18·4	*	13
100	52	*	31
150	95	*	50·5
157·4	102	*	53·5

My tests (column 4) are of tin wires, very long, horizontal, in free air, and tested with alternating current of 80 periods.

The agreement of Sir W. Preece's experimental results with his law is remarkably good, except, as he pointed out at the time, for the fine wires, which are of not much importance. But my results, while agreeing well with those of Sir W. Preece from 14 to 20 mils, show a decided divergence at the largest observed value, and a very serious divergence from the calculated figure for the largest wire which I tried.

The difference between my value and Sir W. Preece's for the largest wire he tested is about 32 per cent. With regard to this I have first to remark that I have found, for the particular dimensions referred to, a cooling effect from the terminals of about 4 per cent., which, applied to Sir W. Preece's

* Apparently not observed.

figures, reduces the discrepancy to 28 per cent.; and, secondly, that unless the effect of time is carefully studied the observed values may be too great. As an instance, I may give my own experience. By applying current by slow increments (or what I then considered slow) to a wire of 100 mils I obtained a value for fusing-current of 44 amperes, against the value 31 which I subsequently found to be the true one, and 52 as given by Sir W. Preece's formula. Not only that, but I obtained a number of results all agreeing within about 2 per cent., which I, at that early stage, considered highly satisfactory. Upon going into the subject mathematically, however, I found that time was of the greatest importance, and, as indicated, convicted myself of the surprising error of 42 per cent. due to "personal equation." I had discovered this before testing the smaller size, unfortunately, but will hazard the calculation that I would have erred 15 to 20 per cent. with a 40-mil fuse. Sir W. Preece, so far as I have observed, makes no mention of this source of error in his papers.

I have not yet quite finished my work on the cooling effect of terminals, but have got far enough to be able to give the length of fuse at which Sir W. Preece's values apply. The following are these lengths :—

Diameter. Mils.	Amperes (Preece).	Approximate Length in Inches.
100	52	3
50	18·4	3
40	13	2½
30	8·5	2½
20	4·65	*

Practical men will recognise in these lengths the ordinary lengths used, or rather longer, so that in practice, and unless the fuse is confined or the terminals get hot, Sir W. Preece's table gives a value of the fusing-current that will not fuse the wire. This is, I believe, the explanation of the fact that the error of Preece's tables has not hitherto been detected by practical men, who seem to have been satisfied that the troubles that have arisen have been due to faults due to the material tin.

Many engineers—not, I think, insurance inspectors—prefer copper as a fusing material. It is significant to note that in my preliminary experiments I tried copper fuses up to about 30 amperes, and found my figures agree with Sir W. Preece's, and that the cooling effect of the terminals is much less than with tin. This was to be expected, since the experimental figures go up to 53 amperes.

A practical point I should like to mention is the remark-

* Very long wire; 5 amperes, = 2 in.

able effect of shellac upon fuse-wires, which was mentioned by Sir W. Preece. I have not yet fully examined the effect on the fusing-current; with a 100-mil wire, long, it increases the fusing-current about 14 per cent., and 10 per cent. with a 40-mil wire. I may here note that thorough oxidation of the surface has the same effect (about) as shellac upon the 100-mil wire.

If the plain fuse-wire simply stretches between its terminals the effect of fusion is first noticed by the centre melting and dropping into a catenary, which slowly increases in length until it reaches within, say, $\frac{1}{2}$ in. of the terminals (if the fuse is short), when it attains a dull-red heat (owing, no doubt, to the specific resistance of molten tin being probably about double that of the solid metal). Oxidation sets in, and after a few hours a thin wire will burn right through. If the wire is long enough, the catenary will increase in length till the weight breaks it off. By experiment I have found that this length is roughly represented (for sizes over 20 mils) by the formula—

$$L\,D = 40, \text{ where } L = \text{length of catenary in inches, and}$$
$$D = \text{diameter of wire in mils.}$$

Thus a 40-mil wire requires a length of $\frac{40}{40} = 1$ in. for its catenary, with, say, $\frac{1}{2}$ in. allowance at each end—2 in. in all—before it will break without getting red-hot. So with 20 mils the length required is 3 in., with a clear space of about $\frac{5}{8}$ in. underneath, to allow for the droop of the catenary. But if the wire is shellacked the effect is that upon fusion the shellac may be seen to dance about in a very lively fashion on the surface of the molten tin, which presents a mirror-surface, until a length of $\frac{1}{4}$ in. is fused, when the wire snaps sharply, the molten material flying back and forming little beads on the unmelted end of the wire. (The voltage of the circuit was about 5 volts, alternating.) This observation seems to be of some practical importance, as I think it is generally understood that shellacking a fuse-wire is intended merely to prevent oxidation.

I may say that I consider the phenomenon to be due to surface-tension, and not prevention of oxidation, because while the before-mentioned catenary is forming, the tin wire breaks off in little avalanches as it melts into the catenary, the surface presenting momentarily the bright appearance of unoxidized metal.

I will now give a table of the properties of my materials so far as I have determined them at present. I have to thank Professor T. H. Easterfield for the determination of the specific gravities of the materials, an operation requiring great skill and care to insure accuracy. I have applied the corrections for specific gravity of water by Volkmann's table, and for air by Regnault's figure, and for dilatation at 0·000063 per degree. The specimens were about 35 mils diameter, varying about 0·2 mil from the mean at most as tested by a micrometer, the diameter being obtained from the lengths and weight, and the lengths about 5 ft. or 6 ft. The wires generally stretched about one-thousandth after coiling round a 3 in. drum. The mean length was taken. Without going into detail, I may say that I believe each measurement to have been accurate to 1 in 1,000, which is quite sufficient for the purpose.

TABLE of SPECIFIC RESISTANCE OF TIN WIRES HARD-DRAWN.

Description of Material.	I. Specific Gravity at 0° C.	II. Specific Resistance, Microhms per C.C. 0° C.	III. 15° C.	IV. Fusing-point, Centigrade (approx.).	V. Diameter from Volume and Length.	VI. Diameter by Micrometer, with Variation from Mean.
Fuse-wire (sample A)—	Ingot.					
No. 1	7·2880	10·969	11·672	224·6	..	20·48 +0·27 −0·13
No. 2	7·2790	10·951	11·653	224·2	..	35·25 +0·2 −0·2
No. 3	7·2863	10·928	11·628			35 circ.
Fuse-wire (sample B)	7·3000	11·263	11·984	223·5 / 223·0	..	35 circ.
Ditto, purified by oxidation and reduction	7·2812	11·088	11·798	..	30·638	30·556 +0·3 −0·3
Fuse-wire (sample C)	7·3144	11·233	11·953	221·3 / 221·0	..	36·88 +0·43 −0·12
Purchased as "chemically pure" (Merck)	7·2935	10·592	11·269	224·9 / 224·3	36·965	36·875 +0·13 −0·07
Australian tin ..	7·2833	10·944	11·645	224·6 / 224·2	..	35·585 +0·08 −0·12
Ditto, remelted in air	7·2914	10·835	11·529	..	..	35·7 +0·05 −0·1
Plumbers' "block" ..	7·3088	11·082	11·791	219·6 / 219·3	36·80	36·71 +0·19 −0·21
Cornish tin ..	7·3606	11·219	11·939	225·6 / 225·0	..	35·68 +0·02 −0·05
Fine fuse-wires drawn by the maker (nominal diameter)—						
14·7 No. 2 ..	Assumed, 7·30	10·598	11·277	..	..	14·68 +0·07 −0·03
14·7 No. 1 ..	Assumed, 7·30	10·547	11·222			
11·3	Assumed, 7·30	10·368	11·032	..	..	11·27 +0·05 −0·1
9·6	Assumed, 7·30	10·116	10·764	..	..	9·57 +0·08 −0·12
8 No. 1 ..	Assumed, 7·30	10·118	10·767	..	7·96	8·01 +0·015 −0·01
8 No. 2 ..	Assumed, 7·30	10·030	10·690			

The resistances were measured near 15°, and corrected to zero by the formula given in the paper for 0° C. (col. II.). The temperatures in this are not corrected; the thermometer has been sent to Kew. The dimensions of the wires are reduced to 0° C. by the coefficient (linear) 21×10^{-6}.

It will be observed that these figures, leaving out the very thin wires, which are perhaps abnormal, do not vary much (8·2 per cent.) from the value $10{\cdot}4 \times 10^{-6}$ ohms per cubic centimetre at 0° C — that is to say, the common impurities do not much affect the conductivities apparently; also, that the materials probably the most pure have the highest conductivity, which is usually the case with metals. The agreement with the Continental authorities is very fair, but with the English there is a very decided disagreement.

The values for specific gravity agree very well with those of Matthiessen, which I calculate to have been 7·282, the only notable exception being the "Cornish tin," which gives a value about 1 per cent. high.

It is now necessary to refer to the results of previous experimenters, and here is the chief difficulty in making original researches of this kind in Wellington. Beyond the "Transactions and Proceedings of the Royal Society" (for which I am indebted to Sir James Hector), and a few years of the *Electrician*, which the Telegraph Department kindly gave me access to, a few works in the public libraries, and technical papers and works of my own, I found nothing available in Wellington. This seems to me a regrettable state of affairs. However, I think I am justified in asserting that Sir W. Preece's tables have never been effectively criticized. Dr. Bottomley, indeed, in a letter to the *Electrician*,* suggests that Sir W. Preece's figures were not in accord with some experiments of his. I may extract a sentence: "And I should expect that it would require currents greater for small wires and smaller for large wires than corresponds to the proportionality to $d\sqrt{d}$," which is what I have found. But in a postscript he adds that a difference in the conditions may alter the law in such a way as "would correspond to what Mr. Preece has found, though, of course, the subject will require investigation." The effect of this criticism may be judged from the date (1884).

Again, in 1892 Professor W. E. Ayrton, F.R.S., and Mr. H. Kilgour made a research into the emissivity of platinum wires up to 14 mils in diameter.† They write: "In 1884 it was observed experimentally that, whereas the electric current required to maintain a thick wire of given material under

* 19th April, 1884, p. 541.

† Phil. Trans. Roy. Soc., 183A, 1892, p. 371, *et seq.*

given conditions at a given temperature was, roughly, proportional to the diameter of the wire raised to the power three halves, the current was more nearly proportional to the first power of the diameter if the wire were thin." Later on, on page 395, after pointing out that their formulæ for emissivity may not be safely extrapolated, they assert that to assume the emissivity to be constant would be to make "an error of hundreds per cent. in the case of some of them" (*i.e.*, wires of diameters "from a small value up to 1 in.").

This is an evident criticism of Sir W. Preece's work, but I am wholly unable to find any practical effect following from it. And, finally, Sir W. Preece's tables are quoted without remark in all the electrical pocket-books I have seen.

The crux of the whole question is the value to be taken for the emissivity which is concerned in the phenomena in the following manner:—

Let C = current in amperes,
$\rho\theta$ = specific resistance at the temperature of fusion,
ϵ = emissivity in absolute measure or in gramme calories per second, per square centimetre, per degree (at the temperature of fusion),
J = Joule's equivalent, gramme calories (Watt-seconds),
D = diameter of wires,
A = a constant,
θ = elevation of temperature of wire at fusion,

then fusion is reached if there is no cooling effect of the terminals in a wire when—

$$C^2\frac{\rho\theta}{D^2} = AJ\epsilon\theta D;$$

$$[\text{or}] \quad C^2 = \frac{AJ\theta\epsilon}{\rho\theta}D^3;$$

$$[\text{or}] \quad C = D^{\frac{3}{2}}\sqrt{\frac{JA\theta}{\rho\theta}\epsilon}.$$

Sir W. Preece assumes the quantities under the root to be a constant (1642, D being inches).

If, now, we take my values for θ and $\rho\theta$ to be correct, we may calculate the constant value for ϵ which is assumed by Sir W. Preece. It is—

$$\epsilon = 0{\cdot}00176 \text{ absolute units (approximately).}$$

Ayrton and Kilgour (*l.c.*) give the formula—

$\epsilon = 0{\cdot}0011113 + 0{\cdot}0143028\ D^{-1}$ mils for a temperature difference of 200° C. for platinum.

The accompanying diagram (Plate XIV.), of which the ordinates are values of ϵ, the abscissæ values of $\frac{1}{D}$ in., shows clearly the relation between Sir W. Preece's law, Ayrton and

Kilgour's law, and the approximate values of ϵ calculated from my results. The experimental values obtained by Ayrton and Kilgour are shown by circles.

It will be seen that my results agree fairly (considering a possible difference between the materials tin and platinum) with Ayrton and Kilgour's experimental results, but do not agree with the extrapolation indicated by the law of Ayrton and Kilgour given above, and that Sir W. Preece's constant value is incompatible with both.

My curve, it will be seen, agrees fairly well with a straight-line law from 157 mils to 20 mils diameter of wire of the following form—

$$\epsilon = 0{\cdot}000314 + 0{\cdot}031\ D^{-1},\ 157 \text{ to } 20,$$

the maximum error being about 8 per cent. at 97 mils (only 4 per cent. if the fusing-current is calculated from the formula, since the current is proportional to the square root of the emissivity). The figures are only provisional, but it is interesting to compare them with the Ayrton and Kilgour formula. However, I do not think that emissivity can be a simple function of the diameter. As the result of a consideration of the factors involved I fancy that the true curve will be found wavy or "kinky."

Experiments upon samples A and B, while giving results hardly distinguishable from each other, both agree in suggesting a kink in the curve at 97 mils.

Of the further work remaining to be done with fuses it will be observed—(1.) That a standard is required for the specification of tin wire (or whatever metal is selected) in the particulars of specific resistance, annealing coefficient, and temperature coefficient (or specific resistance at a temperature near fusing-point) and the fusing-point. At any rate, it should be decided whether a guarantee of "commercial purity" of metal is sufficient. (2.) That the cooling effect of terminals needs inquiry. I hope shortly to publish figures accounting for this factor; but a full theory of this phenomenon involves amongst other things thermal conductivity. This quantity, however, can, I think, be calculated in a form suitable for the purpose from the cooling-effect results. (3.) The effect of change from a horizontal to a vertical position of the fuse-wire must be studied. This should, however, be a small matter after the phenomena for horizontal wires have been determined. Corrections in the form of small percentages should cover it in practical cases. (4.) That then the phenomena of fuses in their porcelain boxes may be studied with some hope of success. This is the problem which I set out to solve; it is the practical problem which interests insurance companies, electrical engineers, and users of electricity alike.

I do not think it reasonable that private individuals should be expected to carry out work of this kind at their own expense, but I shall be content if I have been able to do something towards the conversion of the fusible cutout from an empirical makeshift to a scientific instrument.

In conclusion, I would like to thank Mr. Stuart Richardson, A.M.I.E.E., of the New Zealand Electrical Syndicate, for the loan of measuring-instruments and the use of standard instruments for the calibration of the same.

Note.—I have taken out values for emissivity from the research of J. E. Petavel (*loc. cit.*), and find that they agree very well with my curve. The points are marked in triangles on the chart. The following are the figures (emissivity at 200° C. of platinum wires) :—

Diameter (Mils).	ϵ.		Inch. Int. Diam.
44·15 ...	0·001	in horizontal iron tube.	
44·15 ...	0·00108	in horizontal brass box,	$1\frac{1}{8}$ in. x 3 in. x 3 in.
23·7 ...	0·00148	in horizontal brass box,	$1\frac{1}{8}$ in. x 3 in. x 3 in.

Mr. Petavel also gives a figure from Dr. Bottomley's researches* of a vertical wire, which he calculates at about 11·8 mils, for which $\epsilon = \frac{0{\cdot}8137}{408} = 0{\cdot}001995$, which value, plotted back on Mr. Petavel's curves, fig. 7 reduces to about 0·00165. Then, adding 30 per cent. (to express the difference between a wire vertical and horizontal, estimated from the same curves), we have $\epsilon = 0{\cdot}002145$. This value is plotted in a square, and is given for what it is worth.

Dr. Bottomley in this paper gives results, which I take as the lowest value of ϵ attained by himself, as 45×10^{-6}, and as 30×10^{-6} by Schliermacher, in the best vacua obtainable.

I have taken a value of ϵ for a $\frac{1}{2}$ in. copper rod at 200° C. from Mr. R. W. Stewart's results,† for which $\epsilon = 0{\cdot}000387$, about; also a value from an engineering-book of $\epsilon = 0{\cdot}000245$ for a steam-pipe at about 150° C. These have been plotted in as figures of comparison; Mr. Box's formula ($\epsilon = 0{\cdot}00005710 \times 0{\cdot}0833\ D^{-1}$), which is referred to by Professor Ayrton and Mr. Kilgour, for large cylinders at a temperature not given.

These results, plotted together, suggest a curve for ϵ of some fractional power of D^{-1}, with zero at $\epsilon = 0{\cdot}00005$,

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* Phil. Trans., 178A, 1887.
† Phil. Trans., 184A, 1893.

about, for average surfaces. Such a curve sketched in gave the following trial ordinates:—

D^{-1}.	Trial Value of ϵ.	$\epsilon - 0{\cdot}00005$.	ϵ calculated.
0·2	0·00390	0·00385	0·00396
0·1	0·00255	0·00250	0·00257
0·05	0·00170	0·00165	0·001674
0·02	0·00095	0·00090	0·000956
0·01	0·00065	0·00060	0·00063
0·34	...		0·00553
1·0	...	...	0·010915

Ayrton's formula gives 0·0154 for $D^{-1} = 1{\cdot}0$.

The column "ϵ calculated" is of values of ϵ calculated thus:—

$\epsilon = 0{\cdot}00005 + 0{\cdot}010865(D^{-1})^{\cdot 635}$, D being mils.

As will be seen, the agreement is fairly good as a first approximation.

The corresponding curve has been traced (thin line), marked "B formula." It will be seen to agree in a rough way with the data I have here collected, except for the copper rod and steam-pipe, and also with Professor Ayrton and Mr. Kilgour's results for wires finer than 2·7 mils, which could not be plotted on the diagram. It will be observed that Mr. Box's formula is parallel or tangential to it at 0·92 in. diameter, my own straight-line formula at about 50 to 70 mils, and the formula of Professor Ayrton and Mr. Kilgour at 7 or 8 mils (about the mean diameter of the wire used by them).

It would appear from Dr. Bottomley's and Mr. Schliermacher's researches that the radiation, or electro-magnetic emission, is not more than 0·00003 for silver or platinum tested in vacua. This is not of very different dimensions to the constant of Box's formula. Consequently, I take it, practically, the whole of the emission from ordinary fuse-wires is convective.

As this matter has been elaborated, I wish to again say that my figures are subject to correction, chiefly for thermometer error, especially for the three finer wires (those for which $D^{-1} = 0{\cdot}049$, 0·068, and 0·1258), the physical constants of these wires not yet having been determined.

Art. XLV.—*Investigation into Kauri-resin.*

By E. B. R. Prideaux.

[*Read before the Philosophical Institute of Canterbury, 3rd April, 1901.*]

Plate XVII.

A good deal of interest has been taken of late years in the chemical characteristics of kauri-resin, and especially in the products of its destructive distillation. Mr. Trevor, of Auckland, not long ago conceived the idea of obtaining these products, especially from the scrapings and refuse parts of the "kauri-gum," as it is commonly called.

A syndicate was actually started in this city—Christchurch—to carry out Mr. Trevor's idea, and a good deal of the oil was obtained and purified in the usual way. Investigations were also carried out at Canterbury College, under the supervision of Mr. Page. The gum used on this occasion consisted chiefly of such poor-quality material as would naturally be used for commercial distillation. The following are the results obtained:—

Temperature.	Specific Gravity of Fractions.
140° C.	0·905
140°–160° C.	0·87
160°–265° C.	0·93
265°–335° C.	0·95
335°–400° C.	0·01

It was suggested to me by Mr. Page that a more detailed examination of the chemical properties of the resin would be interesting and useful.

In this paper I propose to give a sketch of the obvious properties of the resin, tables of bromine-absorptions and free-acid determinations, an account of its distillation, and the oils derived therefrom. While making some random experiments on the oil obtained by the syndicate I noticed a little peculiarity, which I will add as a note immediately before the description of the oils.

Kauri-gum is one of New Zealand's staple exports. It is dug up in large quantities from the clay lands which lie to the north of Auckland, and it is almost confined to that peninsula, for the kauri-tree does not grow in the southern part of the

North Island. Besides being dug out of the ground, a good deal of it is gathered fresh from the standing trees, where it has oozed out of the bark. When dug from the ground it is scraped free of earth and shipped away in that condition, no attempt having been made to deal with it here to my knowledge, except by the syndicate mentioned above.

I have looked up the "Transactions of the New Zealand Institute," 1869 to 1900, and found next to nothing about the chemical properties of this resin. I found a good many articles on the behaviour of other resins in the back numbers of the "Journal of the Chemical Society," of which the years from 1870 to 1872 and 1882 to 1900 were accessible to me; but, unfortunately, the number which a dictionary of chemistry gave as containing an investigation of kauri-resin was not to be found.

Among the books which I have most used are Ostwald's "Physico-Chemical Measurements"; Allen's "Commercial Organic Analysis," 1886; "Lubrication and Lubricants," Archbutt and Deeley, 1900; "Destructive Distillation," Mills, 1886; and Sutton's "Volumetric Analysis."

There are two main varieties of kauri-resin—the fresh resin as it hardens on the tree, which is generally white or transparent, and the fossil resin. The appearance of the latter ranges from transparent to opaque, from white to yellow. I used for my distillation the purest fossil resin, obtained from carefully scraped lumps roughly powdered. For finding the bromine-absorptions I used the method of Mills,* first making sure of the results by finding the absorption of a known oil (olive). My reason for using the bromine method rather than the iodine was that a solution of bromine in carbon-disulphide is not so complicated to make up as the solution of iodine-chloride. It is doubtful, besides, whether any results could be obtained from a resin in a reasonable time with the iodine solution. Mills has determined the absorption of kauri-resin to be 108·2. He has not stated the variety of resin which he used, but I got values much higher than this for all varieties. Mills has also noticed that hydrobromic acid is always formed, but gives no figures for it. I have given figures in most cases. The method I adopted was to decant the aqueous part of the solution after the reduction with $Na_2S_2O_3$, wash the CS with water two or three times, adding the water to the part first poured off, then add methyl orange and titrate with decinormal NaOH. After this was done I added phenolphthalein and titrated with decinormal NaOH for organic acids. The values found were nearly the same with very

* Allen's "Commercial Organic Analysis," "Resins"; edition, 1886.

different weights of resin, so it is evident that these acids are soluble to a limited but definite degree in water, as I used nearly the same volume each time for the determination of HI. After the bromine had been absorbed, and before titrating with $Na_2S_2O_3$, I added excess of KI. After the starch blue had been bleached with $Na_2S_2O_3$ it returned on standing in the light, and this went on slowly, in some cases for many days. When kept in the dark there was practically no change. This residual action amounted to more than 0.6 c.c. decinormal $Na_2S_2O_3$, and was seen both in the resin and in the oils distilled from it. I took some of the reduced solution before the blue had had time to reappear, added litmus, and neutralised with decinormal NaOH. Then I blew through it, but instead of turning red it only turned purple, the red of the litmus being masked by the blue of the starch iodide. This shows that it is not only HI, but the excess of KI also, which is oxidized by some constituent of the resin, with liberation of I.

The following is the way in which I derived the figures for the third and fourth columns :—

Suppose x grams of Br are taken.

Let P = part of resin unaffected by Br ;
nH = H atoms replaceable by nBr ;
yBr = weight of Br which can be added to compound :

$$\mathrm{P}n\mathrm{H} + x\mathrm{Br} = \mathrm{P}(n\mathrm{Br}) - (y\mathrm{Br}) + n\mathrm{Br} + (x - 2n - y)\mathrm{Br}.$$
$$y\mathrm{Br} = x\mathrm{Br} - 2n\mathrm{Br} - (x - 2n - y)\mathrm{Br}$$

$(x - 2n - y)$Br is the excess of Br determined as free I.
nBr is the Br determined as HI.

To get the total absorption I substract the weight of Br calculated from $Na_2S_2O_3$ from the weight originally taken and calculate $\frac{\mathrm{Br}}{\mathrm{Weight\ of\ resin}} \times \frac{100}{1}$.

From the weight of Br used in getting the total percentage absorption I now take twice the weight of Br calculated as HBr, and reckon out the percentage absorption of the remainder with the weight of resin taken. By subtracting the latter percentage from the former I get the percentage of Br replacing H in the resin and appearing as free HI. I used all ordinary precautions to keep the solution dry, such as heating and drying the flasks before adding Br, and keeping the standard Br solution and resin-oils over $CaCl_2$.

Kind of Resin.	Total Percentage of Br disappeared.	Percentage Absorption.	Percentage Substitution.	C.c. $\frac{N}{10}$ NaOH for Organic Acids.
Fresh (transparent) ..	153·8	..	..	..
" " ..	165·1	..	..	..
" (dark)	156·6	..	..	..
" (transparent) ..	152·9	63·8	89·1	..
" " ..	160·5	80·3	80·2	1
" " ..	150·9	76·3	74·6	1
" " ..	175·5	99·1	76·4	..
" " ..	166·4	87·9	78·5	1·15
Fossil (white, opaque) ..	158·4	90·9	67·5	..
" " ..	163·2	84·07	79·13	0·5
" (yellow, transparent)	148·2	77·2	71	2
" "	160·2	78·6	81·6	1
Fossil (yellow, transparent, brittle)	145·3	..	..	..
Ditto	143·6	75·6	68	..
Roasted, brittle and dark-brown	143 6	57	86 6	1·2

Free Acids.

I employed the usual method with extra precautions, rendered necessary by the insolubility of the resin. Took a very small portion of the resin and let it steep in absolute alcohol for about half an hour. Then boiled under a reflux condenser for about a quarter of an hour, and let it cool and remain over night before titrating. The resin formed a kind of emulsion with alcohol, but was not completely dissolved even by a very large excess. The neutralisation values kept increasing on dilution, but the rate of increase got slower. I took for final the values obtained at a dilution just not too great to allow the pink colour of the phenolphthalein to be perceived. The figures represent the number of cubic centimetres of normal NaOH required to neutralise 100 grams of the resin.

Kind of Resin.	Weight.	C.c. $\frac{N}{10}$ NaOH.	C.c. Alcohol.	Koettstorfer's Number.
Fresh resin	0·449	4·2	50	100·2
"	0 023	0·5	50	209·2
"	0·0092	0·2	50	217·4
Fossil (white, opaque)	0·3293	4·5	50	73·3
" "	0 0252	0·45	50	178·5
" "	0·0341	0·6	75	173·0
" "	0·0258	0·45	50	174·4
Fossil (yellow, transparent)	0·737	0 8	75	108·5
Ditto	0·1694	0·3	50	177·1
"	0·023	0·43	50	186·9
Fossil (yellow, brittle) melted and cooled	0·04855	0·78	75	160·6
Dark-brown and brittle	0·0337	0·55	75	163·2

Note on Resin-oils.

In a preliminary examination of the crude oil obtained from the refuse, dust, and scrapings of the resin I noticed that it absorbed I from a solution of I in KI when slightly warmed. The method is to take a little of the oil, add starch solution, shake them up, warm slightly, and then add decinormal I solution drop by drop, with vigorous shaking between each drop, until the blue colour is permanent. Neither linseed-oil nor turpentine will take away the colour produced by even a single drop of decinormal I solution. The sample of kauri-resin oil, however, gave a definite absorption. It seemed probable that all resin-oils would do likewise, thus giving a method of detecting them in linseed-oil or turpentine. I determined the absorption of the sample of resin-oil, which was 1·708. I then made a mixture of 2·238 grams of linseed-oil and 0·1064 grams of resin-oil. The calculated percentage of resin-oil in the mixture was therefore 4·5 per cent. I employed upon this mixture the method given above. The decinormal I solution required to give a permanent blue was 0·12 c.c. Therefore the percentage of resin-oil in the mixture calculated from the experiment was $\frac{0{\cdot}001524 \times 100 \times 100}{1{\cdot}7 \times 2{\cdot}3444} = 3{\cdot}82$.

More accurate results could be obtained by using $\frac{N}{100}$ I solution.

Investigation of Oils.

First I distilled a small portion of the pure resin from a glass flask with a thermometer inserted, in order to get the proportions by weight of the various oils from a given weight of resin :—

	Weight in Grams.	Per Cent. of Weight.
(1.) First portion, 50°–100°; about half of this was water; light-yellow oil ...	4·442	24·6
(2.) 100°–190°; a darker-yellow oil ...	2·0278	11·2
(3.) Dark yellowish-green; 190°–280° ...	6·8034	37·7
(4.) Above 280°; darker still, fluorescent ...	1·2326	6·7
(5.) Pitch left in distilling-flask	2·779	15·4
	17·2848	
Weight of resin taken	18·0390	
Gas = ...	0·7542	4·4

I have described before the class of resin used in my distillation. I distilled from a copper still with a copper leading-tube. The resin softens at a low temperature, and gives off a good deal of vapour. It shows a disposition when the temperature is quickly raised to swell up and froth over into the leading-tube. I collected all the oils together and redistilled them from a flask containing a bulb apparatus and a thermometer. When the temperature began to go up steadily I substituted a fresh receiver, and left it there while the thermometer stood still at a fixed point until the temperature began to rise again. I distilled a second time on the same principle and with the same apparatus, and again a third time. (See Plate XVII., fig. 1.)

Descriptions of Oils.

After the first of these distillations the oils fell into seven broad classes—

(1.) Below 100°; colourless; aromatic odour, with very slight smell of resin-oil.

(2.) Light-yellow; strong smell of resin-oil; 100° to about 200°.

(3.) Reddish-yellow; strong smell of resin-oil; 200° to about 280°.

(4.) Light-green; slight smell of resin-oil; 280° to about 300°.

(5.) Greenish-brown; slight smell; 300° to about 310°.

(6.) Greenish-brown; blue fluorescence; slight smell; 310° to about 380°.

(7.) Dark-red; green fluorescence; slight smell; 380° to about 390°.

The temperatures are only approximate, being taken during the distillation. After the third distillation the light-green fraction disappeared.

The boiling-points were now obtained by putting the fractions successively into a small flask fitted with a cork containing a thermometer and a simple glass tube for a reflux condensor. I washed the flask out with CS_2 after each determination. (See Plate XVII., fig. 2.)

The temperature when the thermometer-bulb was immersed in the liquid was usually 2 or 3 degrees above that taken when the bulb was just above the surface of the liquid.

For the readings given I took the temperature of the vapour just above the liquid, and applied a correction for the length of the mercury column in the air. I took the temperature just outside this by means of a smaller thermometer attached.

The following is a description of the oils obtained after the third distillation:—

Distillate.	Boiling-point.	Total Percentage of Br disappeared.	Percentage of Absorption.	Percentage of Substitution.
(1.) Colourless	85°	..	..	..
(2.) Light-yellow ..	102°	162·4	103 8	58·6
(3.) " ..	127°	..	..	..
(4.) " ..	150°	..	..	..
(5.) " ..	161·8°	..	..	..
(6.) " ..	166 3°	..	..	..
(7.) " ..	175·7°	..	..	..
(8.) Reddish-yellow ..	182·8°	..	..	..
(9.) " ..	211·7°	..	..	..
(10.) " ..	224 2°	..	..	..
(11.) " ..	241 3°	114·55	41·44	73·11
(12.) " ..	252·3°	118·5	36·7	71·8
(13.) Reddish-brown. (The change between this and the last colour was gradual, although the ultimate colours were quite different.)	..	..	..	..
(14.) Reddish-brown ..	274·7°	..	..	..
(15.) " ..	285°	..	..	..
(16.) Reddish-brown, blue fluorescence	299°	..	..	..
(17) Ditto	310·3°	..	..	..
(18.) "	319·5°	..	..	..
(19.) "	331 2°	73·3	6	67·3
(20.) "	342·7°	..	..	..
(21.) "	350·6°	..	..	..
(22.) "	356·3°	..	..	..
(23.) "	365·6°	..	..	..
(24.) Dark-red	370°	..	..	..
25.) Dark-red, green fluorescence	377·8°	..	..	..
(26.) Ditto	379·2°	..	..	..

It is evident that there is no uncombined carbon in the clear resin, and yet some is always left after distillation. A good deal of water is given off, only a negligible quantity of which can consist of hygroscopic water, since the resin is all but impervious to water and not hygroscopic, for I ground some to an exceedingly fine powder and weighed—

	Weight in Grams.	Difference.
	17·023	
		0·030
After twenty-four hours in desiccator	=16·993	
		0·018
After a week exposed to the air	=17·011	

It thus contains a very small proportion of water, and, when perfectly dry, absorbs moisture very slowly, even when in a finely powdered condition. So all the water must be due to combined O and H. At the beginning of the distillation the conditions must favour the formation of water, since most of the water is given off just before 100 and up to about 200. After this the proportion of water in the distillate grows negligible. This loss of combined water at an early stage is evidently responsible for the fact that we get a very small proportion of oxidized products in the distilled oils, although the resin itself is a very highly oxidized substance, approximating to the molecular constitution $C_{2n}H_{3n}O_n$ by a combustion. The escaping gases are thus oxidized at or before the moment of liberation, water being separated. This view accounts for the fact that the first runnings of the distillate consist of more unsaturated carbon-compounds, while the later portions are more saturated.* The few bromine numbers I have obtained for the oils bear this out. The total absorptions of bromine decrease as the boiling-points of the distillates rise, but the absorption-figure in the second column† decreases still more remarkably, for the substituted bromine calculated as HI remains nearly constant through the oils experimented with, which, of course, makes the rise in bromine-absorption less abrupt when we take the first column in the table than when we take the second. The first products, even if saturated, would be deprived of some of their H to form water and an unsaturated compound. As the distillation proceeds the O has nearly all been got rid of as water, so there is now no reason why unsaturated compounds should be produced rather than saturated. This accounts for the large drop in the bromine-absorption observed by Mills in the case of ordinary resin-oils between the last of the spirit-like distillate and the beginning of the medium oil. This is the point where the proportion of water in succeeding fractions dwindles almost to nothing. Even now, however, it is probable that the formation of unsaturated compounds is favoured by the small proportion of H left relatively to C. We started with the composition $C_{2n}H_{3n}O_n$; nearly all the O has been removed as H_2O, so we are left with $C_{2n}H_n$ as the basis from which to form the remaining distillate. So at high temperatures the bromine-absorption of the distillate hardly decreases, and remains stationary in the last runnings. We should expect an increase, if anything, at the end—that is, if all the resin is to come over as oil. But if the distillation is pushed to the end there is a residue of pure C, so we must suppose that the unsaturated bodies which would have to be formed to bring over all the C in the combined state are not stable at such high

* Mills has proved this in the case of ordinary resin-oil by the bromine-absorption, which begins at a maximum and decreases with the higher fractions.

† Calculated as I have explained above in the case of the resins.

temperatures. The fact that the most unsaturated bodies come over at the lowest temperatures throws a light upon the chemical difference between the fossil and raw resin. It is probable that there exists in the raw resin some volatile aromatic substance with a much higher bromine-absorption than any constituent of the fossil. Thus the raw resin gives a considerably and consistently higher absorption than the fossil resin, which has lost its more aromatic part by years of exposure. I am speaking of the yellow and brittle fossil resins, which are probably the oldest. The opaque white resin gave bromine-absorptions practically identical with those of the resin gathered from the trees. This fossil resin (white, opaque) was taken from the inside of a massive piece, and so was unlikely to be altered so much as that found granular or in small lumps.

Art. XLVI.—*Facts discovered in his Investigation of the Motions of the Atmosphere in the Southern Hemisphere.*

By Major-General H. Schaw, C.B., R.E.

[*Read before the Wellington Philosophical Society, 16th October, 1900.*]

Plate XV.

During some past years I have given much attention to the wind and weather. In this I have perhaps only followed the example of the multitude, but I have in some measure gone beyond the general interest which we all feel in the weather by endeavouring to get some explanation of the facts we observe. As probably my last communication to the Wellington Philosophical Society, I will endeavour to put on record the small additions to our former stock of knowledge on the subject which I have been able to gather.

It will be remembered that in October, 1897, I described a balanced wind-vane which I had devised, and which was erected above the time-ball in Wellington Harbour, where I still observe its indications. Another similar wind-vane was constructed, and, after having observations made with it for limited periods at Lincoln College, Canterbury, and at Gisborne, it was erected on a pole near the lighthouse at Farewell Spit by the Marine Department, by whose kind offices it has been regularly observed during the last year. All these observations have confirmed my views formerly expressed—that the fluctuations in the atmospheric pressure shown by a barometer at the sea-level are caused mainly by upward and downward currents in the air. The upward currents are in areas over which a cyclonic circulation of the air exists, which in this Southern Hemisphere means a circulation with the hands of the clock, and screwing upwards. The upward motion of the air diminishes its pressure, and so the barometer falls. The downward currents are in anticyclonic areas, where in this Southern Hemisphere the circulation of the air is in the direction opposite to that of the hands of the clock, and screwing downwards, so increasing its pressure and showing a higher barometer.

The upward and downward motions of the air are performed in very complex swirls, and it is the algebraic sum of the pressures in all the superincumbent strata of air which is indicated by the barometer at any place and time.

A belt of cyclones appears to encircle the earth, having their centres ordinarily in about latitude 50° S. They average about fifteen hundred miles in diameter, and travel from west to east at an average speed of 250 knots in twenty-four hours. These cyclones are sometimes in parts of their courses shifted in latitude very considerably, and their rate of travel eastward is very much interfered with by anticyclones at times. Always their course and outline is very much interfered with by land, and especially by high land lying across their course, as the Southern Alps of New Zealand.

The typical form usually taken up by the northern part of a cyclonic storm as it reaches the west coast of the South Island of New Zealand is shown on Plate XV. (a tracing from the isobars of the 11th May, 1900). The special effects of this diversion of the regular circular or elliptical form of the storm is to produce an eddy near Cape Farewell Spit, with northerly winds on the west coast and southerly winds on the east coast of the South Island, which continue southerly on the south coast of the Strait and bend round to northerly, reaching Wellington from the north and bending round again to pass up the south-east coast of the North Island as south-west winds. Moreover, very often an anticyclone is developed at the same time in the great loop over the South Island. Thus it happens that what I had hoped would be an admirable position for the balanced wind-vane to give information about the up and down currents in passing storms, owing to its perfectly free open exposure, very often gives no indication whatever, owing to the eddy or calm between the beginning and the ending of the great bend or loop which encloses the South Island. Occasionally, however, when the centre of the storm is unusually far north, as on the 3rd October, 1899, it passes through Cook Strait, and immediately after the lowest point is passed the balanced wind-vane shows a change to a down current and the barometer begins to rise, thus indicating that the up current is in the advancing part of the cyclone, and that the rising air is filled in behind from the following anticyclone. Further observations will be needed to make this quite certain, but I think there can be no doubt about the fact, although only this one instance has occurred during the year past, in which the balanced wind-vane has been observed at Farewell Spit.

In my paper of the 14th March, 1899, I gave what appeared to be the general system of circulation of the atmosphere in this Southern Hemisphere. The meteorological observations made by the late antarctic expeditions, by the Belgians and by Mr. Borchgrevinck, have shown that in the winter season a high barometer of over 30 in. is frequently observed as far south as 75° latitude. This indicates clearly that the very low barometer, hitherto always observed in the summer in those regions, is not a persistent fact resulting from some hidden cause, but that it is dependent on a belt of cyclones in about 75° S. latitude, as I have supposed, and that in the winter this cyclonic belt is sometimes displaced nearer to or farther from the pole (probably the former), and its place is occupied by anticyclones temporarily. We often see a similar result in the winter season here. The northern belt of anticyclones is displaced southward, and very high barometric readings are prevalent in the South Island. This has been the case in a very marked degree during this last winter. One result of this displacement this year has been that the peculiar clouds which I have called "fish clouds," and which are usually the precursors of a storm at Wellington, have very rarely been observed this year; south winds have also been unusually prevalent.

The constant formation of high anticyclones over the region of the Southern Alps of New Zealand in winter is a fact which has not yet been explained. A similar occurrence is observed over the high mountain belt of Norway, and it is probable that the low temperature of these great mountain masses is a cause of the descending currents of air over them.

To summarise, then, the results of my investigations into the motions of the atmosphere of this Southern Hemisphere, we find—

(1.) That the storms which reach us from the south-west are complete cyclones which circle round from north to east and from south to west while travelling round the earth from west to east, and having their centres usually about latitude 50° S.

(2.) That the old navigators' "roaring forties" or the "brave west winds" are the northerly parts of these cyclones, and that south of 50° or 55° S. latitude in the southern half of their circuits easterly winds are encountered.

(3.) That further south still anticyclones usually exist, and beyond them, in about latiude 75° S., a belt of cyclones cause the very low barometer usually observed there in the summer months.

(4.) That the occasional displacements of the belts of anticyclones and cyclones farther north or south than their normal position which we observe here appears to be also the case with the alternate belts of cyclones and anticyclones which exist between us and the pole.

(5.) That in cyclones there is an upward movement of the air, and in anticyclones there is a downward movement, each being accomplished in many complicated swirls, so that sometimes the inclination of the motion is, in gusts, as much as 40° from the horizontal, although the general upwards or downwards motion is very much less.

(6.) That it is the total effect of the upward or downward motions in the strata of the atmosphere above any place, at any time, which varies the atmospheric pressure shown by the barometer at that place.

(7.) That, while the barometer shows accurately the decrease of atmospheric pressure caused by the ascent of a mountain in calm weather, this mode of ascertaining heights is much interfered with in high winds owing to their deflection upwards by the slopes of the mountain.

(8.) That cyclones and anticyclones are complementary one to the other, and that apparently the rising air in the cyclone is replaced chiefly from the falling air in the following anticyclone.

(9.) That when cyclones collide, if moving in nearly the same direction they coalesce, if moving in nearly opposite directions they repel one another.

(10.) That occasionally small cyclonic circulations are originated in the neutral zones between two anticyclones; these move eastward round the more eastward of the two anticyclones.

(11.) That the cyclones which sometimes reach New Zealand from the north, with easterly winds at first, are tropical cyclones, originating in tropical regions northward of the belt of anticyclones, apparently caused by a concentration of heat in some place. Their forward motion is irregular, but it generally is in a southerly direction, and inclining to the east as they pass between two anticyclones. It is these tropical cyclones which sometimes meet one of the regular antarctic cyclones, and either blend with it or they repel one another, according to the direction in which the tropical cyclone is progressing at the time of meeting.

(12.) That the primary cause of winds is the difference of temperature between the poles and the equator; but the interchange of the cold and heated air is not effected in one great circulation on each side of the equator, but in a series of upward and downward and round-and-round movements, somewhat as shown in pl. lv., vol. xxxi., of the "Transactions of the New Zealand Institute." By such complicated motions the heat of the tropics and the cold at the poles are modified, rain is scattered over the earth, and the air is moved, mixed, and kept pure and healthy. We may not be able to account clearly for the reasons of all these motions, but the rotation of the earth and its globular shape account for the directions of the circulations of cyclones and anticyclones in the two hemispheres, and also for their eastward progress, and for the greater activity of the belt of cyclones in latitude 55° S. than of the anticyclones in latitude 30°, because they are nearer the pole, and they therefore feel more strongly the difference between the rates of eastward motion of the greater mass of air coming from the equator and the smaller and slower-going mass coming from the pole. All is evidently according to law; yet, as in all other branches of our knowledge, we observe constant variety in the action, owing to varying interactions of the various forces which cause it. What these forces are ultimately we are unable to say, except that they are manifestations of the will and power of God.

Art. XLVII.—*Note on the Fog in Wellington on the Morning of the 19th June, 1900.*

By H. N. McLeod.

[*Read before the Wellington Philosophical Society, 28th August, 1900.*]

At 8 a.m., on looking northward from the vicinity of Fort Gordon, near the entrance to Wellington Harbour, there appeared to be a dense fog in the Hutt Valley, which stretched thence along the line of railway into town in a comparatively narrow bank. The fog did not extend as far as Soames Island, and the slight breeze from the north carried the bank into Wellington, where it became mingled with the smoke of the city. The whole of Miramar Peninsula was quite clear and sunny; and I am informed that the same was the case at Karori, and that at Wadestown there was but little fog. From the Worser Bay hill, where the road crosses the saddle, nothing could be seen of Kilbirnie or Newtown, the highest hilltop near Karori only being visible from this spot. The fog itself was met with halfway across the isthmus at the head of Evans Bay, being so dense near Kilbirnie that my cycling companion was not visible at thirty paces distance. In Newtown there was a considerable proportion of smoke in addition, and the vehicular traffic in this part was impeded, and in one or two instances cycle-lamps were lit as a precaution against collision.

The whole mist appeared to me to have been formed in the Hutt Valley overnight and wafted seawards during the morning, much as if it were a river, and gives one an idea of the reason for the winds in Wellington always appearing to blow from north or south points of the compass.

I should like to record here the appearance of a cloud-formation closely conforming to the shape of the harbour, at a low altitude above it, on a calm night shortly previous to the fog above mentioned. Travelling as I did from Wellington to the Heads, there was a very good opportunity for noticing the shape. Above the land all the way was a starlit sky, but over the waters of the harbour was this cloud, stretching from shore to shore, with starlight clearly showing on the hills at the far side of Day's Bay.

I should also like to record the observing of a phenomenon which can best be described as having the appearance of an aurora australis, but without the colouring of one. It was noticed twice by me on clear starlit nights, and on both occasions in a place surrounded by hills. The radiations were, as far as could be judged, of a dun-coloured hue, and converged towards the south, a clear view to the southern horizon being cut off by the hills. There were no clouds visible. I observed a similar phenomenon from the Napier Breakwater in 1896, in which instance the radiations appeared to spring from the east. The time then, however, was 4 p.m., and the effect was caused by shadows of small clouds which were in the path of the sun's rays. At the time of the occurrence under notice there were no clouds, no moon, and nothing which I could think of as a cause. The locality was Miramar, and time 9 p.m.

ART. XLVIII.—*Note on the Vapour-density of Mercury.*

By DOUGLAS HECTOR.

Communicated by Professor Easterfield.

[*Read before the Wellington Philosophical Society, 12th March, 1901.*]

IT is well known that the vapour-densities of many elements diminish at high temperatures owing to dissociation of the gaseous molecules. Thus the researches of Victor Meyer* and of Crafts and Meier† have shown that the vapour-density of iodine is constant between the temperatures of 250°–700°, but that above the latter temperature dissociation commences, and is complete at temperatures above 1,400° (at 152 mm. pressure).

Very few systematic experiments appear to have been made in the opposite direction—*i.e.*, with the object of determining to what extent, if any, an association of the gaseous molecules occurs when the temperature is reduced.

Professor Easterfield has suggested to me that a certain interest would attach to determinations of the vapour-density of the elements made at the lowest possible temperature. I have therefore chosen quicksilver for the first series of experiments.

V. Meyer‡ has shown that mercury is monatomic at temperatures between 440° and 1,565°. More recently H. Brereton Baker has determined the vapour-density of the carefully purified metal in absolutely dry nitrogen at 440°, but no evidence of association could be detected. Vapour-density determinations at lower temperatures than 440° do not appear to have been attempted.

By employing a slightly changed form of the beautiful method described by V. Meyer,§ in which the substance under investigation is gasified in an atmosphere of hydrogen at the ordinary pressure, we have been able to determine the vapour-density of mercury at 236°—*i.e.*, 121° below its boiling-point. Even at this low temperature, however, the molecule of mercury remains monatomic. The actual vapour-density found was 112; calculated for monatomic mercury, 100. The experiment is being extended to other elements.

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* Berichte der deutschen Chem. Gesellsch., xiii., 401, 1723; xiv., 453.

† "Comptes Rendus," 92, 39.

‡ Berichte, xii., 1426.

§ Berichte, xxiii., 313.

V.—MISCELLANEOUS.

Art. XLIX.—*On Entomological Field-work in New Zealand.*

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

[*Presidential Address to the Wellington Philosophical Society, delivered 19th June, 1900.*]

In accordance with the established custom, the task of delivering an inaugural address devolves on me this evening, and I trust that members will excuse the comparatively limited scope of the subject which I have selected for my address. I feel, however, that any essay on general science that I could compile would not be at all adequate for the occasion, more especially when contrasted with those extremely able contributions of a general nature which have been already given to us by several of my predecessors in office.

With your permission, I therefore propose to occupy your attention for a brief interval this evening by some remarks on matters of general interest in connection with entomological field-work in New Zealand, and shall dwell especially on those methods of investigation which are likely, in my opinion, to be the most conducive to the advancement of science in the future. In fact, I intend to emphasize what has to be done, rather than what has been already done, as by this means I hope to stimulate and encourage our rising naturalists to direct their energies into useful channels.

In any country where the insect fauna is incompletely known it may be safely said that the first and most important step to be taken by the naturalist is the formation of good and exhaustive collections of specimens. This is especially the case in New Zealand, where the progress of settlement and the introduction of dominant forms of life are producing the most rapid and far-reaching changes in the original inhabitants, both animal and vegetal. Dr. Sharp, in an address delivered before the Entomological Society of London some years ago, drew special attention to the need for the immediate formation of collections of insects, especially in those parts of the world undergoing rapid changes through the agencies of civilisation. He also mentioned that the felling of forests in islands inflicts a fearful loss on the naturalist. As he points out, the available collecting-power of a community is very small, and we should therefore husband our resources—that is, we should concentrate our efforts on those spots where species are most likely to suffer extinction. These conditions may be said to apply to New Zealand species generally, but more especially, I think, to those species which frequent the native forests, particularly in the North Island.

Hence I consider that forest collecting is at present one of the most important branches of field-work that New Zealand entomologists can take up. This being the case, I shall begin my remarks to-night with a few notes on the collection of entomological specimens in our New Zealand forests.

The best months for forest collecting in the lowlands of New Zealand (meaning by lowlands localities not exceeding 1,500 ft. above the sea-level) are November, December, and January, December being really the best of all. At this season a very large proportion of our known Lepidoptera may be obtained in a favourable locality, as well as large numbers of species belonging to the lesser-known orders of insects. The Coleoptera are also extremely abundant during the early summer, and a great many species may be found by beating the foliage or blossoms of trees over a sheet spread on the ground, or, if the ground be too rough for this, into an inverted umbrella, preferably a large one, lined with some white material. By similar methods a good collection of spiders may also be secured.

I have found that forest ravines or river valleys are much more productive in insects than hill-bush far removed from water. To work a forest fully, it is necessary for the collector to follow up the stream and thoroughly beat the foliage on each side. The insects are then captured with the net as they fly out. To do this successfully requires a sharp eye and quick hand, as a lengthy pursuit is almost always impossible in such situations. If the stream is a fairly small one, wading may often be resorted to with advantage; and, in fact, it is very seldom feasible to work a forest stream efficiently without taking to the water occasionally. Many interesting species of Lepidoptera, Neuroptera, and Diptera (the latter mostly *Tipulidæ*), frequent the overhanging banks of deep forest ravines, and can only be dislodged by a vigorous probing with the stick into all the nooks and crannies. A dried manuka stick, fairly stout and about 5 ft. long, is very suitable for all this class of work, as well as being a most efficient aid in climbing over boulders, logs, &c., which always more or less obstruct the passage of these streams. The same class of stick is also most suitable for mountain work; in fact, the entomologist almost always requires a long stick in one hand and the net in the other.

The black-birch (or beech) forests, which are so common on high ranges, are comparatively poor in insects, though they sometimes yield species not found elsewhere. This is well exemplified on the Dun Mountain, near Nelson, which is, in fact, the only locality where I have taken the curious little black moth (*Dicromodes nigra*) exhibited this evening.

One very interesting feature connected with our forest-dwelling moths is their extreme variability and their very wide geographical range, so far as New Zealand is concerned. I have much pleasure in exhibiting a number of specimens illustrating both these points. Each of the species of insects selected will be seen to vary very much within the limits of the species, and all those represented have been taken at various localities from Wellington southwards as far as Invercargill, and Stewart Island. Unfortunately, but little collecting of Lepidoptera has at present been done in the north, but Captain Broun has investigated the beetles of that region with indomitable energy, as his volumes of published descriptions of additional species abundantly testify. Some experts in the study of the Coleoptera consider, I believe, that a very substantial reduction in the number of species described by the learned captain will ultimately prove necessary ; but, be this as it may, the name of Broun will in the future undoubtedly be associated with a very great number of species of New Zealand beetles.

Many forest-dwelling Lepidoptera are green, and these comprise some of our most beautiful species, their colouring imitating most faithfully the delicate hues of the beautiful moss-covered logs so common in our forests. These species are, unfortunately, extremely difficult to adequately preserve, owing to a tendency almost all these green moths have to fade after death to yellow or dull brown. They should never be exposed to the fumes of cyanide of potassium or laurel-leaves, two common killing agents used by entomologists, but should always be killed by means of the fumes of chloroform very sparingly applied. The specimens should be set immediately they are dead, and dried as rapidly as possible. If these precautions are adopted the beautiful green colouring of the living insect can, to a great extent, be preserved.

The destruction of the forests in the vicinity of Wellington is, of course, a trite subject to every one, and many members can no doubt remember far greater changes in this respect than I can. I may instance, however, as a probable result of this destruction, the striking decadence in the number of two common insects which has taken place within my experience of some eighteen years only. During the summer of 1882–83, which was the first season that I collected insects at Karori, I remember that at evening dusk the air was literally swarming with specimens of *Hydriomena deltoidata.* These moths were so abundant that four or five specimens would fly out of a single bush, and frequently two or three specimens would be captured in the net at once. In fact, the abundance of this particular species was most embarrassing to the collector, as it was liable to be mistaken for many rarer, though somewhat similar, species. Last summer (1899–1900) I certainly did not see more than a dozen specimens of *H. deltoidata*, and it cannot now be called a really abundant species. I have noticed the insect steadily declining in numbers during the whole of my entomological experience in the neighbourhood of Wellington, and I am inclined to attribute it partly to the increase in the number of sparrows, and partly to the denudation of the forests, for, although I have only found the larva of this insect feeding on a species of *Plantago*, I am inclined to think that it also probably feeds on some of our native ferns. The moth used to be most abundant amongst luxurious patches of ferns in rather open spots in the forest, and it is still common in such localities, when these are situated far away from settlement.

Another species that has declined equally in numbers during the same period is *Somatochlora smithii.* During the past three years I have been specially anxious to obtain many examples of this, and, in fact, of all our native dragonflies, and its comparative rarity has consequently been somewhat forcibly brought under my notice. In 1883, I remember, this insect was abundant over every stream in Karori, and at that time I used to frequently observe the females depositing their eggs in the water, the long abdomen being beaten violently on the surface during the process. Now, however, it would be quite impossible to make any such observation. In fact, during the whole of the past summer I saw only two specimens at Karori, and these seemed to have come from a distance, as they were flying very high in the air, apparently migrating. The larva of this insect lives in the mud at the bottom of stagnant streams and ponds, and may, perhaps, have been destroyed by the ever-increasing number of trout, otherwise it is difficult to understand what causes can have led to the great decrease which has taken place in the numbers of the perfect dragon-fly. Introduced insectivorous birds, through feeding on the imago, may, again, be suggested as a cause of decadence; yet the insect is an extremely rapid flier, and should be able to avoid capture to a great extent. However, the fact of a great decrease in the number of specimens of *S. smithii* in this district is certain, whatever may be the cause to which we may attribute it.

A great number of the forest-dwelling species in New Zealand are nocturnal in their habits. These can only be captured by searching the flowers and foliage of shrubs and trees by the aid of a powerful lantern at night. Of all the methods of night collecting in New Zealand the examination of blossoms stands first, and amongst these the flowers of the white rata (*Metrosideros scandens*) are probably the most productive in insect life. One very handsome moth, *Gonophylla nelsonaria*, of which I exhibit a series, has been taken on these blossoms at night only, and, although I have made the most careful searches during the day-time in the localities where the insect has been common, I have never succeeded in finding a single specimen. The flowers of the various species of *Veronica* are also very productive, and Mr. Howes informs me that the blossoms of the common ragwort, which grows so abundantly around Invercargill, is a most attractive flower to nocturnal Lepidoptera in that locality.

I have noticed that the various species of tree-ferns are extremely productive in moths, and large numbers may frequently be dislodged by beating the dead fronds, of which there is often a great accumulation in undisturbed portions of the forest. A sharp kick with the heel of the boot on the stem of the tree-fern is also a very efficient method of dislodging the various insects which lurk amongst the living fronds. The rough stems of these beautiful plants also form resting-places for many interesting species, notably *Porina enysii*, an insect I have seldom met with except in this situation. It is, however, extremely difficult to detect it when resting closely concealed amongst the nodes of the fronds.

Another good method of working for forest species is by means of a careful scrutiny of tree-trunks. This work is sometimes rather tedious, owing to the great difficulty that the unpractised eye at first experiences in detecting insects, which are specially protectively coloured for concealment in such situations; but the results ultimately attained by tree-trunk searching are often extremely satisfactory. The knowledge of the different classes of protective colouring, and of the innumerable protective adaptations and instincts, which is naturally acquired by the entomologist during a careful scrutiny of tree-trunks, is of great scientific value, quite apart from the capture of many interesting specimens. In fact, it may be safely said that the searching for insects in their natural surroundings has led to the perception of some of the most advanced scientific truths with which we are acquainted. I refer more especially to the discovery of the different classes of colouring, structure, and instincts which have been acquired by insects for protective and aggressive purposes through the agency of natural selection. The uses of these peculiarities of colour, &c., could only be accurately interpreted by a more or less complete knowledge of the creatures' natural surroundings, and this knowledge can only be obtained by those lengthy observations in the field which are usually made by the naturalist whilst he is engaged in collecting and searching out rare species in their natural habitats.

That moths and other nocturnal insects are attracted by light is a fact familiar to most people, but the experienced collector desires to turn this habit to good account. To do this effectively much depends on the surroundings of the collector's residence, and if his house happens to have a window facing an extensive area of virgin forest or swamp valuable results may be reasonably anticipated. If practicable a powerful lamp should be exhibited immediately outside the window of the collecting-room, as this has a very extensive range, and another lamp placed on a table just inside the window. The usual accessories—net, bottle, pins, &c —should, of course, be easily available. With regard to the most suitable times for lighting up, I cannot do better than quote from the late Mr. Stainton :—

"Next, two particular points have to be borne in mind—First, you cannot collect by light on bright moonlight nights; you must notice when the moon rises and sets, and light up accordingly. Second, you cannot collect by light if your window faces the wind, for moths fly against the wind, and if the wind is west you must put your light on the east side of the house, or if the wind is east you must have your attracting-room on the west side of the house. Moths begin to come to light as soon as it gets dark, and continue coming for some time—indeed, occasional stragglers will come throughout the night; the collector might therefore, with advantage, remain in his collecting-room till daybreak, ready to secure every specimen the moment it appeared, for some only remain for a short time in the vicinity of the light and then fly away, and others, which remain quietly enough half the night, fly away before daybreak. However, if the collector does not wish to sacrifice his whole night's rest at the shrine of science, let him go to bed about midnight, and let him revisit his collecting-room an hour or two before daybreak to secure any specimens which have come in during the night. On some nights moths come veritably in troops to the light—*Bombyces*, *Noctuæ*, *Geometræ*, *Pyrales*, *Tortrices*, *Tineæ*, and *Pterophori*—it is a mad race which shall come in; but these gala nights are very scarce—sometimes there will not be above three such nights in a year. And here is shown the necessity for the collector, who wishes to attract insects by light, to attend systematically, for the good nights cannot be distinguished by our senses from the bad ones, and if he only lights up now and then, instead of regularly, he will be almost sure to miss the good nights. I once knew a continuous fortnight of good nights. When the small *Psychodæ* come in great numbers, so as to blacken the windows and ceiling of the collecting-room, it is almost an infallible sign that the moths are coming in numbers."

The open lowlands in New Zealand are not nearly so productive in insect life as the forests. The original flora of these localities is, however, undergoing rapid alteration, owing to the extension of settlement, though the changes are not so great as in those places where the complete clearing of extensive forests is proceeding. The tussock-covered plains in many parts of the South Island remain practically in their primitive condition, though the periodical burning of the native grasses must destroy immense numbers of insects, and will no doubt ultimately lead to the extinction of many species. With the exception of a few conspicuous insects, such as *Argyrophenga antipodum, Chrysophanus salustius*, the larger members of the genera *Crambus* and *Leucania*, the Lepidoptera frequenting the lowland tussock plains are not of very general interest. A number of typical species from these localities is shown in the accompanying drawer. It should be mentioned that the silver stripes on the underside of the hind wings of *A. antipodum*, and the long white stripe or stripes which form such a typical marking on the upper surface of the fore wings in the species belonging to the genus *Crambus*, are both protective to an astonishing degree. Although these markings do not appear to resemble blades of grass when the insect is examined by itself, yet when specimens are *in situ* amongst the actual grass the protective value of the striped colouring is very evident, and renders the discovery of the specimens a most difficult matter. It is therefore probable that the striped colouring produces the same general effect on the eye as the varieties of light and shade which exist in a tuft of grass growing under natural conditions.

So efficient is the protection afforded by the colouring of grass-feeding Lepidoptera that it is practically impossible to collect amongst tussock-grass except in fine calm weather, when the insects are either actually on the wing or easily disturbed from the tussocks. I have a very lively recollection of the difficulties experienced in finding even a few specimens of very common insects amongst tussock-grass in bad weather. On one occasion I was on a visit to the Mount Arthur tableland, and we had experienced extremely wet and stormy weather for some days, which prevented collecting of any kind. Following this we had a day of very cold wind with an overcast sky, and, being at last able to venture outside the door of the tent, we determined to search for insects amongst the tussocks, as there was absolutely nothing on the wing. Spending some two or three hours in this way, we succeeded in finding only three or four specimens of the extremely abundant *Crambus crenæus;* but had the weather been warm and the insect flying we certainly could have taken fully ten times as many specimens during the same interval of time.

The larvæ of such of the grass-feeding Lepidoptera of which the transformations are known are also protected by a striped pattern of colouring; but the life-histories of many of these still remain to be discovered, probably owing to their very efficient means of concealment.

Mountain Collecting.

This is probably the most interesting class of collecting we have in New Zealand, but it is not, to my mind, nearly so important a branch of work for this generation of naturalists as the collection of specimens in the lowland forests. Mountains of less than 3,000 ft. in height are in places extensively used for agricultural purposes, and the flora of these localities will consequently be subject to modification and extinction, insect fauna sharing a similar fate; but the flora of the higher mountains is not likely to be much influenced by cultivation, and hence I consider that the immediate formation of collections of the higher alpine species, although of great interest, is not so important to the interests of future science as the preservation of examples of species inhabiting the rapidly disappearing forests. Nevertheless, collections of the mountain species in New Zealand are great desiderata, and as these generally comprise some very attractive insects some of our entomologists may be interested in a short account of such limited experiences of mountain collecting as I have enjoyed.

So far as Wellington is concerned, probably the most accessible locality for a great variety of mountain species is the Mount Arthur tableland, in the Nelson District. As I have already given an account of the entomological resources of this locality in the "Transactions of the New Zealand Institute" for 1889, I will not occupy your time this evening with any more detailed account; but I must remark that subsequent visits have impressed me still further with the absolute necessity for the erection of some sort of permanent shelter in the locality that might be available for the use of naturalists. By a combined movement on the part of a few entomologists and botanists this might be easily arranged.

I should perhaps explain that the meteorological conditions which frequently obtain on the tableland of Mount Arthur, even in the middle of summer, are such as to render a tent a most uncomfortable, not to say highly inefficient, habitation, this condition being further enhanced by the rising of the mountain torrents, which renders retreat to the nearest house—twenty miles away—impossible. I believe, however, that foot-bridges have been placed over all the larger torrents since my last visit (1898); but, notwithstanding this, I can assure you from extensive experience that, except to a person of unusually robust health and heroic temperament, the tableland of Mount Arthur is not a place at which to stay without a house of some description.

During January, 1893, I visited Castle Hill, a well-known locality on the main road between Christchurch and Hokitika. This spot may be said to mark the beginning of the forests, which become denser and more luxuriant as the West Coast is approached. The weather here was very good, and the heat extreme; in fact, it is without doubt the hottest place I have ever visited in New Zealand. Our camp was situated at an elevation of 2,500 ft., and several interesting species occurred in the surrounding birch forest. The mountains here are fairly high, Mount Enys, the highest point attained, having an elevation of over 7,000 ft. On the summit of this mountain I observed a large number of a species of ladybird (*Coccinella novæ-zealandiæ*). They were extremely abundant, and swarming in all directions over the rocks. It is known that these insects frequently migrate for long distances in great swarms, and on one occasion it is stated that the dome of St. Paul's Cathedral in London was red with ladybirds. From these facts I am inclined to think that the large assemblage of ladybirds I observed on the summit of Mount Enys was a migratory swarm, as there was no vegetation there to support the large number of aphides, or plant-lice, which would have been requisite to have supplied so many ladybirds with food during their larval condition.

The spur leading up to Mount Enys is a very long one, but extremely broad and easily traversed. It is really an extensive mountain-chain; and one could walk many miles along the Craigieburn Range at elevations of from 6,000 ft. to 7,000 ft. There were only a few patches of snow on this range at the time of our visit, and on one of these I saw a number of birds with rather long legs and bill, short tail, greyish wings and back, and cream-coloured breast. These birds were busily engaged pecking at some objects in the snow, but I was unable to ascertain the nature of their quest.

During this trip I secured a few specimens of *Erebia pluto*, at elevations of about 4,800 ft. They were larger than those taken on the mountains in the Nelson Province, but smaller than some I subsequently captured on the ranges at the head of Lake Wakatipu. Although four or five new species of moths were discovered as the result of this expedition, I cannot say that I regard Castle Hill as a first-class locality for entomological work.

Probably the ideal spot for alpine collecting in New Zealand is Mount Cook Hermitage. Here the collector has all the comforts and conveniences of a first-class house, and is actually in the midst of a subalpine fauna and flora. During last December I visited this locality, and was fortunate enough to take, amongst other things, a new species of *Declana* (*D. glacialis*), which I exhibit this evening. I propose to describe this insect, with several other new species of *Macro-lepidoptera*, at a subsequent meeting during the session.

My visit to Mount Cook was unfortunately limited to five days only, of which three were more or less wet, so that my entomological investigation of the district is at present extremely imperfect, especially as my energies were very much impaired at the time by an attack of influenza. In spite of these very great drawbacks, however, I saw and obtained a considerable number of novelties, and feel confident that a more prolonged visit a little later in the season—say, from the middle or end of December until the end of January—would be productive of extremely satisfactory results. The great advantage of Mount Cook as an entomological locality is the high altitude (2,500 ft.) of the collector's headquarters. In two or three hours an elevation of over 4,000 ft. can easily be attained, the greatest number of species being found between these limits of elevation. As a matter of fact, very few insects are found above 6,000 ft., and, so far as collecting is concerned, it is quite unnecessary to ascend above this altitude.

During my visit to Mount Cook my explorations were practically confined to the immediate neighbourhood of the Hermitage—*i.e.*, the terminal moraine of the Mueller Glacier, the Hooker River, and the Sealey Range. The first-named locality was the most productive, and was at that season (early December) covered with most beautiful specimens of alpine flowers, the handsome *Ranunculus lyalli* being the most conspicuous. Some very fine grasshoppers were found here, notably *Brachaspis nivalis* and *Paprides nitidus*, and allied species. The first named is a large greyish-brown species, and was found abundantly on the bare moraine close to the ice. The species, unfortunately, have faded very much since they were killed, and their appearance is thus so much altered that I am satisfied, for accurate work, it is essential that descriptions and illustrations of these insects should be made from living specimens. This remark applies, in fact, to all species of bright-green grasshoppers, many of which are extremely beautiful. Diptera were very abundant on the lower portions of the moraine, where vegetation was luxuriant, and I secured several species not previously taken.

On the Sealey Range I found insects very abundant up to about 3,800 ft., taking on the way up several fine examples of the very rare *Notoreas strategica.* Above 3,800 ft. there were many patches of newly fallen snow, and the surface of the ground was very wet and cold. Here were absolutely no insects, so that I did not proceed further up the mountain.

During this visit I did not see any specimens of the mountain butterflies *Erebia pluto* and *Erebia butleri,* but I think I was fully a week too soon for them. No doubt a few really hot days would have made a great difference, and it is almost certain that *Erebia pluto* must be an abundant species in the Mount Cook district, and probably also *E. butleri* occurs there.

During my return journey I had an hour's collecting on the banks of Lake Tekapo. Although nothing of a very striking nature was to be found, I obtained several peculiar little local species, amongst which I may mention *Lythria euclidiata.* From this I am inclined to think that it would reward an entomologist who had plenty of time to spend a day at Lake Tekapo. It would be necessary, however, to select a perfectly calm, sunny day, as there is no shelter in the locality, the country being quite open and covered with tussock-grass; and all those species I observed were resting in hot sunshine on the stones near the edge of the water.

Another extremely interesting entomological locality is the western side of the head of Lake Wakatipu. Here I had the good fortune to spend a week in 1894, with the most satisfactory results. In fact, I think the Humboldt Range is the richest mountain locality I have ever visited, and its interest is further enhanced by the presence there of the extremely local *Erebia butleri.* Until January, 1894, when I found the insect abundant on the Humboldt, only three damaged specimens had ever been taken. These were discovered by Mr. John D. Enys on Whitcombe's Pass, Canterbury, in March, 1879. On the Humboldt Range the forest terminates at about 3,600 ft. above the sea-level—that is, an altitude of 2,600 ft. above the level of the lake. The ascent of the lower portion of the range is very tedious, owing to the quantity of burnt bush that has to be traversed, and a good track might be made with great advantage. Once clear of the bush the travelling is fairly good, but there are many cliffs which require to be carefully watched when the collector is busily engaged in the pursuit of insects. These cliffs are often overhanging, and dripping with water. Their surfaces are nearly always fringed with a luxuriant growth of alpine plants, and it is amongst this vegetation that many rare species of alpine moths abound.

I have much pleasure in exhibiting a drawer of characteristic insects from the Humboldt Range. Amongst the more interesting species in this box may be mentioned *Erebia butleri*, *Xanthorhoe cataphracta*, *Cerozodia plumosa* (I always regret that I did not secure a good series of well-set examples of this *Tipula*), a large weevil at present unnamed, and the very striking ichneumon-fly *Rhyssa antipodum*, which, by the way, also occurs at Mount Arthur. A host of smaller species could also be added.

There is no doubt that this range and the others in the neighbourhood, which are forest-clad at their base, would amply repay a further and much more exhaustive examination than has yet been given to them. Although I ascended the Humboldt Range on three occasions during my week's visit, I was only able to devote a few hours each time to actual collecting, so much time generally being lost in making the ascent and descent. To adequately work the range a permanent camp should be formed at about 3,000 ft. or higher, if possible, and expeditions made from this base in various directions.

As we fortunately have now several trained entomologists in the far south of New Zealand, expeditions on their part into the mountains at the head of either Lake Wakatipu or Lake Te Anau should not present any formidable difficulties or serious cost, and I feel confident that a thorough investigation of the insect fauna of these mountains would be rewarded by many interesting discoveries.

I should add that I spent three days on the eastern side of Lake Wakatipu at Glenorchy, but found the ranges there comparatively barren of insect life. These ranges are bare from base to summit, having no trace of forest on them, and they well exemplify a fact which I mentioned before—*i.e.*, that the most productive mountains for entomological work are those rising out of dense forests. I have invariably noticed this in all my entomological expeditions in New Zealand.

Before concluding this address a few remarks on the value of field natural history and collecting as educational pursuits may not perhaps be deemed inappropriate. Although it is very probable that I am inclined to overrate the importance of natural-history studies generally, yet there are still some, even amongst scientific men, who I fear are inclined to undervalue the work accomplished by collectors. It should, however, be borne in mind that many of our most successful philosophers and scientists have sprung from the ranks of mere collectors, and have not all been produced by the more orthodox, though less original, methods of universities and kindred institutions. Darwin may be fairly taken as a type of man whose unparalleled abilities as a naturalist and philosopher were largely due to his early experiences, firstly as a collector, and subsequently as an observer in the field. His marvellous powers were certainly not acquired by book-learning only, or by the passing of examinations, but almost entirely by original research and patient study in the field. There is no denying the fact that Darwin discovered the most far-reaching law that has yet been discovered in connection with biological science—*i.e.*, the principle of natural selection or the survival of the fittest, a discovery which is only equalled by that of Sir Isaac Newton in astronomy. The fact that Darwin began his scientific career as a collector of beetles will, I trust, be taken by the Society as some excuse for the amount of time I have occupied in delivering an address on entomological collecting in New Zealand.

ART. L.—*The Extension of University and Science Work in New Zealand.*

By H. HILL, B.A., F.G.S.

[*Read before the Hawke's Bay Philosophical Institute, 12th October, 1896.*]

WHAT is known as the "university extension movement" in England has already reached its majority. The movement was begun in the year 1873 by the governing authorities of the University of Cambridge, who, having considered certain memorials from a number of public bodies interested in the advancement of education, including women's educational associations, committees of industrial co-operative societies and mechanics' institutes, decided "that the Syndicate be empowered to make the experiment of organizing courses of lectures at a limited number of centres, and to make provision for holding such examinations as they might consider expedient, on condition that the requisite funds were guaranteed by the local authorities." The plan adopted by the University rapidly grew in popularity, and the scope of the work was widened, and soon other universities were engaged in the movement, so that to-day every university in Great Britain is engaged in carrying the higher thought and learning to the people by means of lectures under the guidance of specialists in the various subjects of study. For the session ending with the year 1891, which is the latest complete return I have, it appears that the University of Cambridge carried on "extension work" in forty-seven centres in England. The attendance at the classes established in these centres averaged 11,595 students for the year. The London Society carried on similar work, and had an attendance of 13,000 students, whilst the University of Oxford and the Victoria University had an attendance of nearly 19,000. Hence we have the remarkable fact that by means of classes in connection with four educational centres 43,595 students have been added in a single year to the list of those who come into direct contact with the higher educational influence of the universities. We need not enter here into an estimate of the effects such increase of students is likely to have upon the future thought and mind of England, but it can hardly be doubted that the universities and the nation as a whole will be largely benefited by the adaptive process which is going on. Each university has become a new source of educational vitality, and the directive tendency that is being given to students in the pursuit of a definite course of study is of high moment, whether considered from an individualistic or from a national point of view.

The widening of educational advantages is of high importance to those who are engaged in business pursuits during the day. Such persons enjoy the fullest opportunities for study if they so desire, and the smallness of the fee demanded for attendance at the university classes is such that even the poorest in the community may share with the richest the educational benefits such as the opening of "extension classes" has made possible. New Zealand has not yet arrived at that stage when the citizens of our growing towns have come to feel the necessity of doing something to extend the educational benefits of the people in the higher fields of learning, and outside what may be set down as work belonging to the government of the country. As colonists we are collectivists in matters educational, and on the whole the people appear to be quite satisfied with what the Government does for education. Our country has few manufactures, and the question of over-population is not one likely to cause anxiety among us for many years to come. The question of the advancement of the arts and sciences is not just now of pressing importance, and, unfortunately, it is seldom that men in any country anticipate future needs. To satisfy the wants of to-day is in the main accounted sufficient, and hence it is that as colonists our people have hardly reached that stage in social and political evolution such as the people of older countries like England and elsewhere have attained. Our public scheme of education has satisfied the people—far too easily it appears to me—and there are many to be found who think that the system is second to none. It is a serious mistake to make, for our primary system is scientifically very defective, seeing that it is non-adaptive to the needs of the people. I appreciate to the fullest the fact that the system offers to every child in the country the right of receiving a certain type of instruction, but there is a wide gulf between a permit to receive a certain form of instruction and the giving of instruction which is adaptive and anticipatory. However, like everything else, education is evolutionary, and it may be assumed that the time will come when a modification will be found necessary in our primary system such as is here suggested.

Before proceeding to discuss the question of university extension in this country it may be well to review in outline our present educational standing. We are supposed by many to be tending to a purely socialistic form of government. Much of our legislation is said to be tending that way, but to those who strive to harmonize the tendencies of legislation in its application to life the facts hardly support the contention. The education system such as we have is certainly not democratic in its tendency. In some measure the country has charge of primary education, but every step outside the primary stage up to the university itself is only the semblance of State control without any of the powers which are necessary to bring the various educational forces into one harmonious whole. There is no continuous and complete scheme of education established even in the matter of primary education, and the high schools and university colleges, such as are in operation in various centres, are carried on by authorities altogether independent of Government control, although all of them are maintained in great part out of revenues derived from State endowments. Under what is known as the "voluntary system" it is easy to understand the difference between the aided and the public schools of England. The latter are self-sustaining, and offer a type of education specially adapted to English polity. Public schools like Eton, Harrow, and Cheltenham are purely class schools established for specific purposes. They receive no Government aid, and need no Government control, as their prestige can only be sustained by maintaining high tone, efficient control, and capable tuition. But English precedents cannot be taken as applying to this country. The people of New Zealand possess no hereditary rights, and what is understood in England as "society" and class distinction do not and cannot exist here. Environment is a factor that cannot be neglected, and it is certain that whatever advantages there are in education, no matter of what kind or character, those advantages belong in common to all the people of every kind and degree. The difficulties which have limited until lately the educational advantages of the poorer people of England need not exist in this country, for the State, by means of its large reservations of public lands, has provided an income sufficient to assist every intelligent and ambitious youth to pursue his studies from the primary school to the university. And such a plan in a new community like ours is reasonable, and commends itself in its fullest acceptance to all who desire to see the best and most promising of our young colonists receive due recognition in the land of their birth.

But even when the widest advantages are offered two factors will always operate in regulating the number of those who are likely to continue their studies in the higher branches of learning. These are, first, the physical condition of the children themselves; and, second, the competency of parents to maintain their offspring at school. It is manifest that children of weak bodies are not able to pursue their studies with the same power and prospect of success as those who are physically strong. These latter, however, are subjected to disabilities of a special kind in the case of poor parents, for they are withdrawn from school at an early age in most cases to enter upon the battle of life, and the field is left open mostly to the children of comparatively the well-to-do, or to those whose bodies are incapable of undergoing much physical toil and exertion.

It would provide a subject for an interesting inquiry were it possible to follow, as it were, step by step the history—the school history it ought to be—of ten thousand children from the date of their entry into the schools at the age of five years to the time when they ought to quit, at the close of their fifteenth birthday. How many of the ten thousand would be attending school at the end of the period, and why would the numbers be so few? Death would account for some; but, in any case, the results would differ widely in every hundred children of the poor, of the middle well-to-do class, and of the rich. The demands and needs of the poor compel parents to withdraw their children from school at an early age, and the higher pathways of learning are mostly left open for the benefit of children who are more fortunate if not more capable than their poorer neighbours. The law of the strongest and the fittest does not operate here, for the law of parental necessity forces the physically capable to neglect the mental part of their training in order that they might minister to the needs of home. But difficulties such as these, though they can hardly be avoided, can be minimised.

The freeing of the schools from the payment of fees for instruction has largely added to the school attendance as lately shown in England, and parents are coming to recognise how important it is for their children to receive as much schooling as possible. The primary schools, however, constitute the limit of the large majority of children, and even long before the highest standard of the school is reached necessity has caused the withdrawal of most of those who successfully met the requirements of the lower standards. In the case of children who succeed in getting through the standard course, and would proceed further, the question of school fees bars the way. Many parents would gladly sacrifice the earning-capacity of their children if by so doing it would enable them to be instructed in the higher branches of knowledge, but at present this is impossible. Fees are chargeable at every high school and university college in the colony, and they undoubtedly constitute a bar to the acquisition of that form of wealth which should be free to every one choosing to seek after it. But why are fees necessary for attendance at secondary schools, or even university colleges? Were they private institutions like the class schools in England, to which reference has been made, the case would be on a different footing, but all the higher educational institutions are highly endowed by the State. Defective organization is at the root of the whole matter, but no man in the country has yet been bold enough to attack this important question. The subject, however, will have to be dealt with, for it is to the best interest of the country that the revenues from education endowments are spent for the common good.

But let us inquire as to the character and extent of these endowments. The information is to be obtained among the public records. From time to time there have been published to the order of the House of Representatives certain papers dealing with the extent and value of the land areas that have been reserved in this colony—First, for the benefit of primary education; second, for secondary education; third, for the special endowment of certain high schools; fourth, for the endowment of university colleges; fifth, for the endowment of a university. The latest return of such reserves in my possession is dated 1885, and I am uncertain whether any public return has been issued since then. This, however, is sufficient for the purpose of my inquiry, as it shows that the colonists have not been unmindful in the way of making large endowments for the maintenance and support of education.

The extent of land reserved in the colony for the benefit of primary education amounted to 466,049 acres in 1885; but under what is known as the Education Reserves Act of 1877 there must be set aside 5 per cent. of all the land in the colony before being offered for public sale. Thus large reservations must have been made during the past ten years, and no doubt the lands set aside and known as primary-education reserves must largely exceed 500,000 acres. All these lands are vested in School Commissioners, who control them in each provincial district for the Government, and who pay all revenues from such lands either into the Consolidated Fund or into such fund as may be authorised for the maintenance of the primary schools.

The secondary-education reserves are controlled in the same way, but, curiously, the income derived from the lease of them is paid over to the high-school authorities in the several education districts, though there appears to be no legal authority for the adoption of this course. The governors of high schools have separate and special endowments of their own, which were allotted when these schools were constituted. The lands controlled by the secondary-school Commissioners amounted to acres, whilst the governors of high schools either have or had 152,234 acres of town and country lands, from which large revenues are drawn for the maintenance and support of middle-class education.

The fourth class of reserves is for the benefit of what are known as the university colleges. These are four in number, Christchurch, Dunedin, Wellington, and Auckland each having one. The college at Wellington has only been constituted a short time, and it does not appear that any lands have yet been set aside as an endowment for it. The reserves of the Canterbury College and the Otago Univerity College amount to 314,000 acres, or about 500 square miles of country; in other words, an area representing one two-hundredth of the whole of New Zealand is set apart and administered by independent authorities for the benefit of two colleges. The estimated value of these endowments ten years ago was £245,000, and the annual rent-roll was £13,306. The Auckland University College has an endowment of more than 30,000 acres of the public land, but I have been unable to discover from returns either estimated value or what income is being derived from the lease of them. Suffice it to say that an annual grant of £4,000 is made to the College by the Government towards maintenance in addition to what may be derived from the lease of the endowments. Finally, there are the special endowments for the benefit of the New Zealand University.* These lands amount to something like 46,000 acres, and their value ten years ago was set down at £32,535. At that time only a portion of the land was leased, which brought in an annual income of £775.

What the rent-roll from all the secondary and higher endowments was I have no means of knowing, but that they

* The New Zealand University was deprived of all land endowments by the Act of 1874, and has never enjoyed any revenue therefrom, as it all passed to credit of local bodies.—Ed.

were large and ample for the wants of the several schools and colleges there can be no manner of doubt. If now the high schools are excluded from consideration, seeing they form no part of the higher aspect of training as a branch of university work, there remain in the colony four university colleges as centres of teaching, and the University proper, which is simply an examining body for conferring degrees. The large endowments held by at least three of the colleges have already been enumerated.

With respect to the functions of the University, the Act of 1874, under which it was constituted, says, "That the University hereby established is so established not for the purpose of teaching, but for the purpose of encouraging in the manner hereinafter provided the pursuit of a liberal education, and ascertaining by means of examination the persons who have acquired proficiency in literature, science, or art by the pursuit of a liberal course of education." From this extract it will be seen that the University has no power to foster higher education further than to grant degrees in art, science, and literature. Thus the authorities of the University could not establish colleges or classes for teaching purposes, nor does it appear from the Act that they could promote the establishment of centres of instruction outside the area of the present university colleges on the lines of the extension scheme which is being so successfully carried on by all the English universities. The only really active teaching forces in the colony for the advancement of the higher learning are the four university colleges, and each of these might extend its operations. These institutions are affiliated to the New Zealand University, and they carry on in each centre the same kind of academical preparation as Cambridge and Oxford in England, where the power of conferring degrees is held by each university. Here the university colleges possess no such authority, except that the Otago University Council may confer degrees under an old provincial Ordinance, but which for all practical purposes is now a dead-letter. The power of conferring degrees held by the University, which exists as an entity apart from the college, is of much importance, for, whilst the latter can aim at specialisation and adaptation to local requirements, the same standard of attainments is demanded from all in the University examinations. The power possessed by the Universities of Cambridge, Oxford, or London of conferring degrees may have advantages in the opinion of some compared with the plan adopted in our own colony. A Cambridge man is one of a special type, distinct in many respects from an Oxford man, and a London graduate differs from both. It is probable, however, that a degree issued by a central authority like the University of New Zealand would be of greater value to the recipients, in the same way as the New Zealand degree would carry with it a higher status than if issued by one of the university colleges, for every increase in the number of degree-conferring authorities diminishes the value of the degree irrespective of scholarship.

We have seen that the University and the affiliated colleges, with one exception, are highly endowed; but the endowments differ from those usually held by similar institutions in England. The revenues of the colleges are derived from what in reality are public lands. The colleges, however, are controlled at present by authorities who are not amenable to Government control under any Act. This statement hardly expresses the actual facts, for each year a balance-sheet is published at the instance of the Government, in which the income and expenditure of each college are given, with a brief report of the work done during the year. But the Government has no controlling-power over the expenditure or in the administrative work of either institution. The annual expenditure on salaries in the Auckland University College is between £3,000 and £4,000. In Christchurch the salaries amount to about £5,000, and in Dunedin to a little over £6,000. In addition to the fixed salaries, most of the professors receive the fees paid by students for attendance at the college lectures.

But this is not the only curious thing about the administrative work of the university colleges. The lectures have been planned on the lines of the old universities, like Cambridge or Oxford, and they continue for little more than six months out of every twelve. Perhaps the number of lectures delivered is sufficient for the students who attend them, but it can hardly be supposed that twelve months' salary should be paid for six months' work. Under more effective discipline and administration such a state of affairs could hardly exist. As now planned, the professors in each university college are limited in the exercise of their duties to the delivery of lectures in the colleges where they are engaged. A six-months course of lectures may possibly suffice for the undergraduates, but ought this to entitle the professors to a six-months rest? Let it be remembered that the professors are specialists of a special type, and their services ought to be utilised to the fullest extent for the good and general welfare of the colony.

No doubt the country has received and is receiving many advantages by the establishment of university colleges, but the educational organization of the country is imperfect from whatever practical standpoint it is viewed, whilst the benefits offered by the colleges to districts like Wanganui and Hawke's Bay are of little or no value. The school life of the great majority of the boys and girls in this district closes after passing the Fourth or Fifth Standard in the primary school, and there is no further opportunity offered to such pupils to pursue their studies further. A like remark applies with equal force to the pupils who quit the high schools. Advancement beyond an ordinary high-school course is now impossible, except in a few rare instances where parents are blessed with sufficient funds for the maintenance of their children at one of the university centres. Under our present imperfectly developed methods the people in districts like Wanganui, Nelson, Invercargill, and Hawke's Bay are heavily handicapped in all the higher walks of life by the absence of educational facilities such as are offered to the people in the more highly favoured centres of learning.

Now the question arises whether it is not possible to organize some scheme whereby arrangements can be made for the establishment of special centres, either on the lines of the university extension movement or on the plan of the Science and Art Department in England. Thus Napier, Wanganui, Nelson, and Invercargill, to be followed by others as the need arises, might each be made a centre of higher educational work as a preliminary to the University course. But the motive force and organizing capacity are wanting. The only State machinery in operation is that established for the furtherance of elementary education, and the question arises how "university extension" can be carried out. As explained already, the University is simply an examining body, and, although the University Senate might countenance the establishment of classes under capable tutors, it is doubtful whether they possess the power to carry on examinations and issue certificates which are of a lower grade than the arts degree. This, however, could be put to the test. But a difficulty at once appears. Men of capacity and power as lecturers and specialists are wanted to initiate any scheme such as is here suggested. Outside the college centres higher educational thought and activity are dead, and the only hope for the future is to be found in the opening of "university extension centres" by the college professors, aided by men of equal academic standing.

Nothing illustrates the prevailing deadness better than the futile attempts that have been made in Napier itself to create mental activity of a higher kind. Parliamentary unions, debating clubs, amateur and literary clubs have all been tried with a view to arouse the mental energies of the better class of young men, but failure has invariably followed each attempt. And yet clubs for the promotion of athletics, such as cricket, football, and cycling, flourish here and everywhere throughout the colony. There is perhaps no other country where young men enter with greater zeal into physical competitions with each other. From north to south, winter and summer alike, the country rings with the doings of some local or interprovincial team of footballers or cricketers, or with the prowess shown by some member of a bicycle club. And why is this display of energy so great in the case of the physical aspect of life and so dead as regards the mental? The difference is simply one of organization and reward. Physical development comes home directly to the individual. On every hand there are clubs for the emulation of young men in feats of endurance, skill, or prowess of some kind, and, what is of more moment, opportunities are provided whereby young men from the smallest districts are able to compete against the best talent in the country. There is no need to go to any special centre for training or professional advice, as every town and township is made a training-school for the development of physical endurance and skill, whilst the public Press and the athletic associations constitute a professional court second to none for the recognition of excellence of a special kind. The desire for honourable distinction is strong in human kind, and it is ever active in the minds of those whose energies are being exercised under healthy surroundings.

But why is there so much energy shown in the physical side of human nature and so little in the mental, more particularly with respect to higher education? Let the methods adopted by the Government and by the responsible educational authorities for the higher training and culture of the people be compared with those employed for the physical development and training of young men, and the causes of educational indifference and deadness will soon become manifest. On the one hand there are organization, emulation, and opportunity to excel, and on the other there is conventionalism, a holding-fast to the past, and a mistrust of change. It was a saying of the late Matthew Arnold that the great need of the primary school in England was to simplify the work. The same thing is badly wanted in our country just now. Isolated governing bodies are in possession of the educational field. They control all the pathways to the higher pasture lands of learning, and none can enter except by the payment of a heavy toll. Co-ordination of studies is absent, and nothing is done to induce young people to pursue their studies in the higher pathways of knowledge. People living in towns where university colleges are already established receive certain benefits, but even these are small compared with what is possible under a system so co-ordinated that the whole colony might be interested as much in the pursuit of learning as it is in the pursuit of pleasure. Education, if it is to flourish, must be as available to all as the air we breathe and the water we drink. Its diffusion impoverishes none, but supplies means of blessing to all, and hence the university colleges should be organized with a view to the multiplication of educational opportunities throughout the land, so as to create emulation and hope amongst our young men and women.

It can hardly be expected that we shall excel as a people in these days of competition by becoming exclusive, for the outside world is active and aggressive. Our thoughts, our energies, and our minds must be prepared to accept the new order of things, for the "old order changeth, giving place to the new," and, stem the current as we may, we cannot turn back the inevitable torrent. The educational life of Old England has been renewed by this adaptation of university life to meet the new conditions of the country—the outcome of a generous scheme of public elementary education. The time has come to press for similar concessions here. Lectures by men connected with university work, or who have graduated in honours, would prove a powerful attraction to yonng people. We have seen by what means the physical side of life is promoted and encouraged amongst us, and a like success awaits the higher educational training of the people if proper means are taken to formulate a popular working scheme. Let it be kept in view that the social and mental condition of the people is not what it was a few years ago. Everything in nature is ever in motion, and adaptation and development are simply the necessary conditions of change. Universities and colleges of the old type have had their day, and the "resort of a leisured class" they can never hope to be again, if maintained at the public expense and worked for the common good.

I have pointed out as briefly as possible the conditions regulating the higher education of this country. Defects have been named and modifications suggested, and the example set by the university authorities in England has been quoted to show the good work it is possible to accomplish under proper organization in the spread of higher education among the masses. We are compelled to run in the race of nations whether we like to do so or not. Competition is everywhere. Competition brings change, and unless we wish to be led rather than ourselves to lead we must take the proper means to prepare the rising generation for the competition that is before them. Education has become a necessity in the evolution of our race. Physical, moral, social, and intellectual education are present-day needs, and they must be provided for the people as generously as a good father provides for the needs of his family.

I shall conclude this paper by giving in summary form what, in my opinion, is wanted to bring the educational forces of this country into effective working-order, so that emulation in educational pursuits may be fostered and districts like our own assisted in the development of that higher intellectual life which the university colleges have it in their power to give under a properly organized scheme such as I have suggested here :—

(1.) The university colleges should be free to all, without fee or payment of any kind. Admission to be by examination.

(2.) The services of the professors should be available at intervals for the promotion of university extension work in districts like Hawke's Bay, Wanganui, Nelson, and Southland.

(3.) The University should encourage the establishment of such extension work, and formulate a scheme for the examination of students.

(4.) A central department should be organized on the lines of the English Department of Science and Art, which should be controlled either by the University or the present Department of Education.

(5.) The department should have power to hold examinations in science and art, and to issue certificates of competency to successful students.

(6.) Encouragement should be given to public bodies like Town and County Councils and other duly constituted Boards to open classes for the teaching of art, science, and literature as may be necessary.

(7.) Certificates gained at such classes should be recognised by the Education Department and by the Government as qualifying for appointment.

(8.) Maintenance scholarships should be established, open to all, for admission either to the university colleges or to some technical school of science.

(9.) Similar scholarships should be established for senior pupils at the high schools.

(10.) The high schools throughout the colony should be reorganized, and their course of studies co-ordinated with the syllabus in the primary schools.

(11.) Arrangements should be made for instruction in the primary schools, under certain conditions, in subjects like algebra, French, and Euclid.

(12.) The education reserves not specialised, and at present in the hands of the School Commissioners, should be used to provide the necessary funds for (8) and (9) scholarships.

Art. LI.—*The Early Days of Printing in New Zealand: A Chapter of Interesting History.*

By H. Hill, B.A., F.G.S.

[*Read before the Hawke's Bay Philosophical Institute, 13th August, 1900.*]

The details of the early settlement of New Zealand are getting to be better known year by year. We have still fourteen years to run before a century will have passed by since the time when English people first landed in this country for the purpose of establishing a home. They were not settlers as is usually understood by the term, but their mission was the training of the natives in "peace and good-will," as well towards one another as towards those who might come and wish to dwell among them.

Although a paper bearing upon the history of New Zealand may be written without reference to the earliest comers and workers, it is impossible to write a true history of the country—of its earliest known condition and the effect of the first operating influences upon the natives—without dealing in some measure with the missionary work that took place between 1814 and 1843, when an English bishop came to reside in the country. Our philosophical society debars—and rightly so—the consideration of religious topics; but there is a wide gulf separating historical fact in which missionaries are concerned and the discussion of topics bearing on religion and dogma. Had it not been for the work of the missionary there would have been no New Zealand history as now understood, and it is doubtful whether efforts would have been made to add the country to the list of England's colonial possessions.

That great man Samuel Marsden, whose history has yet to be written, and whose power and worth are as yet so little understood by the English nation, was the first to realise the importance of New Zealand as a field of missionary effort. It is true that Governor King, of New South Wales, during the period of his Governorship of Norfolk Island, was equally attentive with Mr. Marsden to two young natives of New Zealand—Tooi and Huru—who were kidnapped, and subsequently taken to Norfolk Island for the purpose of instructing the convicts how to prepare the *Phormium tenax*, or native flax, the island being used by the British Government as a convict settlement. The two young men were taken to the island in H.M.S. "Dædalus" in April, 1793. They were treated with much consideration during their stay on the island by both Governor King and Mr. Marsden; and in November of the same year the Governor made a special journey to New Zealand, carrying with him the two natives, who had been taught many useful things, among which may be named the way to cultivate maize. Subsequently Mr. Marsden greatly interested himself in certain New-Zealanders whom he met on board ship on his way from England to Sydney. So determined was he to render help to the natives of New Zealand—who were at the time known as cannibals and savages of the worst type—that he decided to visit the country with a certain Ruatara, who had been his ship companion from England, and from whom Marsden obtained much information concerning New Zealand. This was towards the close of the year 1814. From that time onward, for more than twenty years, the history of New Zealand is mainly on the pages of missionary effort. As showing the practical side of Mr. Marsden's character, it is only necessary to quote from a letter which he addressed to the secretary in England of the Church Missionary Society from Paramatta, near Sydney, on 4th March, 1817. He therein commends two young natives of New Zealand to the good offices of the society—one named Tooi, in Mr. Marsden's school at Paramatta for three years, and the other, whose name was Teeterree, had been there for eighteen months. "The time had arrived," wrote Mr. Marsden, "when they might visit England, to enlarge their ideas and prepare them for great usefulness to their countrymen; for," continues Mr. Marsden, "I still entertain the same idea of New-Zealanders that I have for years past—viz, that they are prepared for receiving any instruction which we can give them." And then the practical side of the man comes out: "If you could get any person to form a vocabulary of the New Zealand language while they remain in London it would be a great advantage to the mission. Tooi is very quick, and can speak the English language pretty well; so that I think this may be done better in London than Mr. Kendall can do it in New Zealand. I wish on no account that these young men should be idle, and if they cannot be employed in assisting to form a vocabulary they should be put to learn rope-making. The New-Zealanders have been considered the most ferocious cannibals and the most warlike savages in the known world. Cannibals they are, and readily admit it. They are warlike also; but they are very noble, and naturally kind and affectionate, and in many moral qualities they would put our nominal Christians to shame." Such was the estimate of the New-Zealanders in 1817, and the proposals made by Mr. Marsden with a view to their emancipation and civilisation are among the most practical and humane that have ever been suggested. Three years after Mr. Marsden addressed his letter to London the Rev. Samuel Lee published a Maori grammar, based in a large measure upon one which the Rev. Mr. Kendall had prepared during his residence as a missionary in New Zealand.

The difficulties of settlement in a new country, and among a people possessing no literature, and whose language had to be learnt and systematized, can hardly be realised by those who dwell in civilised communities. It was useless to appeal to the natives on abstract questions of religion, and admirable judgment was shown by Mr. Marsden in his selecting men for the conversion of the natives who possessed qualifications of a practical character, such as would appeal to the daily wants and social needs of a people. Men capable of using axe, saw, spade, plane, hammer, and plough were of the kind most useful in the early days of settlement. Instruction in the arts leading to the social betterment of the race was eminently practical, and convincing even to a savage people; and if that injunction of Mr. Marsden's, "I wish on no account that these young men should be idle," could have been carried out fully and completely the native race would have to-day promise of a great future.

In 1823 Henry Williams landed in New Zealand, at the time when Mr. Marsden was making his fourth visit to the country; and it is interesting to find that the first letter that he wrote to London after his arrival contained two requests—one that his brother William might come, the other that a printing-press might be sent. Both of these requests were supplied in due course, but William Williams anticipated the arrival of the press about eight years, and it was well that the events took place as they did. William Williams had a great capacity for work, for organization, and for learning the native language, and it was not long before he grasped the position of affairs with respect to the native race. There had been what was termed a "language committee" at work before the arrival of William Williams, but some of the members possessed small scholarship, and, although the native language had been learnt, it had hardly been arranged in a way suitable for literary purposes. A new committee, known as a "translation committee," was set up, consisting of Messrs. William Williams, Yate, and Puckey, and it is to these three persons, but mainly to the former, that the native language of the Maori was fixed in its present written form. Translation was comparatively slow, but in the year 1829 sufficient progress had been made with parts of the liturgy and certain chapters of the Bible to warrant the committee in having the same published for native use. With this end in view, Mr. Yate was sent to Sydney to superintend the issue of the first Maori book from the press. The issue numbered 550 copies, and the contents were as follows: First three chapters of Genesis, eighth chapter of St. Matthew, first four chapters of St. John, seven hymns, and four catechisms.

On the 31st July, 1830, it is recorded that the schooner "Active" arrived at the Bay of Islands from Sydney, having on board Mr. Yate, with his books, and a James Smith, printer, among the passengers. James Smith was a lad fifteen years of age. The date of the arrival of the schooner is a very important one in connection with the history of printing, for the *Missionary Register* of January, 1831, page 67, says, "The Rev. W. Yate took a printing-press with him to New Zealand on his return to the mission in July last from New South Wales. The press had been sent from this country at the instance of the missionaries." In the same *Register* Mr. Yate says, "I am about to take with me to New Zealand a youth aged fifteen years, very strongly recommended by Mr. Marsden; he is to assist in printing, for which purpose I have put him in the *Gazette* office till we sail." On the 1st September, 1830, Mr. Yate wrote, "Employed with James Smith in printing off a few hymns in the native language. We succeeded beyond our most sanguine expectations. . . . You will perceive by a copy of a hymn forwarded by this conveyance that we shall be able in a short time to manage it."

There appears to be no copy in this country of any work done by Mr. Yate and James Smith, but I believe several copies are among the records of the Church Missionary Society in England, and I have seen a photographed copy of the catechism which is said to have been printed in the year 1830. The "short time" referred to in the above quotation seems never to have arrived, for the press, the printer, James Smith, and the type disappeared as mysteriously as they appeared. Where* the press was set up —whether at Waimate or Paihia—is a mystery, and no one, as far as I can find, has ever been able to discover anything about the press, for which Mr. Yate sent thanks to London, and about which he never once made mention, either in his book, published in 1837, or in his many communications during the seven or eight years that he remained as a missionary in the country after his return from Sydney. It could hardly be supposed that the "translation committee," of which Mr. Yate himself was a member, would be unacquainted with the press and the printer that arrived in

* Since writing this paper I have heard from Alex. H. Turnbull, Esq., of Wellington, that the Church Missionary Society has a copy of a Church catechism printed at Kerikeri in 1830.—H. H.

1830; yet we find the committee continuing their labours of translation, and in the latter half of 1832 Mr. Yate was again commissioned to proceed to Sydney to superintend the issue of a more complete book for the use of the Maori Church." On the 2nd March, 1833, he reported to the other members of the committee in the following words: "I have completed the liturgy, catechisms, and hymns"; and on the 21st May he again reported: "I am happy to say I have at last finished the printing." With his letter he sent two bound volumes of the new book, containing morning and evening prayers, sacramental service, the services of infant and adult baptism, services for marriage, burial, and the churching of women. There were also four catechisms, twenty-seven hymns, the first nine chapters of Genesis, Gospels of St. Matthew and St. John, Acts, Epistle to the Romans, and First Epistle to the Corinthians. The issue consisted of three thousand books for the Church Missionary Society following and three hundred for the Wesleyans at Hokianga, who used the same books in teaching the natives the art of reading and writing.

At this period the schools for instruction were very active, and, judging by the anxiety shown among the natives from all parts of the North Island to acquire the art of reading, much value must be attached to reading and writing as important adjuncts in the civilisation of a people. It is curious to observe, however, that the natives were carefully kept from acquiring a knowledge of the English language. Communications, converse, correspondence were all carried on in the language that had been acquired by the incoming teachers and settlers.

The early efforts of the missionaries were directed to the training of the natives in European, or rather English, habits and modes of living, whilst the language that was to amend and modify a nation, and which in itself contained all that could be expressed of the ways, customs, and aspirations of a people, was to remain for both Europeans and Maoris alike. But about this time increased vitality began to be manifested. The two religious bodies had hoped to keep the Maori communities under their own particular control. It was impossible, however, to keep back the traders, who flocked to the country from Sydney and America, and the new contact was by no means satisfactory. What the religious orders taught by practice and precept was directly opposed by the precept and practice of the sailors, runaway convicts, and others who landed at different times in the vicinity of Hokianga and the Bay of Islands, where European settlement first took place. And what had been done as yet for the uplifting of the natives in the direction of civilisation?

For the first fifteen years of New Zealand's contact with a civilising race the controlling influences were industry and religion. It was not the English language or literature that operated to regulate and influence the actions and habits of the natives. As already pointed out, it took twenty years for the issue of 3,800 books to the natives in their own language, and at the same time hardly a step had been taken to instruct the Maoris in the English language. The influence of the religious teachers had been great in the way of modifying the instincts of a savage race that had lived long in isolation and had been untouched by external agencies. Intercourse is the mother of change in all conditions of being, and the isolation of the natives when brought into contact with what represented the highest form of the religious side of civilisation was slow to imitate, though it regarded with respect, the men who "preached and practised"—a new thing to the people. The real influence of the religious teacher consisted in his skill and his ability to supply the higher comforts and conveniences of life, and the provision that was made for the betterment of the social condition of the people was the secret and source of the influence exercised by the teachers of religion. The new contact of the natives with sailors and others of like aspirations broke the spell of religious seclusion in the country.

The ten years between 1830 and 1840 may be termed the "second period" in the process of change through which the natives went before coming under the direct control of England. The books issued to the natives between 1830 and 1834 may be set down as the first fruits of the new period; but, though the aim was to foster the religious life, they acted in the direction of creating a desire for other books, and that desire was not long in being met. But it could not be met by the isolation of language that was preached and hoped for by the teachers of the day. The natives were not taught the English language, but those of them who were brought in contact with the rabble that often gathered together from the ships at Kororareka and other places in the Bay of Islands soon acquired the power of expressing themselves in the not too elegant English of the sailors, ex-convicts, and others who delighted to throw difficulties in the way of those men and women who strove to raise the natives to purer aims and hopes. It was the meeting at the "cross-ways" in the thirties, where we can trace the growth among the natives themselves of wider ambitions and wider views than was possible so long as they followed the course laid down for them by their first teachers.

Things in the Bay of Islands flourished in a widely different way to what had been expected by those who, fixing a foundation, had hoped to maintain a predominating influence over the native race. But the new influences came in through advancing trade and more frequent intercourse with the external world. The time had come for the arrival of a new factor in the educational enlightenment of the Maoris.

On the 30th December, 1834, there arrived in the Bay of Islands a printing-press sent out direct from London. Mr. William Colenso, a young man twenty-three years of age, was also sent out as the printer in charge. The description given of the event shall be told by the words of those who were concerned at the time. Mr. W. R. Wade, who was the superintendent of the press, in a letter dated the 10th January, 1835, says, "The arrival of the press is, as we expected, hailed by our friends here as a memorable event for New Zealand, and, as for the natives, those who assisted in bringing it ashore shouted and danced in the sand when told it was *ta pukapuka* (a book-press, or book-making machine). There is an extraordinary demand for books all around." In a letter written by Mr. Colenso about the same time, after describing the reception he received at the time of landing, he says, "The next morning the natives surrounded us, crying '*Kapai miharere*' (very good morning), uttering exclamations of joy, and tendering their hands on every side; and when the Rev. Mr. Williams gave them to understand that I was a printer, and came out to print books for them, they were quite elated. No hero of olden times was ever received by his army with greater *éclat;* they appeared as if they would deify me. During the week I was busily employed with the natives in landing the goods, and on Saturday, the 3rd January, 1835, a memorable epoch in the annals of New Zealand, I succeeded in getting the printing-press landed. I was obliged to unpack it on board, but I am happy to say it is all safe on shore. Could you but have witnessed the natives when it was landed: they danced, they shouted, and capered about in the water, giving vent to the wildest effusions of joy, inquiring the use of this and the place of that with all that eagerness for which uncivilised nature is remarkable—*certainly they had never seen such a thing before.* I trust soon to be enabled to get it to work. Throughout the island there appears to be a universal movement, a mighty striving of the people. The chiefs of distant tribes come down to Waimate and this place for books. . . . I have seen them myself gladly bring their store of potatoes for a book." It is a strange circumstance that the words in italics were never contradicted. The missionary authorities in London and the translators on the committee in New Zealand, who must have been aware of Mr. Yate's press, would hardly have permitted such a statement as that made by Mr. Colenso to pass by without contradiction, and certainly Mr. Colenso was too careful of what was right and honourable to take to himself any honour which rightly belonged to another.

Mr. Yate went to England at the end of 1835, and he reached Sydney, on his way back to New Zealand, on the 13th June, 1836. In the thirty-seventh annual report of the Religious Tract Society, pages 52, 53, it is reported: "The Rev. W. Yate during his residence in England reported to the committee the progress made in New Zealand in the publication of useful books. The committee have granted to Mr. Yate copies of the Tahitian and Rarotongan books published for the South Sea Islands, and copies of their juvenile works. Mr. Yate hopes soon to commence printing some tracts in the native language, towards which object the committee will be happy to contribute." It is difficult to harmonize this statement with any claims that are put forth on Mr. Yate's behalf that he was the first to print anything in New Zealand. He recognises the publication of "useful books" as having taken place before leaving for England in the later months of the year 1835, and those books consisted solely of the Ephesians, Philippians, and the Gospel of St. Luke, which were printed by Mr. Colenso; for in July, 1835, Mr. Colenso reports to London: "I have been employed in cleaning and setting up the press, making and getting tools to rights, laying types in cases, composing and working off two thousand of the Epistles to the Ephesians and Philippians and folding and sewing the same, composing and working off six hundred tables, and numerous little things for the station, as cutting out boards, and mounting lessons, writing, &c."

On the 5th January, 1836, the work of the second half-year of 1835 is thus summarised: "I have been engaged in composing and printing one thousand copies of St. Luke's Gospel and a 12mo. book of sixty-seven pages, since which I have bound in leather and cloth upwards of four hundred of these Gospels. I have also printed seventy-five circular-letters in English and seventy-five in the native language for the British Resident."

If it be true that Mr. Yate printed certain hymns and a catechism in 1830 at Kerikeri, then the statement that "he hopes to commence printing some tracts in the native language" had already been accomplished, and as he was not the printer, and had nothing whatever to do with printing in 1835, it is difficult to understand the position taken up by this forceful and not over-particular missionary. In any case, it was stated by Messrs. Coates and Beecham, of the Church Missionary Society and Wesleyan Mission, before the Commission held to inquire into the "Present state of the Islands of New Zealand," the report of which was ordered to be printed by the House of Commons on the 8th August, 1838, "that the press was first introduced into New Zealand in 1835, and that Mr. Colenso was the first printer" (page 196). The press that was set up at Paihia under the direction of Mr. Colenso was erected there for three reasons—(*a*) In order to be near the editor of the New Testament, William Williams; (*b*) to be away from the constant interruptions pertaining to a station at the harbour; and (*c*) to be safe from Maori inroad and pillage. These reasons are stated by Mr. Colenso in his paper "Fifty Years Ago in New Zealand," 1888.

At the time of setting up the press a motley gathering of nondescripts was to be found in various places within the bounds of the Bay of Islands; but it is a curious reflection for the thoughtful to find that no heed appears to have been paid to the state of the wild English and Americans, who appeared among the natives like the seven devils among the swine. The press and the teachers were for native use, and traders, whalers, and ex-convicts were to go their own ways. and supply their own wants in the manner that might seem to them best.

It can hardly be understood at this period as to the state of the people in the numerous settlements to be found in the Bay of Islands at the time of setting up the printing-press. There was no regulating authority whatsoever, for, although a British Resident, in the person of Mr. Busby, had arrived from Sydney in 1833, he could exercise no control, having no executive power and no means of enforcing his decrees. The state of affairs grew so serious that the principal natives of the north took up the matter and decided to do for themselves what it had been their hope would be done for them by the English Government. At an important assemblage of chiefs on the 28th October, 1835, they declared for national independence in the following words:—

"1. We, the hereditary chiefs and heads of tribes of the northern parts of New Zealand, being assembled at Waitangi, in the Bay of Islands, on the 28th day of October, 1835, declare the independence of our country, which is hereby constituted and declared to be an independent State, under the designation of the united tribes of New Zealand.

"2. All sovereign power and authority within the territories within the united States of New Zealand is hereby declared to reside entirely and exclusively in the hereditary chiefs and heads of tribes in their collective capacity, who also declare that they will not permit any legislative authority separate from themselves in their collective capacity to exist, nor any function of government to be exercised within the said territories unless by persons appointed by them and acting under the authority of laws regularly enacted by them in congress assembled.

"3. The hereditary chiefs and heads of tribes agreed tc meet in congress at Waitangi in the autumn of each year for the purpose of framing laws for the dispensation of justice, the preservation of peace and good order, and the regulation of trade, and they cordially invite the southern tribes to lay aside their private animosities and to consult the safety and welfare of our common country by joining the confederation of the united tribes.

"4. They also agree to send a copy of this declaration to His Majesty the King of England, to thank him for his acknowledgment of their flag, and, in return for the friendship and protection they have shown and are prepared to show to such of his loyal subjects as have settled in their country and resorted to its shores for the purposes of trade, they entreat that he will continue to be the parent of their infant State, and that he will become its protector from all attempts upon their independence."

This Proclamation was signed in the presence of the British Resident, and there were four English witnesses, two of them missionaries and the others merchants. This is a translation of the circular which was printed by Mr. Colenso at Paihia. It bears the heading, "Wakaputanga o te Rangatira tanga o Niu Tirene."

Although this claim for independence by the natives was made at a great meeting on the 28th October, 1835, the following entry occurs in Mr. Colenso's "Day- and Wastebook," which is in my possession, and extends from May, 1836, to the 24th July, 1843, and contains all dealings connected with printing at the missionary press that was set up at Paihia. The entry runs as follows:—

> 26th April, 1837. James Busby, Esq.: Printing, &c., 100 foolscap folio "Declaration of Independence of Native Chiefs," £1 1s.

The information contained in the "Day- and Waste-book" is of particular public interest, and, were space available, I should like to give extracts that have never yet been made public. I shall, however, limit the work to extracts that have particular reference to matters of historic importance during the years in which Mr. Colenso was connected with the press.

It is curious to find that the printing of the "declaration of independence" in the native language, several copies of which are in my possession, should have taken place eighteen months or so after the meeting at which the declaration was made. Why this course was adopted cannot now be discovered, but the years 1836–38 are perhaps among the worst and most lawless through which natives and colonials have passed; and perhaps the assent of the British Government had not been received by the Resident to the claims set up by the natives. Comparatively little printing was done at the missionary press beyond what was required for the instruction of the natives, but there are several important exceptions, such as the following: In May, 1836, the state of things in and about the Settlement of Kororareka had become so dreadful that a few of the better class, who had not lost all sense of decency and self-respect, determined to do something to stem the tide of disorder and drunkenness that dominated the whole, or nearly the whole, of the population such as had gathered together in the vicinity of the shipping-places in the Bay of Islands. In May, 1834, it was decided to call a public meeting at Kororareka for the purpose of establishing a temperance society, and the following placard—the first issued in English in New Zealand—was published:—

TEMPERANCE SOCIETY.

On Wednesday, the 11th day of May inst.,
A
Public Meeting
Will be held in the
Church at Kororareka
For the purpose of establishing a
TEMPERANCE SOCIETY.

The attendance of all Persons desirous of promoting Peace, Order, and Sobriety is most earnestly requested.

The British Resident will take the chair at 12 o'cock.

Dated May 4th, 1836.

Paihia: Printed at the Press of the Church Missionary Society.

The above is a literal copy of the placard I have, and which is the only copy known as far as I can gather. I remember that Mr. Colenso, a short time before his death, related the circumstances of the placard and of the printing of the first English book, which was a report of the New Zealand Temperance Society. A brief reference to each of these publications will be found on page 12 of Mr. Colenso's Jubilee paper, "Fifty Years Ago in New Zealand," a paper of surpassing interest to students of early history and settlement.

On the 5th October, 1836, the following entry occurs in the "Day- and Waste-book":—

James Busby, Esq., British Resident: Printing 75 folio copies fools cap circulars relating to Baron de Thierry, £1 1s.

And on the 12th October:—

James Busby, Esq.: Compositing and printing 70 foolscap 4to circulars in native language relative to Baron de Thierry, 10s. 6d.

No other printing is entered as having been done during 1836–37 beyond the work connected with the printing of the New Testament. This highly important undertaking was carried on by the appointment, on the 14th November, 1836, of John Bevan and Henry Mann in the printing-office at £1 10s. per week; but on the 28th January, 1837, their services appeared to have ended, as full payment of wages was made on that date, and no further mention is made of them. A few days afterwards—*i.e.*, the 15th February—there is the following entry:—

> Engaged James Powell, pressman; 16th, commenced.
> Feb. 22. Engaged C. F. Opham, pressman; commenced; 7s. day.
> Feb. 27. Agreed with J. Powell and C. Opham at 25 cents per token—*i.e.*, 1s. English money.
> Oct. 4. Printed first part sheet grammar, demy 12mo.
> Dec. 30. Finished printing New Testament, 5,000 copies, demy 8vo. "Glory be to God alone!"

I possess a copy of the grammar and of the New Testament as printed on the dates named, and, whilst both works represent an inestimable amount of labour, of scholarship, and evident desire to be of some benefit to the native race, one cannot help expressing the view that much more good would have resulted by following along the lines laid down by the first missionary. Assimilation comes quickest through and by means of language, and every effort should have been put forth to teach the natives to speak the language of their teachers, for then a new line of thought would have sprung up in the case of the younger generations. The fostering of the language as spoken by the natives simply intensified the peculiar religious notions of the native race, and affected in a marked manner their subsequent conduct socially and religiously. The completion of the New Testament reflected the highest credit upon the translation committee and Mr. Colenso, who was responsible for the printing.

Much historical importance attached to the printing of circulars in English and Maori relating to the Baron de Thierry, because at this time New Zealand was declared to be independent, and yet the British Resident deemed it proper to issue an address to His Britannic Majesty's subjects who were then resident in New Zealand. This address is referred to by the Rev. J. Beecham, general secretary to the Wesleyan Mission, in his evidence before the House of Lords in 1838 as having been issued in 1835 (10th October), but, as shown above, the entries in the "Day- and Waste-book" are 5th and 12th October respectively, 1836. Baron de Thierry's address to the white residents of New Zealand is dated Sydney, 20th September, 1837, and I have it from Mrs. Allen, an old lady at present residing at Farndon, that she was at Hokianga as a servant to the Rev. Mr. Turner at the time when Baron de Thierry arrived, in December, 1837. Mr. Turner was present at the meeting, and strove to settle the disagreements between the natives and the Baron. As in the case of the "declaration of independence," it may be that the circulars were printed some time after the actual events took place; but, in any case, the printing of circulars relating to Baron de Thierry and to the "declaration of independence" are entered in the "Day- and Waste-book" in the order of their happening, though neither at the time when the event actually took place or is reported to have taken place.

In 1838 little printing was done. Both the editor of the translation committee and Mr. Colenso were granted leave of absence, and we find them journeying towards the East Cape, and the latter began that work of collecting New Zealand plants for which in later years he became justly noted. The only printing that was done were two tracts—one being the consecration of a burial-ground, four pages, of which one hundred copies were issued; the other the confirmation service, of which two hundred copies were printed. As usual, they were in the native tongue, and were printed for the convenience of Bishop Abraham, of Sydney, who visited New Zealand in the summer of 1838, to find that a bishop of the Roman Catholic Church was already working in the country; and from this time forward there was remarkable activity in the printing-office at Paihia, for many thousands of books were issued in the native language, all of which, however, were made up of prayers, catechisms, and formularies of some kind or other.

The condition of the people in the Bay of Islands—both native and European—was indescribably bad. Whilst the natives were being saturated with forms of prayer, and creeds, and catechism which to them could not possibly have the slightest interest or meaning, the white population were permitted to go their own ways and do almost as they pleased. Each was a law unto himself. Duty as a principle of conduct could not result from the instruction given by the teachers, and as soon as the native mind came within the grip of the lower influences of human nature such as were to be found in all their ugliness at Kororareka and other places the weakness of the training of the natives was quickly seen. The chief found pleasure in gratifying his new-found friends, whilst he was at the same time able to obtain without difficulty what he could not obtain as long as he remained under the tutelage of formularies that tied him down to a form of life that he did not understand and could not utilise for his benefit. Many thousands of religious books or papers were issued, and it is evident that the printing-office was hardly pressed for want of help. It is not necessary to give the different books that were printed and issued, but the following items will be of interest:—

July 29. James Busby, Esq.: To compositing and printing 200 copies of prospectus of Victoria Institution, £1 1s.
Aug. 10. Compositing and printing circular-letter, 70 copies, for calling meeting at Kororareka, 7s. 6d.
Aug. 12. Compositing and printing "placard" calling meeting, 40 copies, 7s. 6d.
May 1. To paid Iretoro and Tame, two natives, for presswork, one pair jacket and trousers each.
May 3. James Richards: Pair trousers, 5s.; hat, 4s.; pair stockings, 3s. 6d.; waistcoat, 5s. 6d.—about 20s., with articles to him before these for sundry jobs during the last four months in printing and binding.

The meetings at Kororareka became more frequent as time went on, for matters were in an utterly disorganized state. So bad, in fact, had become the condition of the place that in May, 1838, a few of the leading men of business, with the captains and officers of the ships in the bay, formed themselves into an association for the purpose of mutual safety and protection. Like most things that were started in those times, the rules that were drawn up were sent to Sydney to be printed, and the documents containing the rules of the association of householders at Kororareka were printed and issued from the *Herald* Office, Sydney, on the 11th June, 1838. The only existing copy of the rules that were drawn up by the householders is in the possession of Mr. A. H. Turnbull, of Wellington.

Whilst the better class of people in the Bay of Islands were taking measures to protect themselves from lawlessness of all sorts, the House of Lords in England was holding an inquiry into the state of New Zealand. The news from New Zealand had reached the British Government through the Governor of New South Wales and the secretaries of the missionary societies; but the immediate cause of the inquiry was on account of a proposal, made by an association termed the "New Zealand Association," for the colonisation of the country: "The New Zealand Association consists of two classes of members—First, heads of families—fathers—who have determined to establish themselves in the proposed colony; secondly, public men, who, for the sake of public objects alone, are willing"—to use their own words in addressing Her Majesty's Government—"to undertake the responsible and not very easy task of carrying the measure into execution." The report of the Royal Commission was issued in August, 1838, and the information it contained—which was based on the evidence of men intimately connected with the country—was such that no civilised Government could permit such a state of things to continue such as the evidence disclosed. "Such is the depravity evinced by some Europeans, Americans, &c., at the Bay of Islands that one place is termed 'Hell'"; and the same authority says, "A wicked New-Zealander will turn on one sometimes, when reproved, and say, in reference to our countrymen, 'Physician, heal thyself.' It is a lamentable fact that where European society increases there is in proportion also a laxity of morals among the heathen with whom they reside. . . . I could write facts which would make a modest person blush for our countrymen" ("Report on the Present State of New Zealand," page 311).

Following the issue of the report the British Government decided to take a more active part in the maintenance of law and order in New Zealand, and on the 14th August, 1839, Lord Normanby issued to Captain Hobson, on his appointment as British Consul, certain instructions, from which the following extract is taken. These instructions are to be found in New Zealand parliamentary papers, 1840, pages 37, 38, and they show the views held by the British Government at that date as to the rights of the New Zealand chiefs to independence: "We acknowledge" (so runs Lord Normanby's instructions, and speaking for his Government) "New Zealand as a sovereign and independent State, so far as it is possible to make that acknowledgment in favour of a people composed of numerous dispersed and petty tribes who possess few political relations to each other and are incompetent to act or to deliberate in concert. But the admission of their rights, though inevitably qualified by this consideration, hangs on the faith of the British Crown. The Queen, in common with Her Majesty's immediate predecessor, disclaims for herself and her subjects every pretension to seize on the islands of New Zealand, or to govern them as a part of the dominion of Great Britain, unless the free and intelligent consent of the natives, expressed according to their established usages, shall be first obtained."

Captain Hobson, R.N., arrived in New Zealand on the 29th January, 1840, in H.M.S. "Herald." He was authorised to assume the title of Lieutenant-Governor in the event of the aborigines being "willing to recognise Her Majesty's sovereign authority over the whole or any parts of the country." Mr. Colenso's "Day- and Waste-book" gives us information that is of unusual interest and public importance, and, as it is entirely new and deals with matters bearing upon the events that are of historic value in the history of this country, I shall quote them in full. On the 30th January, 1840, occurs the following entry:—

Captain Hobson, R.N.
To compositing and printing 100 4to foolscap circulars for assembling natives at Waitangi, 12s.
$2\frac{1}{4}$ quires foolscap for same, 2s., 4s. 6d.
To compositing and printing 100 foolscap folio Proclamations, £1 1s.
To compositing and printing 100 foolscap folio Proclamations, £1 1s.
$4\frac{1}{2}$ quires foolscap for ditto, 2s., 9s.

In vol. ii., pages 11, 12, of the "Life of Henry Williams," referring to the part taken by Mr. Williams in connection with the Treaty of Waitangi, it is stated: "On the night of the 30th January I was called up (at Waimate) by a messenger from the bay to say that Captain Hobson had arrived in the bay as Governor of New Zealand, and that he wished to see me as early as possible." (Mr. Williams had only just returned from an extended journey through the island by way of the Wanganui River to Taupo, the first that had ever been made by a European.) "In the afternoon I went on board H.M.S. 'Herald,' and was met by Captain Hobson, to whom I expressed my gratification that he had arrived to put an end to the great excitement then existing in the purchase of lands, caused by the sudden influx of Europeans arriving by every vessel from the colonies." At this date he had not received any intimation that the Government were contemplating any movement towards New Zealand, though much correspondence had transpired in consequence of the proceedings of the New Zealand Company. It will have been noticed that the order for printing circulars calling together the natives at Waitangi is entered 30th January, or the day following that on which Captain Hobson landed in New Zealand. It would appear, therefore, that the Lieutenant-Governor that was to be lost no time in communicating with the British Resident, Mr. Busby, who lived at Waitangi, and that action was immediately taken to assemble the natives. From the original copies of the Treaty of Waitangi, it is evident that Mr. Busby had a good deal to do in formulating the terms in which the treaty was to be submitted to the natives at the meeting which had been called by printed circulars. "On the 4th February, about 4 o'clock p.m.," says Henry Williams, page 12, vol. ii., "Captain Hobson came to me with the Treaty of Waitangi in English for me to translate into Maori, saying that he would meet me in the morning at the House of the British Resident, Mr. Busby, when it must be read to the chiefs assembled, at 10 o'clock." At the meeting that took place the Rev. Mr. Williams acted as interpreter for Captain Hobson.

The descriptive account of the proceedings of the native meeting that took place on Wednesday and Thursday, 5th and 6th February, at Waitangi, at which missionaries, settlers, and natives assembled to meet the Lieutenant-Governor, will be found in Mr. Colenso's paper entitled "The Signing of the Treaty of Waitangi," published by the Government in 1890. It is full of historic incidents, and shows how carefully the natives discussed the prospects of their position, and the benefits likely to result by asking the Queen to become their ruler. Undoubtedly Captain Hobson showed admirable tact in dealing with a matter of such importance. I shall not give here the terms of the treaty or enter the Proclamations that followed the signing of the treaty; but, as the printing necessary for the requirements of the new Government had to be done by Mr. Colenso at the missionary press, it will be found of interest to give in regular order the printing that was done after the meeting had been held at which the treaty was first signed:—

Feb. 17. Captain Hobson, R.N.: Compositing and printing 200 copies of treaty, foolscap folio, £1 10s. 6d.; 4½ quires of foolscap paper for above, at 2s., 9s.

Mar. 31. Captain Hobson, R.N. (ordered by W. Shortland, Esq.): Compositing and printing 100 impounding notices, £1 1s.; 2 quires folio post paper for same, at 3s., 6s.

No further printing appears to have been done for the new Administration till the 27th April, when the following entry occurs:—

April 27. Captain Hobson, R.N.: Compositing and printing 100 foolscap 4to circulars, 12s.; 2¼ quires foolscap paper for same, at 2s., 4s. 6d.

May 4. Lieutenant-Governor Hobson: Compositing and printing 100 f lio post Proclamations, £1 1s.; 2¼ quires folio post paper, at 2s. 6d., 5s. 8d.

May 6. Lieutenant-Governor Hobson: Compositing and printing 200 demy 4to Proclamations in native, £1 1s.; 2 quires demy paper for same, 5s.

May 11. Printing 200 ditto, ditto, 8s.; 2 quires demy paper for same, 5s.

May 22. Lieutenant-Governor Hobson: Compositing and printing 100 copies of folio foolscap Proclamation asserting Queen's sovereignty over Southern Islands, £1 1s.; compositing and printing 100 copies of folio foolscap Proclamation asserting Queen's sovereignty over Northern Island, &c., £1 1s.; 4½ quires of foolscap for above, at 2s., 9s.

June 16. Government of New Zealand: Compositing and printing 100 Proclamations, corrected copy, asserting Queen's sovereignty over New Zealand, £1 1s.; 2¼ quires of foolscap for above, at 2s., 4s. 6d.

It will be noticed here that a corrected Proclamation was issued on the 16th June, it having been discovered by Mr. Colenso that a serious error had occurred in the wording of the Proclamation which was printed and issued on the 22nd May, which ran as follows: "Now, therefore, I, William Hobson, Lieutenant-Governor of New Zealand, do hereby proclaim and declare to all men that from and after the date of these presents the full sovereignty of the islands of New Zealand, extending from 34 degrees 30 min. north to 47 degrees 10 min. south latitude, and between 166 degrees 5 min. to 179 degrees of east longitude, vest in Her Majesty Queen Victoria." Of course, every one is aware what this Proclamation was intended to include, but its peculiar wording implied the extension of New Zealand in a northerly direction as far as Japan. I saw the original Proclamation a short time before Mr. Colenso died, but what has become of it since I am unable to discover.

The day before the amended Proclamation was issued—that is, the 15th June—the first paper was published by G. A. Eager and Co., of Kororareka, and bore the title of the *Bay of Islands Observer.* This paper was naturally used by the governing authorities as an advertising medium for official notices, but a misunderstanding between the authorities and the proprietors took place, and on the 15th December the paper ceased to exist. This, no doubt, accounts for the item that appears in the "Day- and Waste-book" for the 30th December, thus :—

> Government of New Zealand.
> Compositing Gazette Extraordinary, No. 1, 4 pages, demy 4to (12 columns of matter), £6 6s.
> Printing 150 copies of same, 18s.
> 3½ quires demy paper for same, at 2s. 6d., 8s. 9d.

The Government were seemingly in want of funds, for the amount of this item was not paid till the following September, and it is entered in the "Day- and Waste-book" as follows :—

> Received of Colonel Godfrey (Land Commissioner) a cheque on bank for amount of bill for printing, £7 12s. 9d.

All the other items for printing on behalf of the New Zealand Government had previously been paid on the 22nd December, 1840, by G. Cooper, Esq., the final amount being £14 12s. 7d.

There are several entries during the period covered by the years 1840–41 which might be given here as showing the growing importance of the printing-press and the increasing value of the books that were being constantly issued. The entries of sales for Testaments at 4s. each are numerous, but sometimes "free" copies were issued, such as the following :—

> Jan. 28, 1840. Testament presented to Patume on his baptism.
> Feb. 20. Received for five Testaments from J. Busby, Esq., £1.
> April 2. Presented to Commodore Wilkes, American squadron, one Testament, one prayer-book, one catechism.
> May 4. Received for a Testament from French Commodore, 4s.
> May 13, 1841. Presented to Lady Franklin one Testament, one psalter, one grammar, one primer, one prayer, &c.

Entries of this kind might be indefinitely extended, but these are given to show the new influences that were beginning to act upon the new colony.

It has already been explained that the years 1839–40 were years of remarkable activity in connection with the printing-press, of which Mr. Colenso was at this time the superintendent. Quite a staff of printers appear to have been at work, and soon new buildings were needed, and new presses to complete the many publications that were deemed necessary to supply to the natives. The removal of the press, cases, type, &c., to the new printing-office took place in March, 1840, and the following curious entries appear in the "Day-book":—

March 21. By paid Tame, one guernsey frock, 3s. 9d.; paid Pua, one guernsey frock, 3s. 9d.; paid Hoka, one guernsey frock, 3s. 9d.; paid Ruru, one flushing ja^ket, 5s.; paid Baker's lads, in soap, tobacco, and pipes, for assisting in removing press, &c., 1s. 6d.

For the five months ending May, 1840, over seventy thousand copies of different tracts, prayers, catechisms, &c., were issued and ready for distribution, and the entries showing the districts to which the several publications were sent from time to time show also the movements of the missionaries over the different portions of the North Island.

By the end of 1842 all parts of the Island had been visited, and new forces were beginning to operate in the work of settlement and civilisation. It would prove an interesting chapter in the history of New Zealand to deal with the opposing forces that came into play immediately following the Treaty of Waitangi, but my purpose is merely to trace as briefly as may be the part played by Mr. Colenso as the first printer in New Zealand.

The arrival of Bishop Selwyn in 1842 altered the course of Mr. Colenso's life, and, although he continued to play an important part in the history of the colony, Mr. Colenso ceased to have anything to do with the press after July, 1843, the last entry in the "Day-book" being the 24th July. From this date Mr. John Telford became press superintendent; but the subsequent events at Kororareka and elsewhere in the Bay of Islands, and the establishment of Auckland as the capital town of the colony in September, 1840, eventually caused the removal of the Church Missionary Society's press to Auckland. Mr. Colenso's work as a printer had been done.

It seems but yesterday since we had Mr. Colenso with us — a man whose noble bearing won the respect and admiration of all. When he came to New Zealand at the end of 1834 the population other than natives consisted of only a few hundred persons, made up mostly of whalers, run-away sailors, ex-convicts, and nondescripts from New South Wales.

His work was for the natives, and he gave his whole energy and skill to the performance of that work. As a printer few have excelled him, and to-day his books will stand comparison with the best issued in the country. He played a part. and he played it well, at an important period in the history of his country. He ever strove to foster the welfare of the natives, and no man can say that he ever used his vast knowledge of Maori customs for the advancement of his own interests as against those of the natives. Of his ministerial work nothing need be said, as it is outside the purview of this paper. Suffice it to say that as a citizen, and as one of the founders of this branch of the New Zealand Institute, his name is held in honourable esteem, and among the historical names that will pass down to posterity not the least one will be the name of William Colenso, F.R.S., printer, scientist, and philanthropist—the man who printed the first book in New Zealand, who discovered more new plants than any one else in New Zealand, and by his bequests has shown how much he loved the outcast and the wanderer, whom he was ever ready to help and succour.

Art. LII.—*On Ancient Maori Relics from Canterbury, New Zealand.*

By W. W. Smith, F.E.S.

[*Read before the Philosophical Institute of Canterbury, 27th February, 1901.*]

Plate XVI.

Having devoted much time during the last eighteen years to visiting and exploring old encampments and rude dwellings of the ancient Maori in the South Island, I would lay before the members of the Philosophical Institute some observations on stone implements and other ancient relics of the Te Rapawai, Waitaha, and Ngatimamoe Tribes, now extinct.

The numerous discoveries during the first fifty years of English settlement in Canterbury of many valuable relics of long ago have also furnished much valuable evidence of the habits of these vanished peoples. Although remnants of ancient pas, hunting encampments, and other rude habitations of the ancient Maori occur in the South Island * from

* *Vide* paper by Joshua Rutland "On the Ancient Pit-dwellings of the Pelorus Sound District, South Island, New Zealand" (*Journal of the Polynesian Society*, vol. vi., p. 77).

Pelorus Sound to the Bluff, Canterbury unquestionably supported the largest population. The area would be chosen by the extinct tribes, like their destroyers the Ngaitahu, as being more easily accessible, and as yielding a greater supply of marine and fresh-water fish, together with land-birds, including the extinct moas, forest products, and fern-root.

We are now living in an important period, when all data respecting these interesting relics of an ancient past in these islands should be carefully collected and accurately recorded. When the old pioneer settlers of the plains have all passed away, leaving those treasures behind them which they found when they ploughed the virgin soil; when the original features of the plains shall have wholly changed, and perhaps the aboriginal inhabitants—the noble Maori—shall have vanished, they will then be cherished as being among the most valuable possessions of the New Zealand museums. It is very regrettable that the numerous specimens of ancient stone implements and other valuable articles now in the possession of the settlers cannot be brought together to form a South Island collection, "for the good," as Captain Hutton expressed it to me, "of those who are to come after us." From the forms of the implements, the various materials they are made of, and the localities where they were discovered, we are able to form an accurate opinion of the economy and habits of their aboriginal owners.

Amongst the stone implements* I have collected there are some curious types or forms not represented in the Canterbury Museum collection. They comprise both rude and polished implements of very varied forms, while they are made from a variety of rocks occurring in widely separated districts in the South Island. I have also examined numerous and, in some instances, unique specimens now in the possession of many of the older settlers, by whom they are much prized. In every case I have been permitted to photograph or sketch them, and figures of some are shown on Plate XVI. As many sites of the ancient encampments and other rude dwellings of the extinct tribes are rapidly disappearing before the advancement of agriculture, I will refer only to those which I have visited and examined.

To all interested in the history of bygone tribes of the Maori in the South Island there is invariably great pleasure in carefully exploring old encampments and collecting every remnant to be found in their vicinity. The painted rock-shelters and caves in the limestone rocks at Weka Pass, Opihi, Albury, and Maerewhenua, in North Otago, have

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* Now placed permanently in the Maori house of the Canterbury Museum.

yielded few relics excepting charred bones of the moas and other birds, together with bones of the extinct native rat and dog. At the present time, however, no perfect exploration of the floors of these rude dwellings has been made. About 90 per cent. of the valuable stone implements, weapons, and other articles used by the prehistoric Maori have been ploughed up on the open plains, also on the lower downs, and in the smaller valleys near the base of the ranges.* As they have been found in every district in Ashburton County, there can be no doubt but that Canterbury was formerly occupied by a large Maori population. At the mouths of the larger rivers of the plains *umus*, or Maori ovens, of different ages were formerly very abundant, but have nearly all been obliterated by the plough or hidden under the dense growth of English grasses. Along the base of the ranges between the Rakaia and Rangitata Rivers innumerable old ovens were discovered by the early settlers when ploughing the tussock land, while several ancient encampments still remain in the district unexplored. A large number of both perfect and broken stone implements, rude and polished, of great age and manufactured from various rocks occurring in the neighbourhood and from the valued greenstone of the West Coast, have also been discovered there. The forest and fern clad country between the two great glacier rivers afforded a great supply of food to the prehistoric Maori. Until about fifteen years ago the magnificent primeval forest at Springburn was teeming with pigeons and parrots and other bush-birds, while in the swamps ducks, swamp-hens, and wekas abounded. Mr. Donald McKenzie has preserved on his property at Stavely a solitary grand old black-pine (*Podocarpus spicata*), which the Maoris of Little River assert was tabooed in olden times by the chiefs of Ngatimamoe, and later by those of Ngaitahu, when on their annual rat-trapping, pigeon-spearing, and bird-snaring excursions to the district from old Kaiapohia. Unfortunately, the charming old forest is now disappearing rapidly, and with it also the old haunts and traces of the ancient Maori.

The area of primeval forest existing at Little River, south of Banks Peninsula, fifty years ago was all that remained—excepting a small area at Riccarton—of an extensive forest, formerly extending thirty-five miles south of the peninsula around Lake Waihora (Ellesmere) on the plains side, and inland for fifteen miles. In much of the heavy swampy land

* The admirably arranged collection in the Canterbury Museum contains several axes and adzes, found in the South Island, identical in form and manufactured from the same material as are several in the Auckland and Wellington Museums. Possibly some of them may have been brought hither during the several migrations from the North Island during the last few centuries.

the first colonists, when ploughing and clearing it, found large quantities of buried charred trunks of several species of native forest-trees of considerable dimensions. They comprise totara (*Podocarpus totara*), black-pine (*P. spicata*), miro (*P. ferruginea*), white-pine (*P. dacrydioides*), manuka (*Leptospermum scoparium*), broadleaf (*Griselinea littoralis*), and several other species. An upright trunk of white-pine still exists on Mr. G. Jameson's property, three miles inland from Lake Ellesmere. Large roots and trunks of these indigenous forest-trees are also at the present time dug out of the old extensive swamp formerly extending from near the Ashburton River to south of the Hinds, a distance of fourteen miles. An area of the same old fallen forest exists several miles seawards of Winchester, eighteen miles south of Hinds, where men are annually employed by contract raising the fallen trunks and disposing of them to the settlers for firewood. In these three areas many stone and wooden implements, together with valuable *kumetes*, or food-bowls, and other ruder relics of barbaric times, have been ploughed or dug out by the settlers within the last thirty years. The implements, of many forms and qualities, and other native utensils belonging to extinct tribes found on or near the sites of the burned or buried forests,* or in ancient forests still flourishing, were probably lost or mislaid by their owners while hunting.

Several discoveries of various numbers of stone adzes, axes, and fish-knives found hidden together in the soil have been made in Ashburton County since the beginning of English settlement forty-five years ago. Mr. M. McCormick, an old bachelor settler in the early days, found "about half a barrow-load" of stone implements hidden in a *cache* on his land. Stone being then scarce on the richer land of the plains, he built his rude fireplace with them, excepting one of the form marked E on Plate XVI., which he still retains. An examination of fragments of these burned stone axes shows some of them to have been only rudely flaked into shape, while others were semi-polished, and all manufactured from several varieties of basalt.

Among the more valuable old Maori relics unearthed from the sites of the vanished forests of the plains is the boat-like *kumete*, or food-bowl (2), now in the possession of Mr. James Bishop, of Wheatstone, near Ashburton. The polished fern-beater (6) of a fine quality of black basalt, and the greenstone chisel (10) or knife, with a long cutting edge, together with

* In referring to these areas as "buried forest" it only implies that the numerous trunks, after being charred in a growing position, were subsequently blown down and submerged in the swampy land where they grew. The timber of many of them is still in a remarkably sound condition.

several other different implements, were also ploughed up by Mr. Bishop on his property. The fern-beater is now in the possession of Mr. A. W. Beaven, of Christchurch, who readily permitted me to have it photographed. The *kumete* is carved out of miro-pine, and measures in length 15 in., breadth 8 in., depth 8 in. Although somewhat injured, it is an admirable specimen of Ngatimamoe handicraft.

As already stated, the country on the upper parts of the Canterbury Plains between the Rakaia and Rangitata Rivers was formerly populated by the extinct Ngatimamoe and preceding tribes. During the progress of settlement many stone implements have been found throughout the area. The perfectly finished argillite chisel (8) was found at Mayfield by Mr. Kellahan, jun. Mr. G. L. Twentyman also found at Mayfield a curious narrow adze made from the casing of the greenstone. Ten years ago Mr. John Hood, of Mount Somers, showed me two large axes, one of basalt the other of Mount Somers sandstone, found on his property. Mr. Price, sen., gave me several broken implements of basalt which he discovered on the site of an unexplored old Maori encampment at Mount Somers. Several other valuable stone tools of great age have also been discovered at Mount Somers, but these I have not seen. Two years ago an interesting discovery was made on Mrs. Campbell's farm, a few miles below Mount Somers. It consisted of nine finely finished fish-knives, all of one size and shape. Six were flaked from the same block of argillite, and three from a reddish-yellow chert. They were the finest knives of their class I have seen. But, unfortunately, before I visited Mrs. Campbell to see them the children had destroyed them all except two, one of which is now in the Canterbury Museum. Mrs. Joli, of Springburn, six miles north of Mount Somers, possesses two finely polished broad-faced tools—an adze and an axe—of one size, found in the bush, flaked from a block of beautifully mottled greenstone. The Rev. Mr. Westbrook, F.G.S., found a broken greenstone chisel lying exposed on the limestone rock in the gorge of the Ashburton River. I have heard of several other valuable implements having been found in the Springburn district, some of them now being in Mr. Muirhead's possession, but I have not examined them. Many more will probably be discovered when the old encampments are explored, and as settlement advances.

During the formation of new roads twenty years ago at the old Spread Eagle, on the North Ashburton Stream, some large stone implements were ploughed up by the contractors, and were left lying on the side of the newly formed road. A workman employed on the work informed me that there were "seven or eight of them," and that they were all "rough, large axes made of bluestone," or bluish basalt, I presume, which is common at the ranges fifteen miles from Spread Eagle and in the river-bed near where they were found.

Two years ago the Ashburton Borough foreman, while forming a new street, ploughed up a large semi-polished sandstone axe (A) with a small piece of the top broken off. On the south side, but in the vicinity of the river, several variously shaped old implements have been found during the progress of settlement.

Mrs. Buckley, of Lagmhor, possesses a fine old, though somewhat worn, broad-faced Ngatimamoe adze of greenstone, found thirty years ago near the Lagmhor Creek, a perennial stream crossing the plains through the Lagmhor Estate.

Four years ago Mr. Thomas Rattray found a wooden fern-beater (9) on the Ashburton River bed, which he generously added to my collection. The broad-faced polished greenstone axe (3) and the small beautifully finished mottled-chert adze (5) were ploughed up at the mouth of the river by Mr. J. McCoskery and by Mr. J. Trevurza in Wakanui respectively. The block of bowenite (1), showing method of cutting out implements, was found by Mr. Jackman, of Willoughby, at the mouth of the Rangitata River four years ago. Bowenite is a paler and softer variety of jade, and was not so much used by the extinct South Island Maoris as the darker and harder varieties of greenstone. The small, narrow, but perfectly formed and polished adze (4) is made of a rare and beautiful greenstone, and is the only specimen of its class I have seen in any collection. It was ploughed up, along with a large tomahawk, at Arowhenua, South Canterbury, twelve years ago by Mr. R. Brown, now of Longbeach. The small, thin greenstone chisel (7) was ploughed up by a farmer at Pendarves, near Ashburton, and purchased for me by Mr. R. Murray, watchmaker. The large roughly chipped axe (F) was ploughed up on the site of the buried forest near the River Hinds, and sent to me by Mr. John Price. This form of stone axe, of very dark basalt, with a polished edge only, is rare, and of great age. The series on Plate XVI. (lettered) illustrate several transitional forms in use among the older pioneer tribes of Murihuku. The finely finished axe (12) was found near one of the painted rock-shelters at Albury, and evidently had been very little used. I have recently received a neatly finished chisel of dark argillite from Mr. F. Batchelor, of Albury, who found it a few miles distant from the painted rocks. When at Albury last I examined a large rough adze of basalt, also found on the Opawa River bed near the village.

When on a visit with Mr. A. Hamilton to Albury and the Opihi Valley four years ago, for the purpose of sketching the Ngatimamoe paintings* on the limestone-rock shelters, Mr. Edwin Ley showed us, at his home on the Opihi River, some broken greenstone chisels which he had found in the valley. They were of the same finely mottled jade as the two described belonging to Mrs. Joli, of Springburn. Many more stone implements of different types have been discovered at Kakahu and on the Waitohi Downs within the last twenty years. In the latter district some years ago a party of contractors, in cutting through a small hill, discovered a valuable Maori *mere* of pure nephrite, to which the Maoris of Temuka laid claim as a long-lost tribal heirloom. At the present time it is in the possession of a private gentleman at Temuka. The innumerable Maori ovens exposed by the plough throughout the Albury, Kakahu, Waitohi, Opihi, and Waimate districts, when breaking up the land in the early days of settlement, show the country named to have been occupied by a considerable Maori population in former ages. There is no question but that they were for centuries nomadic, and chiefly depended on fishing and hunting for their sustenance. Their stone implements also underwent great modification, both in form and finish and in the use of better materials for their manufacture. The Maoris of New Zealand may safely claim the honour of having manufactured a greater variety of forms of stone tools and weapons from a greater variety of materials than any other race of people during the Stone Age in any part of the world

The Rev. Canon Stack, in his "History of the South Island Maoris," in computing the respective periods of occupation of the South Island by the extinct tribes, assigns Waitaha from 1477 to 1577. In his "Kaiapohia" he also states that the great forests formerly covering the Canterbury Plains were destroyed during the occupation of the South Island by Waitaha. We have unmistakable evidence of the former existence of extensive areas of forest of great age on the plains. I have also shown that numerous stone tools and other native utensils have been found on all their sites throughout Canterbury. Implements rude, semi-polished, and perfectly polished, of basalt, argillite, sandstone, ironstone, chert, and greenstone of several qualities, have been found associated together on the sites of these ancient forests. The circumstances under which they have been discovered by many of the early settlers supply conclusive evidence that greenstone was known to the Te Rapuwai and Waitaha long before the advent of Ngatimamoe to the South Island. They unquestionably used greenstone tools, but of more imperfect forms and quality than those subsequently used by Ngatimamoe and Ngaitahu. No

* Trans. N.Z. Inst., 1896.

greenstone *meres* have ever been found associated with their implements. The large finely formed and polished *meres* of nephrite and various qualities of jade were undoubtedly manufactured and first used by Ngaitahu, who greatly improved the form and quality of their implements, especially the *mere* and the *kapu*, since their advent to the South Island.

I have lately examined three large somewhat thin and blunted chisels of ironstone, found near Hinds by Mr. R. Moore of Longbeach. They are semi-polished and of great age, and evidently had been discarded by their owner. The four implements (E, D, G, H) were discovered together on the site of the buried forest at Doyleston, and procured for me by Mr. J. McLachlan, M.H.R. D is of an inferior greenstone, much worn and semi-polished. G and H are of two varieties of dark fine-grained basalt, also semi-polished and much worn. E is of a rough-grained bluish basalt in fine condition, and evidently had been very little used.

Large blocks of greenstone were found three years ago at the mouth of the Rangitata, showing several adzes *in situ* in process of cutting. Unfortunately, the ploughmen broke them in pieces to obtain each a piece of the beautiful jade.

But the most valuable relic of Ngaitahu ever found on the plains is a large *mere* of almost transparent nephrite, which was ploughed up, on poor land near Waterton, by a farmer in whose possession it now remains.

When time permits I hope, in the future, to add to the foregoing somewhat cursory record of discoveries of prehistoric relics of the extinct Maori tribes of the South Island.

It is regrettable that so little exploration is done among the old encampments and rock-shelters formerly tenanted by the extinct Maori tribes. Such work could not fail in adding greatly to our knowledge of the ethnology of the ancient Maori. There are also many extremely interesting features in the traditions of the South Island natives. Further research on the lines I have suggested would probably decide the question as to whether or not the ancient forests of the Canterbury Plains were destroyed by the traditional "great fire of Tamatea," or at what period they were destroyed. Apart from all traditions, ethnologists admit that the Maoris were the noblest and most enlightened race that ever lived during the Stone Age in any country in the world.

Art. LIII.—*An Optical Illusion.*

By G. W. Tiffen.

[*Read before the Hawke's Bay Philosophical Institute, 10th September, 1900.*]

Some time in March last the following clipping appeared in the *Poverty Bay Herald* :—

"A friend, known to us as trustworthy, sends us the following account by a relative of hers of a remarkable phenomenon of light which she recently observed at Gisborne. She says, 'As we were coming up the hill on the Whataupoko side of the footbridge, the sun, which was just setting, being at our backs, we, of course, saw our shadows walking up the hill in front of us. But, instead of being black, as they should have been, our dresses were white, with a very faint black rim round the hem and up the sides, and were perfectly transparent. Now, I had on my last winter dress, which is long and very thick indeed, and Lu had on a navy-blue serge; but, in spite of that, we could see through skirts, petticoats, and everything else, our limbs, black, shapeless, and exaggerated in thinness, reaching right from our shoes to our waists. We were so astonished that we thought we must have been mistaken, and went away back to the bridge and walked up the hill again, with exactly the same result. Did you ever hear anything so queer? It was a very stuffy, close day, and just at that precise time there was a rainbow over Kaiti Hill, which was also peculiar, being thick in the middle and thin at both ends, and with some of its colours bright and others very dull. As soon as we reached the top of the hill our shadows became black again, and continued so till the sun had set.' Will some experienced scientific friend explain this affair for the benefit of our readers? Mr. J. L. Holland writes to the Auckland *Herald*, stating that the same atmospheric effect was discovered by members of his family two years ago in front of his own residence, Grafton Road. The conditions under which it has been observed are: The pavement thoroughly wet and the night fairly dark, with the gas-lamp on the opposite corner alight, the shadow of a person thrown on the fence in front of the house gives the exact result described by the ladies in the paragraph—namely, a modification of the Rontgen rays, the limbs being distinctly seen through the dresses or clothing."

The nature of the above-mentioned clipping is so very startling that the reader's first thought is one of incredulity, while the suggestion that the effects produced were somewhat akin to those of the Rongten rays causes the reader to look upon the discovery with some degree of interest.

It was with some such feelings as these that I decided, if possible, to see through myself. Before doing so it was necessary to ascertain what were the necessary conditions.

Now, from the clipping it will be found that the phenomenon was observed, by different persons and at different times, in both Gisborne and Auckland. On comparing them we find that the conditions in both cases were somewhat similar. Thus, at Gisborne we find—(1) The sun at a low angle and behind the observers; (2) a sheet of water, also behind, but below the observers; (3) an incline plane on which the shadow was cast. At Auckland the conditions were—(1) A gas-lamp, apparently at some distance away and consequently at a low angle; (2) water over the pavement and below the observer; (3) a fence on which the shadow was cast. One other point may be noticed—namely, at Gisborne there was a rainbow. As no useful results were obtained by the use of a prism, it would appear that the rainbow is not in any way associated with the observed phenomenon, and this is borne out by experiment.

Having ascertained the necessary conditions, we are now in a position to experiment on ourselves; but before proceeding to do this let us notice some peculiarities respecting the shadow. We learn—(1) That, instead of being black, it was "white, with a faint black rim round the hem and up the sides"; transparent, or semi-transparent, more aptly describes its appearance: the dresses themselves were not white or transparent, as may be seen by experiment. (2.) The shadow of the limbs reached as high as the waist, but no higher, nor can it be produced higher than the waist. (3.) The phenomenon was lost when the observers reached the top of the hill. (The hill here spoken of is merely the steep eastern bank of the river; on the western side the bank has a very gradual slope towards the river.)

Now, on crossing over the bridge from west to east it will be found that the path bends slightly towards the right hand as it ascends the bank of the river, thus allowing the sun's rays to be uninterruptedly reflected from the river. This reflection would, at that time of day, nearly coincide with the slope of this bank, and therefore the reflected rays would not be met with after the top of the bank was reached.

As the phenomenon may be seen as well by night as by day, it is optional whether we investigate it by either sunlight or lamplight. Lamplight offers perhaps the best advantages, though the shadow is necessarily less distinct than that produced by daylight.

My experiments were carried out at night. They were simple. The asphalted yard was thoroughly wetted and the kitchen gas-jet lighted. This threw its light both on the asphalt and on a paling fence. On putting on my overcoat and going close to the fence I was greatly astonished to find, in the shadow, my lower limbs apparently as high as my waist. So far, then, all was well, the newly discovered species of Rontgen ray acting beautifully; but, alas! when my overcoat touched the ground, preventing light passing between it and the asphalt, the phenomenon vanished. At the same time the shadow lost its transparency and became black. On the coat, which is perfectly opaque, being raised the phenomenon reappeared. On holding the coat out with one hand and with the other placing my hat behind the coat, nothing of the hat could be seen in the shadow, but when the hat was lowered until its rim was below the edge of the overcoat that part of the hat was seen higher up in the shadow, appearing like a whole hat. On another occasion, using a piece of board and a stick, two distinct shadows were cast, showing the stick not joined, but well separated.

It appears, therefore, to be pretty clear that the light does not pass through the clothing, and that the phenomenon is caused by reflected light blending with the original shadow and casting an elongated shadow of that part of one's lower limbs below the dress or cloak into the original shadow, thus producing the appearances already described. This "strange freak of light" may therefore be well classed among the optical illusions.

Art. LIV.—*The Bite of the Katipo.*

By Dr. Fyffe.

[*Read before the Wellington Philosophical Society, 15th January, 1901.*]

The short paper I have to lay before you is, I fear, devoid of any great scientific interest. Its only merit lies in the fact that, as far as I can ascertain, no proper account has ever been given of the exact effects of the bite of a katipo (*Latrodectus katipo*). I fear, though I will try to be as little technical as I can, the description of this case must be tinged with medical terms. Any such terms I will with pleasure explain afterwards if it is deemed necessary.

On the 29th November, 1900, D. H. came to me from Petone. He stated that he had been collecting drift-wood on the beach, and while doing so he felt a sudden sharp pain on the back of his left hand. On looking at his hand he found a red spider making its escape across the skin. He immediately killed the spider, bringing me the remains. There was no doubt the animal was a katipo. I saw the patient, who was aged eighteen, about three hours after the bite. He staggered into my consulting-room, and whilst showing me his hand, and explaining how its present condition came about, fainted. He recovered after applying restoratives. I then examined his hand. Though the bite had occurred only three hours before there was acute cellulitis (inflammation of the soft tissues) all over the back of the hand, spreading up into the forearm. The point where the bite had been made was the seat of most acute inflammation. The lymphatics up the arm on its extensor surface were red, and standing out like cords as far as the elbow. The glands at the bend of the elbow were enlarged and very painful. The axillary glands were painful, but not enlarged. The interesting part of the case, however, was the general condition of the patient; as I stated, the man fainted when he came to see me. I may say that he had come in by train and driven to my house, so that no undue exertion had been used. The heart's action was irregular and feeble in the extreme. The pupils of the eye were dilated, and acted badly to light and accommodation. There was some involuntary muscular twitching, chiefly of the face and of the left-arm muscles. The knee-jerks were almost absent. The arm-reflexes had entirely gone, both superficial and deep. The man felt sick, and his tongue was dirty. His temperature was 101° Fahr. He had relatives in Wellington, and I sent him straight home to bed, visiting him an hour later. I then found the inflammation in the left hand had greatly increased, and he was delirious, with a temperature of 103° Fahr. I at once administered ether, and made several deep incisions on the dorsum of the left hand down to the bone, and, as the back of the forearm was œdematous, I made two further incisions there. They all bled freely, which bleeding I did not stop. All the incisions were dressed with antiseptic double cyanide gauze soaked in 1-in-40 carbolic. The next morning the patient was quite rational, the heart's action was much stronger, and the local inflammation had greatly subsided. From this time onwards he made an uninterrupted recovery.

The points of interest are, first, the intensity of the local inflammation. In this case had the man used a knife freely when bitten, caused copious bleeding, and then sucked the wound he probably would have escaped with very little further trouble; but, instead, he left the bite alone. The local effect of the bite was not unlike that of a scorpion, though not by any means so severe. The acute nature of the cellulitis coming on in so short a time shows that the poison must be an irritant of a very powerful order. The second point is that while the poison has powerful local it has a very marked general effect. The enfeebling of the heart's action, the weak pulse, delirium, and general debility show that, besides the irritant, there is a second ingredient which acts upon the body as a whole.

In most of these poisonous animals, particularly in snakes, such as cobras, a body known as an albumose has been isolated from their poison, which has been shown to be, at any rate, one of the causes of the poisoning. I cannot help thinking that in the case of the katipo the element which brings on such acute general symptoms, as distinct from the local, is of the nature of an albumose. I took the trouble to collect about a tablespoonful of the blood which came away from the incisions in the inflamed tissue. The blood was very watery and contained far less than its proper amount of red corpuscles—a sign of albumose poisoning. Further, it would not coagulate easily, which is yet another sign. I separated off the albumens from the blood and tested for albumoses, of which there are three. I was enabled to find a large quantity of deutero-albumose in the specimen—a quantity far in advance of anything one would expect to find in the blood, even in a case of cellulitis. On such evidence it would not be safe to say that deutero-albumose is one of the factors in the poison; it would be necessary to extract the poison from the animal and examine it chemically first. I only point out as a curious coincidence that, whereas in snake-bite albumoses are found in their poison, in the blood which came from the tissues immediately affected by the bite of the katipo there was an excess of an albumose present. I may say that the tests for an albumose are very definite. On adding cold nitric acid after other albumens have been coagulated by saturation with ammonium-sulphate, albumoses are precipitated in the cold from the filtrate and dissolve up again on heating, reappearing on cooling. Further, they give a pink colour with the so-called biuret reaction. These results were obtained in this case.

As to the general treatment of the patient, I gave him digitalis, ether, and ammonia, to support the heart's action. Surgical measures are, however, of by far the greatest value. Free incision and sucking the wound is the best remedy.

In conclusion, I must apologize for the very slight nature of this paper.

Art. LV.—*Seals as Navigators*.

By R. Henry.

[*Read before the Wellington Philosophical Society, 16th October, 1900.*]

In olden times, no doubt, seals were very numerous, and when all travelling towards their breeding-islands at one season the old natives may have followed them, or steered the course the various parties were going, and thus dispensed with chart and compass and provisions, for even now some natives can catch seals with a harpoon at sea. To show how tame they used to be, one of the old voyagers wrote as follows of the seals on Mas-a-fura in 1767: "We went ashore, but could hardly set a foot down, the seals lay so thick. . . . We had to kill a notable number of them, because they were continually running against us." And, again: "The seals on the southern islands were so tame that they played fearlessly about the men who were skinning those they had just killed." That was only a hundred and fifty years ago; and, with millions of such seals as those, there is not a shadow of a doubt but that five hundred or a thousand years ago the natives could have followed them and caught them in the ocean for food when on their voyages of discovery.

In the year 1798 a million sealskins were taken from the neighbourhood of Mas-a-fura to Canton, and three millions and a half were taken before they were exterminated on that one island. No one will ever know how many millions were taken from our southern islands, because, what with Americans and others, whose interest it was to keep their successes secret, one-tenth of the skins taken may not have been recorded.

Most of the facts stated in the following are gathered from the report of the Behring Sea Commission.

The Commander and Pribyloff Islands, when first discovered, in 1741 and 1786 respectively, were entirely uninhabited by man; nor has any evidence been found since on either group that man had previously visited them. They were the only islands in the North Pacific that were not peopled or visited by man, and this was evidently the sole reason why the seals had chosen them for breeding-places, because the fur-seal when resorting to the land for breeding is practically defenceless, and is incapable alike of resistance or effective flight, while its flesh and fat are highly prized by all native tribes as food.

To quote from the report: "If further evidence be required, it is furnished by the facts relating to the fur-seal of the Southern Hemisphere, where all the notable breeding-places or rookeries were discovered on insular lands to which man had never come, and on which, during this critical period of the annual cycle of its life, the fur-seal was also exempt from the attacks of other terrestrial animals to which it would have been an easy prey. . . . This being granted, it is, perhaps, a legitimate subject for speculation what the conditions . . . of all the islands in the world were before their occupation by men."

Seals may have inhabited the world for ages before man, and have had a hereditary knowledge of all the islands in the sea. They may have been as numerous as man is now, for they would not care for land-animals so long as they had sacred breeding-places on islands off the coasts; and we may have no idea of the number of seals that existed before men started to butcher them.

The report from Cape Colony says, "Upon several islands, especially in the Ichaboe group, are to be found the remains of vast numbers of seal, probably the effect of an epidemic disease at some distant period. In many places the hair, which is practically indestructible, has been found mixed with earth to the depth of several feet, and this, when sifted, gives a fair percentage of ammonia and phosphates, probably the residue of the bones and bodies of dead animals." Those islands are on the coast just below the Tropic of Capricorn, so that the natives would hardly need the skins for clothes; and the "epidemic" was probably the clubs of the northern fur-hunters.

Norfolk Island is a mere dot in the great ocean, and about five hundred miles away from anywhere; and, to show how hard a thing it is to find a small island like that, we may cite the hunt our swift steamers had for the "Perthshire," and they might be as long finding Norfolk Island if they did not know where it was located; yet the old canoe-men found it, and lived there for a while, although they had all left it before Captain Cook found it in 1774. Perhaps Norfolk Island is Hawaiki (the traditional starting-point of the Maori), but we cannot tell, as there was no one there to tell us the name of it. From its lonely position I have no doubt it was once a great seal-rookery, and that the natives found it by following the seals when they were going home to breed, and lived there until they were all eaten or driven away. After the seals had gone, the natives, who were accustomed to the fleshpots, would say, "Our soul abhorreth bananas and fish; there are plenty of splendid trees; let us make a lot of big canoes and follow the seals to the south-east at their next breeding-season." This might account for the Maori migration to New Zealand, because, with the prevailing winds, they could hardly miss it from Norfolk Island.

Before the advent of man, New Zealand, being without any offensive land-animals and having abundance of fish, was probably the greatest old seal-rookery in the world, and would have been quite easy to find by those who could keep afloat in canoes; but such people would never have been able to go back to Hawaiki if there were no seals going to point them out the way; and for the same reason they would not go willingly to Australia. The "darkies" were too handy with their spears to suit the seals.

The Sandwich Islands were still more lonely, for they were about a thousand miles away from anywhere; yet the old natives found them, and, I think, brought pigs there. They must have known where they were going, or, at least, were confident of finding land somewhere. Those islands were almost sure to have been seal-rookeries, and the seals may have been so tame and got so used to the canoes that they would come alongside within reach of the clubs and spears.

If this theory be correct, it would put the whole mystery of navigation in a nutshell, because it would supply chart, compass, and provisions.

Even now some Indians and Esquimaux catch the timid seals with harpoons, so that in the early days it would have been only child's play.

In this way all the lonely islands may have been discovered and populated. In the case of Easter Island, where we find the old temples and ruins, the people may have wisely farmed the seals, and have thereby flourished for centuries, until some civil war allowed the seals to be murdered as they were elsewhere, and then the people would dwindle away.

Easter Island is only about fifteen hundred miles from Mas-a-fura and Juan Fernandez, which was a little too far for them to follow the seals.

The Pribyloffs were only three hundred miles away from a thickly populated chain of islands, and yet the Indians never found them. Probably they had plenty of travelling seals around their own shores. The Russians only found them ten years after the American war of independence and Captain Cook's time. So that the seals had hidden themselves well.

The seals were, one after the other, hunted away from their old homes, first by natives in canoes, and then by modern navigators in ships. And it is wonderful how they tried to avoid man by seeking out the most distant and lonely islands in the ocean. It seems as if they had a hereditary knowledge — like the young cuckoos — of where the islands were and where they had to go to find a temporary home;

or could it be that wandering seals found an island in the trackless sea and studied its suitability (owing to the absence of man, regardless of climate and all other conditions) for a home for themselves, and then marked down its position on their wonderful chart, in brain or memory, so that they could find it ever afterwards at any appointed time, though they may possibly have wandered through hundreds of islands and thousands of miles of sea? How the seals managed to do this I cannot even begin to think. The whole subject is outside of my mental horizon. I am not only deficient in the faculty, but in the machinery, for understanding what it is. As for "instinct," it is only a catchpenny way of solving the puzzle, because we see that with it they have used the very best of reasoning, perhaps better than we are capable of understanding. Instead of "instinct" for the animals, it is just as likely that man is wholly deficient in some of the most wonderful and useful qualities of mind.

It is well known now that the seals go away from the Pribyloffs for two-thirds of the year, and make journeys of many thousands of miles, and return at the proper time almost to a day. This implies that they must always have a so-called "instinctive" knowledge of their position at sea.

According to Dr. Conan Doyle the hair-seals in the Arctic Ocean perform a more difficult feat than this, which also gives a hint of how the native navigators may have used other seals. He writes, "For breeding purposes the seals all come together at a variable spot which is evidently prearranged among them, and as this place may be anywhere within many hundreds of square miles of floating ice it is no easy matter for the sealer to find it. The means by which he sets about it are simple but ingenious. As the ship makes its way through the loose ice-streams a school of seals is observed travelling through the water. Their direction is carefully taken by compass and marked on the chart. An hour afterwards perhaps another school is seen. This is also taken and marked. When those bearings have been taken several times the various lines upon the chart are prolonged until they intersect. At this point, or near it, it is likely that the main pack of seals will be found." Thus the old native navigators could have taken the direction of a school of seals, and have followed it by sun or stars till they saw another school to correct their course again; and in this way, at the beginning of the breeding-season, they would be sure to find the rookeries and plenty of food and clothing-material waiting for them on the beaches.

Seals' bones are very perishable, for they are nearly as scarce in Dusky Sound as Maori tools. I put a seal's carcase up on the land so that I might get the skeleton, but when I went for it a year or two after it was half-perished, and the bones in a worse condition than a sheep's would have been after ten or twenty years. This will account for the scarcity of their remains.

Art. LVI.—*Rats and Plague.*

By H. C. Field.

[*Read before the Wellington Philosophical Society, 28th August, 1900.*]

The publicity lately given to the fact that rats are subject to bubonic plague, and disseminate the disease, reminds me that during my colonial residence of close on half a century, and mostly occupied in survey-work in the bush, I have noticed at intervals of about seven years a great mortality amongst these troublesome little animals. In such seasons dead ones lay about in large numbers, particularly in the vicinity of water, while many others were too weak to get out of the way of ourselves and our dogs. The mortality always began about the time when the peaches were ripe, and lasted till the winter. I then thought it arose from the rats eating some poisonous plant which was unusually plentiful in those seasons, or possibly from some fungus of the nature of ergot rendering their food unwholesome; but I now think the disease may possibly have been some form of plague. In the same seasons there was a similar mortality among the wild pigs, numbers of which died, while the rest became so poor that we could hardly get one that was fit to eat. I thought this might arise from the pigs eating the dead rats, as I could not see anything to account for it otherwise; but I think these facts worth mentioning.

The connection between rats and plague seems generally regarded as a new discovery, but, curiously enough, we have very old evidence to the contrary. When Sennacherib invaded Egypt, about the year 850 B.C., he collected his forces at Lachish (now Tel el Hes), a town in the extreme south of Palestine, at which the routes from the various parts of the Assyrian Empire converged. Some of these routes crossed the Jordan at different points, while others crossed what is now Arabia Deserta and came round the southern end of the Dead Sea. When all were assembled Sennacherib crossed the Egyptian frontier and laid siege to Pelusium, a city situate beside the easternmost branch of the Nile. Here a pestilence broke out among his troops, and in a short time killed so many that the rest had to return to the high healthy table-land of Moab to save their lives. This is the simple account given in an Egyptian inscription deciphered about twenty years ago. With our modern knowledge we can tell exactly what occurred. The natural home of the plague, from which it is never absent, and from which it always starts on its devastating rounds, is the swampy region along the lower Tigris and Euphrates. A contingent from the locality, no doubt, carried the disease to Lachish, but at first it attracted no special notice. When, however, it found itself in so congenial a region as the swampy delta of the Nile it spread with great rapidity, and compelled the raising of the siege. The plague is always very fatal in Egypt. Lowe, in his work on that country, says that in 1837 it carried off in a few weeks, in Cairo, a number of people greater than the whole male population of the city, so we can quite understand how Sennacherib's army suffered.

Herodotus, however—who is generally supposed to have written about 2,300 years ago, but whose book, in the form in which we have it, is certainly not of much earlier date than 100 B.C.—attributes the disaster to rats, vast swarms of which, he says, invaded the Assyrian camps and rendered the troops powerless by devouring their bowstrings and the leathern handles of their shields. His account, like the Egyptian one, attributes the disaster to the intervention of the Egyptian gods; and he adds that the rat was thenceforth regarded as a sacred animal in Egypt. The disaster is also mentioned in the Bible, though, of course, in a distorted and exaggerated manner, as if it had occurred when Sennacherib was besieging Jerusalem, which was not the case. Indirectly, however, it no doubt did affect the Jews. Hezekiah was clearly a partisan of Egypt, and it is quite intelligible that when Sennacherib broke up his camp at Lachish and advanced into Egypt he left a small force behind him to hold the Jews in check and keep them from interrupting his communications, and that when the main army had to retire this force was also withdrawn, and so the Jews were relieved from the anxiety which its presence had caused them.

The Assyrian account, found in Sennacherib's palace at Nineveh, and now in the British Museum, says nothing about the pestilence, and attributes the return of the army to rebellious risings at home; in fact, it mixes up this affair with the previous war, in which Hezekiah is said to have joined with other neighbouring kings in rebelling against Sennacherib, and to have been punished by being deprived of a number of towns and compelled to hand over to Sennacherib not only a large amount of money and valuables, but also his wives, his concubines, and his singing-men and singing-women. In fact, Sennacherib represents the invasion as successful, and attributes the success to the Assyrian gods, just as the Biblical account ascribes the disaster to the intervention of the Jewish God Yahveh, whose name we English for the last two or three hundred years have mispronounced "Jehovah."

NOTE.—A passage referring to the connection between rats and the plague is probably not generally known, and may be of interest. In the travels in China of the late Captain Gill, published in 1883, under the title of "The River of Golden Sand," the writer, when speaking of the great Mahometan rebellion a few years previously, says, "During the rebellion a horrible epidemic, like the plague, appeared, that, first of all, attacked the rats. These animals used to die about the houses for a few days, and then they would migrate in vast numbers from the towns to the fields. After this the disease seized upon the miserable population, and carried off an enormous number of the people."

ART. LVII.—*The Population of New Zealand.*

By H. W. SEGAR, M.A., Professor of Mathematics, University College, Auckland.

[*Read before the Auckland Institute, 4th June, 1900.*]

THE following paper presents the argument of the presidential address for the year 1900 to the Auckland branch of the New Zealand Institute. The address was not written out, but was delivered by the aid of a few notes and diagrams. The diagrams are not reproduced, as there is not the same necessity for them here as in making a subject which depends so largely on statistics clear to a public audience.

Many tables are given to illustrate special points, and these deal sometimes with populations outside New Zealand. In such cases the results of the censuses of 1890 and 1891 are used, though, except when comparisons are made or some other census used for some special purpose, figures for New Zealand are taken from the census of 1896. Many of the tables are taken from blue-books and other statistical sources, and others were specially calculated. In these latter there is no attempt at an extreme accuracy such as would be unnecessary and beyond the purpose in hand, but no factors are neglected that would make any material difference to the argument.

In New Zealand statistics Maoris are excluded, and emigration and immigration are to a large extent not taken into account. Every statement cannot be made with an account attached of every small modification that can arise from various sources; if the statement is correct for all practical purposes, it is sufficient.

The same liberality of interpretation must be given here as is necessary on all occasions on which effects depending mainly on one or two principal causes, but at the same time subject to various perturbations, are dealt with.

The Diversity of Age-distribution of Populations.

When we compare the age-distributions of the populations of different countries we find a diversity which is at first astonishing. This is sufficiently illustrated, perhaps, in the following table, in which we compare the populations of New Zealand, England, and France—that is, the populations of a new country, an old country with an increasing population, and an old country with an almost stationary population:—

Table I.—Population, by Age, of New Zealand, England, and France. Percentage in each Group.

Age.	Percentage of Population in		
	New Zealand.	England.	France.
0–10	27·2	23·9	17·5
10–20	23·5	21·3	17·4
20–30	16·7	17 2	16·3
30–40	11 9	13·1	13·8
40–50	9·4	9·9	12·3
50–60	7·0	7·1	10 1
60–70	3·0	4·7	7·6
70 and over	1·3	2·8	5·0

This diversity is found to be considerable even between old countries or between new ones, but is naturally more marked, as a rule, when old countries are compared with new ones.

The Stationary Distribution of Population.

For the purposes of comparison it may be of advantage to consider at once the distribution of the ages of the people which we shall speak of as the "stationary distribution."

The ages of the people will be said to have a stationary distribution when, on comparing the numbers living at any two specified ages, the number living at the greater of the two ages is equal to the number of those at the less that should survive to reach the greater age.

If a population had such a distribution, and if the annual number of births and the rates of mortality at the several ages were to remain constant, the population would be stationary—that is, would itself also remain constant in respect both to total and to age distribution; for the population at any age would be replaced, after any number of years, by an equal population of the same age. For such a population the birth-rate would be constant; and, further, the total population being constant, the annual number of deaths would be equal to that of births, and the death-rate would consequently be constant and equal to the birth-rate. What this common birth- and death-rate would be for any country would depend on the rates of mortality of the people; the more favourable the rates of mortality the greater would be the total population due to a given annual number of births, and hence the smaller would be the birth- and death-rate. For each country we should have a different stationary distribution, varying according to the rates of mortality at the several ages obtaining.

Any increase or decrease in the magnitude of a population having a stationary distribution could take place only through an increase or decrease in the annual number of births or by changes in the rates of mortality.

A portion only of a population contained between any two ages may have a stationary distribution independently of the rest of the population. In such a case, if the rates of mortality remain constant, an increase or decrease of its total can follow only from a corresponding change in the numbers entering in the course of time from the ranks of those of inferior ages or from excess of immigration or emigration.

If the annual number of births be constant for any number of years in any country whose population is not materially disturbed by immigration and emigration, a stationary distribution of ages is produced throughout that portion of the population born within the period. Thus almost the whole population of France has a practically stationary distribution of ages, with the result that the population as a whole is almost stationary; while at the last census the distribution of the population of New Zealand was stationary for the ages 0–17, as a result of a practically constant annual number of births having obtained in the colony for about a corresponding number of years.

The following table gives the age-distributions of the population of New Zealand for the years 1881 and 1896, and that corresponding to a stationary state, on the basis of an annual number of births of 20,000. The rates of mortality made use of here and elsewhere are those published for New Zealand by Mr. C. E. Adams, B.Sc., A.I.A., F.S.S., in the "Transactions of the New Zealand Institute," vol. xxix., 1896, pp. 52–60. As these, however, only extend to the age of seventy-five, I have been obliged to fall back for ages beyond this on the English tables of Dr. W. Ogle. The effect of this may be to produce an error, which, however, will not be a very substantial one, on account of the small proportion of our people over seventy-five years of age, and none of the arguments in the sequel can be materially affected by any probable error that can arise on this account. The results in the table were calculated for each year of age, but, for the sake of brevity, are presented here grouped in five-year age-periods. Those of unspecified ages are left out of account, as also those over 100 years of age; but only a very small number of people are thus neglected.

Table II.—Comparison of Actual Age-distribution with Stationary State for New Zealand.

Ages.	Population, 1881.	Population, 1896.	Stationary State. Annual Number of Births=20,000.
0–5	82,289	83,659	90,361
5–10	67,915	86,025	87,349
10–15	57,622	85,467	86,335
15–20	42,609	80,734	85,111
20–25	41,365	68,716	83,222
25–30	40,586	59,595	81,023
30–35	34,595	45,213	78,627
35–40	33,562	40,587	75,867
40–45	31,100	34,854	72,801
45–50	21,341	29,555	69,377
50–55	14,563	27,726	65,283
55–60	7,820	22,849	60,151
60–65	6,339	16,782	53,668
65–70	3,232	10,240	45,236
70–75	2,087	5,424	35,197
75–80	992	3,231	23,160
80–85	455	1,265	11,484
85–90	89	435	4,198
90–95	34	123	979
95–100	6	34	134
Totals..	488,601	702,518	1,109,563

The total population for a stationary state corresponding to 20,000 births annually—namely, 1,109,563—should be noted. This means that, if the annual number of births in New Zealand were to reach 20,000 and remain at that figure, the total population would only reach about 1,110,000. The common birth-rate and death-rate would be 18·03.

CONVERGENCY OF AGE-DISTRIBUTION.

The falling-off in the number of people living as we rise from any year of age to a greater one may be spoken of as the convergency of the age-distribution, and the age-distribution may be said to be more or less convergent according as the numbers fall off more or less rapidly as we ascend to the greater ages. In a stationary state the convergency of the age-distribution will depend on the rates of mortality of the people at the several ages; the more favourable to life the rates are the less will be the convergency of age-distribution. When the actual age-distribution of a population is more convergent than the corresponding stationary distribution the population at the various ages are generally increasing, for at each age there is generally a smaller number living than will survive to that age from amongst those of any less age. Conversely, if the population at the several ages is increasing the actual age-distribution must be more convergent than for the stationary state. These facts are verified by an examination of any growing population, and Table II. shows that, in New Zealand, the convergency of age-distribution beyond the fifteenth year was very much greater at the last census than it would be in a stationary state. It is because of this age-distribution of population that the total population of New Zealand has continued to increase rapidly of late years, in spite of the fact that the annual number of births has not been increasing.

Such a state of age-distribution has in general been brought about by a growing annual number of births in the past. The people of reproductive ages generally produce a number of children sufficiently in excess of their own numbers for the survivors to the reproductive age to be greater than the number of their parents, and this goes on continually. In the case of new countries, however, this is not a complete explanation; but this matter will be again adverted to.

THE YOUTH OF THE POPULATION OF NEW ZEALAND.

A perusal of Table I. will show that New Zealand has a larger proportion of young people and a very much smaller proportion of old people than either England or France, so that the average age in New Zealand is very much smaller than in either of these other countries. Indeed, the table shows that more than half of New Zealand's population was, at the time of the 1891 census, under twenty years of age, whereas in the case of France there was scarcely more than half under thirty years of age; and in the stationary state there would be about equal numbers under and over thirty-two years of age. More extended tables might be given and further comparisons made, but we shall let it suffice to state that these would only bear out the statement that, compared with most other populations, that of New Zealand is very young. This fact will be found to have a very important bearing on many points connected with New Zealand population statistics.

The populations of the other Australasian Colonies are largely similar in this respect to that of New Zealand, but there are substantial differences, nevertheless, in the age-distributions of these populations. Thus the proportion of males sixty-five years and over to the total male population varies from 1·63 per cent. in Queensland to 5·55 per cent. in Tasmania, while the proportion at the ages under fifteen years varies from 28·73 per cent. in Western Australia to 38·01 per cent. in New Zealand, and 38·37 per cent. in South Australia. The differences are due chiefly to the histories of the several colonies and the date, character, and extent of immigration.

The Small Death-rate of New Zealand.

Further, the death-rate of New Zealand is exceptionally small. This fact is almost invariably quoted as being due to our climate and the conditions of life of our people. These factors must have some influence on the death-rate, no doubt, but before any conclusions can be drawn from the actual death-rate the distribution of the population according to age must be taken into account. The rates of mortality vary exceedingly according to age. According to data given by Mr. C. E. Adams, B.Sc., A.I.A., in the "Transactions of the New Zealand Institute," the death-rate per thousand for males in New Zealand is 102 in the first year, 21 in the second year, 7·5 in the third year, and continues to diminish until it becomes as small as 2·2 for the ages 10–15. From then onwards, however, the rate increases, though it does not become considerable again until the ages 55–60, when it is 22; but after that it increases very rapidly, reaching as high as 95·8 for the ages 75–80. The course of the death-rates for females is much the same.

If, then, we had a population either of young babies only or old people only our general death-rate would be excessively high; and it must be obvious that the distribution of population according to age must have a great influence in determining the general death-rate. If one nation has a greater proportion of population at the ages for which the death-rate is small and a smaller proportion at the ages for which the death-rate is large than another, we must expect the first to have the smaller death-rate if other conditions are the same. It is little use comparing the general death-rates of two countries unless these considerations are taken into account, and the proper way of comparing the vitality of the people of one country with that of the people of another is by comparing the death-rates of the two peoples for the several ages. This was done for New Zealand, Victoria, and England by Mr. C. E. Adams, B.Sc., A.I.A., and the results given are very favourable to New Zealand, so that, even if the age-distributions were the same in these three countries, New Zealand would still have the smallest death-rate, though it would not be so small relatively to the others as it actually is.

Again, the average death-rate in Sweden for the years 1887–96 was 16·48. This was the smallest in Europe, but is large compared with that of New Zealand, which was 9·87 during the same period. If, however, the age-distribution in New Zealand had been the same as in Sweden, the death-rate for New Zealand would have been about 14 instead of 9·87 during the same period, and in 1894 would have reached as high as 14·44.

We have already seen that, if the ages of the people had a stationary distribution, the death-rate would be 18·03, whereas the actual rate is about 10. The smallness of this actual rate, then, is due mainly to the youth of the people.

THE ANNUAL NUMBER OF BIRTHS AND THE BIRTH-RATE OF NEW ZEALAND.

Up to and including the year 1880 the number of births per annum in New Zealand always increased from year to year. The number for 1880, which was 19,341, was not reached again, however, till 1884, in which year the number of births was 19,846, and up to the present moment this remains the record. For the last twenty-one years the births have been as exhibited in the following table:—

TABLE III.—BIRTHS IN NEW ZEALAND.

Years.	Total Number of Births.	Average Annual Number of Births.
1879	18,070	18,070
1880–84	96,130	19,226
1885–89	95,486	19,097
1890–94	91,142	18,228
1895–99	93,685	18,737
1879–99	394,513	18,786

Thus the average for the last five years is somewhat less than that for the last twenty-one years ; and during the whole of these twenty-one years the numbers of births in the several years did not vary from the average for the whole period by more than 5 per cent. in either direction. Further, for each of the six years 1882–87 the number of births exceeded 1,900; but this number has never since been attained, with the consequence that, at the last census, the number of children in the colony of ages 5–10 was actually less than that recorded at the previous census.

Effects of a Constant Annual Number of Births.

For some twenty years we have thus had a practically constant annual number of births, and in consequence, and by reason also of the growth of the population as a whole, a rapidly diminishing birth-rate. This is a phenomenon of the highest importance. If it continues it must bring about a practically stationary state of the whole population in a comparatively short period. At the time of the census of 1896 it had already brought about a practically stationary distribution of population of the ages 0–17, and at the present time the distribution of ages 0–20 must be stationary. The consequences have already begun to appear in the schools of the colony, the attendances at which rose continuously until 1898, but in that year the first falling-off in numbers was recorded. In the North Island the number of children attending school continues to increase, but this increase is counterbalanced by the decrease in the South Island, where the falling-off in school-attendance has led in many cases to the discharge of teachers.

So long as the annual number of births remains constant this stationary portion of the population will continue to spread ; five years later the distribution of ages 0–25 will be stationary, and so on until the whole population is reduced to this state. A greater and greater portion of the population will fill up to the stationary level corresponding to the annual number of births and will there remain.

We have seen that an annual number of births equal to 20,000 will produce a population only of about 1,110,000, and if the annual number of births were not to reach 20,000 the total population could not even reach this number, except so far as it is aided by immigration ; the annual increase would become less and less, and the total population would approach its limit more and more slowly, until at last the annual increase would not be worth taking into account.

Future Births in New Zealand.

What, then, are the chances that the state of things begun twenty years ago and continued to the present time may yet continue for a period long enough to produce serious effects in the direction indicated? This is a question to which no certain answer can be given; yet there are considerations worthy of attention in connection with this very important matter.

During the years 1881–96 the population of females at the reproductive ages increased from 96,139 to 158,201, or by 64·5 per cent. It has still further increased during the last four years; but the number of children born last year only just exceeded the number born in 1881, and was decidedly less than the number born in 1880. Moreover, the past few years have been years of exceptional prosperity, and the marriage-rate has been higher than for very many years; yet, though there had been a small steady increase in the annual number of births from 1892 to 1898, last year showed another falling-off, and the number for the year was over a thousand less than the record number of 1884. Thus, for some twenty years, in good times and in bad, the growth of the practice of rearing only small families has counteracted the tendency of the growth of the population to produce an increased number of births from year to year. This practice may have reached its full development or it may not. This question the future only can decide for us; but, if the practice continues for many years more to grow sufficiently to keep the annual number of births constant, the reproductive ages will be included in those having a stationary distribution, and will cease to increase in numbers. Then, no increase in the annual number of births can be expected except from a diminution in the practice of restricting births; and, unless this change takes place, it will only be a matter of time for the older ages to fill up in the same way, and for the whole population to become stationary.

CHANGE OF AGE-DISTRIBUTION IN NEW ZEALAND.

Not only when we compare the age-distribution for different countries, but when we compare the age-distribution of the population of the same country at different periods, we sometimes find a very great variability. The following table illustrates this for the case of New Zealand:—

TABLE IV.—POPULATION OF NEW ZEALAND BY AGE. PERCENTAGE IN EACH GROUP.

Ages.	Dec., 1864.	Dec., 1867.	Feb., 1871.	March, 1874.	March, 1878.	April, 1881.	March, 1886.	April, 1891.	April, 1896.
0–21	42·89	44·40	47·46	50·29	52·17	52·96	53·47	52·46	49·94
21–65	56·48	54·74	51·46	48·49	46·54	45·63	44·72	45·25	47·11
65 and over	0·63	0·86	1·08	1·22	1·29	1·41	1·81	2·29	2·95

This variability is further illustrated in the case of New Zealand by Table II., giving the results of the censuses of 1881 and 1896, and by the following table, which exhibits a remarkable difference in the rates at which different sections of the population increased between the censuses of 1891 and 1896 :—

Table V.—Population of New Zealand by Age.

Age.	Census, 1891.	Census, 1896.	Increase per Cent.
0–5	83,204	83,659	0·55
5–10	86,080	86,025	−0·06
10–15	81,084	85,467	5·4
15–20	65,237	80,734	23·7
20–25	58,142	68,716	18·2
25–30	46,080	59,595	29·3
30–35	39,911	45,213	13·3
35–40	35,619	40,587	13·9
40–45	31,191	34,854	11·7
45–50	28,860	29,555	2·4
50–55	26,692	27,726	3·9
55–60	17,095	22,849	33·6
60–65	12,153	16,782	38·0
65–70	6,487	10,240	57·8
70–75	4,381	5,424	23·8
75–80	2,127	3,231	51·9
80–85	922	1,265	37·2
85 and over	425	596	40·2
Total ..	626,658	703,360	12·24

It will be seen that, between the two censuses, two sections of the people increased at a rate much in excess of that for the people as a whole. The first of these consisted of those at the early supporting and reproductive ages, included in the years 15–30, and the rate of increase was about double that of the general rate. The next census should show a similar increase in those of the ages 20–35, so that the number of people of these ages are increasing at the present time at a rate about double that for the whole population, and have been doing so for some time. This must be very largely responsible for the greatly increased marriage-rate. The marriage-rate has risen steadily from 5·94 per thousand in 1895 to 7·28 per thousand in 1899. This increase in the marriage-rate is usually attributed solely to the influence of prosperity. Prosperity must have a large share in bringing about the increase, but so also must the fact that the increase of the number of people at the marrying-ages has recently been so much more rapid than that of the people as a whole.

The other section of the people that has been increasing with special rapidity is that consisting of those of fifty-five years of age and over. This feature is of special importance, and we shall discuss it in particular in the next section.

THE INCREASING PROPORTION OF OLD PEOPLE IN NEW ZEALAND.

A glance down the percentage column of Table V. will reveal at once the extraordinary increase that took place between the last two censuses in the number of old people compared with the increase in the population as a whole. This disproportionate increase has been taking place for a very long time, for Table IV. shows that the percentage of old people has grown steadily from 0·63 in 1864 to 2·95 in 1896.

It is a matter not only of deep interest, but of national importance, to inquire how rapid will be this increase, and how far it will extend in the future. To calculate the percentage at any future period, however, involves knowing the population at the time, and this involves some hypothesis as to what the number of births will be in future years. We shall, consequently, consider at present only the increase that may be expected in the actual number of old people, leaving the question of ratio to the whole population for consideration later on.

By means of life-tables we may predict, with all reasonable accuracy, how many persons out of any sufficiently large number at any given age will survive after any given number of years. Persons 100 years of age and over we may neglect. Let us, then, investigate what the number of old people in New Zealand may be expected to be at the time of the census of 1911. The persons that will be from sixty-five to ninety-nine years of age eleven years hence will be the survivors of those that were from fifty to eighty-four years of age at the last census (1896), neglecting, of course, the effect of immigration and emigration, which, even if it were to take place again on a fairly large scale, would but slightly affect this particular question.

The following table gives in the second column the number of persons alive at the census of 1896 at all ages from fifty to eighty-four, and in the fourth column the number of each of these that may be expected to survive in the year 1911:—

Table VI.—Expected Number of Old People in New Zealand in 1911.

Census, 1896.		Census, 1911.	
Age.	Population.	Age.	Expected Population.
50	7,909	65	5,792
51	4,092	66	2,921
52	5,656	67	3,924
53	4,784	68	3,217
54	5,285	69	3,439
55	5,699	70	3,580
56	5,562	71	3,373
57	3,845	72	2,252
58	4,195	73	2,364
59	3,548	74	1,914
60	5,445	75	2,764
61	2,547	76	1,193
62	3,168	77	1,360
63	3,093	78	1,211
64	2,529	79	892
65	3,038	80	963
66	2,309	81	653
67	1,823	82	455
68	1,650	83	360
69	1,420	84	268
70	1,763	85	286
71	923	86	127
72	1,017	87	118
73	883	88	85
74	838	89	63
75	927	90	57
76	907	91	44
77	581	92	23
78	478	93	16
79	338	94	8
80	414	95	7
81	241	96	3
82	245	97	3
83	180	98	1
84	185	99	1
Total	..	..	43,737

The total is 43,737; and those for 1901 and 1906 similarly calculated come to 28,024 and 36,039 respectively.

The estimate for 1911 means that, taking 26,000 as a reasonably accurate estimate of the number of old people living at the present time, there will be an increase during the next eleven years of about 68·6 per cent. in the number of old people. He would be a very sanguine man who, having observed closely present tendencies, would expect an increase in the whole population of more than 15 per cent. during the same period. Thus it is a practical certainty that the ratio of old people to the whole population will continue in the immediate future to increase at much the same rate as it has been doing during recent years.

Now let us look ahead as far as we can without any special hypothesis as to how many births will take place in the future. In 1961, or sixty-one years hence, the people of sixty-five years and over will be, in the main, survivors of those that were of thirty-four years and under at the last census. Supposing the absence, for the present, of disturbing causes, the result of the application of the life-tables is as given in the next table. Although calculated for each year of age, the figures are given, for the sake of brevity, for five-year periods only:—

TABLE VII.—EXPECTED NUMBER OF OLD PEOPLE IN NEW ZEALAND IN 1961.

Census, 1896.		Census, 1961.	
Age.	Population.	Age.	Expected Population.
0–5	83,659	65–70	41,815
5–10	86,025	70–75	34,632
10–15	85,467	75–80	23,573
15–20	80,734	80–85	10,928
20–25	68,716	85–90	3,451
25–30	59,595	90–95	746
30–35	45,213	95–100	84
Total ..	..	..	115,229

Thus the total number of people of age sixty-five and over may be expected by the year 1961 to reach a total of about 115,000. It may be urged that what will exist sixty-one years hence is of no moment at the present time; but the result shows that the forces at work will not produce their full effect during the next few years only, and for many years to come the number of old people will increase at a rate greatly in excess of any likely rate of increase of the population as a whole.

This phenomenon is not peculiar to New Zealand; it is exhibited to a more or less equal degree by the Australasian

Colonies generally, and even largely by most of the old countries. For instance, in England the departmental committee appointed to inquire into the financial aspects of the proposals made last session by the Select Committee on Old-age Pensions arrived at the conclusion that, if the pension-age were fixed at sixty-five, the scheme would involve a progressive annual expenditure commencing at £10,300,000, and rising in 1921 to £15,650,000, corresponding to an increase of 50 per cent. in the number of old people during the next twenty-one years, an increase out of proportion to any likely increase in the whole population.

The cause of the phenomenon in England is obvious, depending simply on the facts that the old people of to-day are the survivors of those born sixty-five or more years ago, and that the old people of twenty-one years hence will be the survivors of those born forty-four and more years ago, while throughout the century, until quite recent years, there has been a continually increasing annual number of births, combined with a marked improvement in respect to chance of life, due largely to advance in medical science, improvements in sanitation, increasing care of the poor, and an all-round improvement in the standard of comfort. It must always be borne in mind that an increase in the number of births, though it affects the population as a whole at once, does not affect the population of old people for sixty-five years, and it then continues to affect that part of the population appreciably, though to a diminishing extent, for the next thirty-five years or so. The rapidly increasing annual number of births that took place in England towards the middle of the century, and gave such an impulse to the population that it continued to increase rapidly in spite of the large subsequent emigration, is now producing a similar effect on the aged portion of the population.

The cause of the phenomenon in New Zealand, or in any new country, is different. Our aged people, for instance, are not to any extent the survivors of persons born in the colony—in fact, at the last census, out of the 20,756 old people of European stock in the colony, only fifty-nine were born in New Zealand; thus our old-age population may be considered as at present entirely the result of immigration. Now, the great bulk of the immigrants came in the years 1861–65 and 1874–79. These immigrants were of all ages, but were mainly of the ages of early manhood, with a fair proportion of children, the obvious consequence being that only a small proportion have had time to reach old age.

Be it noted that the estimates given for New Zealand are independent of future births. The 115,000 old people of 1961 will be the survivors of the present population, but what ratio this population of old people will bear to the whole population depends on what the whole population will be. If, for instance, the annual number of births were 20,000, the total population would reach ultimately about 1,110,000, while of these no less than about 120,000, or 10·8 per cent., would be old people of sixty-five years or over. This represents a limiting case, useful for comparison, however, for, as the annual number of births tends towards a state of constancy, so will the distribution of the population tend towards the condition that would follow from a constant annual number of births. The general and continued fall of birth-rates renders it probable that in the near future many populations, including that of New Zealand, that have been very progressive hitherto will not differ greatly from this stationary state.

It may seem utterly improbable at first that a population can come into existence having such a large proportion of old people as 10·8 per cent., or almost four times the proportion there was in New Zealand at the time of the last census. It should be borne in mind, however, that the state of things which can produce this large proportion—namely, an approximately constant annual number of births—has hitherto only obtained in one country having reliable statistics. That country is France, and there already the proportion of old people reaches 8·1 per cent., although even in France the annual number of births has not been approximately constant for a length of time sufficient for the maximum effect to have been produced. Considering this actual example, and the fact that life is longer in New Zealand on the average than in France, the possibility I have pointed out may continue to astonish, but there can be no room left for incredulity.

EFFECT ON DEATH-RATE.

We have previously pointed out the dependence of the death-rate upon the age-distribution of the people, as well as upon the rates of mortality at the several ages. A great increase in the proportion of old people, amongst whom the death-rate is many times the general death-rate, must tend to increase that general rate. But, on the other hand, a decrease in the proportion of children in the first two years of age tends to diminish the general death-rate, for the mortality amongst young children is very great. Further, the increase in the proportion of old people will not have a very great influence in affecting the death-rate so long as that proportion is still small. Consequently, we find that until comparatively recently the death-rate of New Zealand had no permanent tendency to increase, and was even very much less in 1896, when it was 9·10 per thousand, than in 1891, when it was 10·35. Since 1896, however, the increase has been substantial and steady, the death-rates for the years 1896–99 being 9·10, 9·14, 9·84, and 10·24 respectively.

The proportion of old people, in fact, has now reached a magnitude which makes the number of deaths of old people bear a very substantial ratio to the total number of deaths, and consequently the increase in the proportion of old people in the population will have a considerable influence, by reason of the corresponding increase in the number of deaths of old people, in affecting both the total annual number of deaths and the death-rate. This is illustrated by the following table, giving the annual number of deaths of people over sixty years of age, the total number of deaths, and the percentage the former are of the latter for the years 1896–99:—

Deaths, 1896–99.

Year.	Deaths of Persons over Sixty Years of Age.	Total Number of Deaths.	Percentage.
1896	1,666	6,432	25·90
1897	1,892	6,595	28·68
1898	2,248	7,244	31·03
1899	2,293	7,680	29·85

We may thus expect the death-rate to increase in the future to a figure considerably greater than that at which it stands at present.

Increase of Population of New Zealand.

Increase of population is due to two causes, excess of births over deaths and excess of immigration over emigration.

Now, the excess of births over deaths in New Zealand reached its maximum in 1884, while for 1899 the excess was not as great as it was in 1876—*i.e.*, twenty-four years ago.

The following table gives the excess of births over deaths for the last twenty-four years:—

TABLE VIII.—EXCESS OF BIRTHS OVER DEATHS IN NEW ZEALAND.

Year.	Excess of Births over Deaths.	Year.	Excess of Births over Deaths.
1876	11,264	1888	13,194
1877	12,171	1889	12,685
1878	13,125	1890	12,284
1879	12,487	1891	11,755
1880	13,904	1892	11,417
1881	13,241	1893	11,420
1882	13,308	1894	11,610
1883	13,121	1895	11,683
1884	14,106	1896	12,180
1885	13,612	1897	12,142
1886	13,164	1898	11,711
1887	12,998	1899	11,155

We have considered reasons for thinking that, though the annual number of births may increase, it is probable the increase will not be great; on the other hand, the annual number of deaths is bound to increase pretty constantly and considerably. Consequently, it is more than probable the annual increase by excess of births over deaths will diminish further. With the population increasing, although probably by constantly less amounts, this will mean a continued fall in the percentage of increase from births and deaths. This percentage is of importance, and is what we ought generally to consider, rather than the absolute numbers.

In 1899 the rate of increase reached as low as 1·48 per cent. This is still a fair rate of annual increase, however, and would double the population in forty-seven years; but it is due to our small death-rate, which itself is due to a temporary condition of our population, and must certainly increase considerably. Unless, then, there is a revival in the births we must expect this rate of increase to diminish very much.

The increase, however, has recently been taking place in the ranks of the adults, the births simply being sufficient only to replace those that have been passing from the stage of childhood to that of manhood. As the adult population forms just about half of the whole, it follows that the adult population has been increasing at the rate of about 3 per cent. per annum. Further, this increase has been chiefly in the portion of the adult population at productive ages; hence, apart from the abnormal prosperity of recent years, the commerce of the colony and the returns of the Post Office and other governmental departments should show an advance greater than would be expected at first sight to follow from the rate of increase of population as a whole.

The increase in population through the excess of immigration over emigration has at times reached great proportions. During the years 1861–65, for instance, the total reached 93,169, and during the years 1874–79 it reached 110,932. These were the great flood-times of immigration. During recent years, however, the excess of immigration over emigration has ceased to be of great importance; indeed, during the years 1888–91 there was a loss of 13,941 by excess of emigration, and although in the following years—1892–93—there was once more a gain of 15,370, this was, no doubt, largely due to return of many who had left the colony in the less prosperous years preceding. Since 1893 the largest excess of immigration has been 2,752 and the smallest 895, and it would appear that it would be safe to estimate the likely average excess of immigration in the immediate future as not more than 2,000. This would only add a population of 100,000 in fifty years. But even this amount is not likely to continue; since as the country fills up there will be less and less to attract settlers, while the land has been always the great attraction for immigrants.

A stationary state must be reached ultimately by the population of each country and by the population of the world. If it is not brought about by a voluntary restriction of births, bringing down the birth-rate to the level of the death-rate, it must arise from the raising of the death-rate to the level of the birth-rate by the increase of the severity of the struggle for existence, and the consequent falling-off in the standard of living.

If brought about in the latter way the rates of mortality will be high and the age-distribution very convergent, the ratio of the number of old people to the whole population being comparatively small; but, if brought about by the former means, the rates of mortality will be low and the age-distribution not very convergent, the ratio of the number of old people to the whole population being comparatively great. And in proportion as the one cause or the other operates will the resulting condition of the population compare with the effects which that cause alone would produce.

Hitherto, with the exception of modern France, when a population has been more or less stationary the voluntary restriction of births has rarely had any appreciable influence, whereas there are now signs throughout the civilised world of an extensive and still rapidly growing restriction of births; and nowhere, with the exception of France, has the practice manifested itself more than in the Australian Colonies, and in none of these colonies more than in our own New Zealand. To discuss the ethics of the practice or the means of effecting it is not part of my present plan, but it is important to observe that the nature of both is such as to leave us no hope for its diminution in the future, whereas there is no necessary limit to its growth short of the disappearance of the family, though the love of parenthood instinctive in the race gives us a moral guarantee that the child will not altogether disappear from the home. The child, however, may still be with us and yet not in numbers sufficient to increase or even to keep up the population ; and, whatever will be the limit ultimately reached in this or in any other country, the steady unchecked fall of birth-rates makes it appear unlikely that in the course of a few years the practice of restricting families will fall very far short of the limit required to produce a stationary state.

That this prospect is of vast moment all will allow, but that it is to be regretted all will not agree. Many will, from religious motives, refuse to grant the possibility of good arising from a condition of things consequent on what may appear a vice ; but there is no escaping the fact that a voluntary stoppage of increase of population is the only thing that can prevent the same effect being brought about ultimately by misery, hardship, and disease. True, we might increase and multiply much further yet, in this part of the world at least, with no risk of consequent suffering ; but it happens that the very populations to whom increase might even be beneficial are the very ones that have most conspicuously adopted the practice that must make future increase slow indeed, when in a few years, by reason of the changed age-distribution of the people, the death-rate has risen to a higher and more permanent level.

It will indeed be remarkable if, in these parts of the world, the future shows that we are already near the time when governments, colonial and municipal, may cease to allow for future increases of requirements, and the unearned increment will cease to annoy financial reformers.

OLD-AGE PENSIONS.

We have seen that the population of sixty-five years of age and over, and therefore qualified in respect to age for the receipt of old-age pensions, will reach by 1911 a total of about 43,737. If the number of old-age pensioners and the cost of the pensions increase proportionally with the number of old people, the rate of increase in the cost of old-age pensions will be altogether out of proportion to the rate of increase of the population, and consequently, under normal circumstances, to the rate of increase of the resources of the country. How far this disproportionate increase may extend has already been pointed out. If New Zealand had permanently an annual number of births equal to about 20,000, the total population would reach ultimately only about 1,100,000, and of these no less than 120,000, or 10·9 per cent. of the whole, would be old people eligible in respect to age for old-age pensions—*i.e.*, the number of old-age pensioners might be expected to increase somewhere about fivefold while the whole population increased only about 30 or 40 per cent. Unfortunately, as we have seen, there is too great a chance that the annual number of births will long remain under or about 20,000, and, as long as it does, so will the proportion of old people to the whole population tend towards this limit.

But not only have we a large proportionate increase in the cost of old-age pensions to expect from this source, but we must expect in the future a larger percentage of the old people to receive old-age pensions than have hitherto taken advantage of them, and this for several reasons. The majority of old people of the present day arrived here in the early days of the colony, and it must be expected for several reasons that of these a greater proportion will have succeeded in attaining easy circumstances and providing for old age than will generally succeed in so doing among a population living through times of more normal conditions. Again, there will be gradually a smaller and smaller number of old people disinclined to accept pensions because of their savouring of charity and poor-relief, and a smaller and smaller number who will be disqualified on account of not having lived the requisite minimum number of years in the colony. Moreover, recent years have been very prosperous, and when commercial depression once more returns to us the old will suffer with others, and many now barely provided for by invested savings or supported by relatives out of their surplus will then feel the need of other help, and the State is likely, just when it is itself most in need of relief, to have to dispense that commodity to a greater extent than ever.

The report of the Registrar of Old-age Pensions for the year ending 31st March, 1900, estimates that 41·4 per cent. of the old people of the colony, exclusive of Maoris and Chinese, were then in receipt of pensions, but not all of these were receiving full pensions.

Now, in making estimates for the cost of old-age-pension schemes in England and in New South Wales it was assumed that the number and value of the pensions would be equivalent to 50 per cent. of the old people receiving full pensions. For the reasons pointed out above it seems probable that the cost of the pensions in New Zealand will grow so as to accord more closely with this hypothesis. If this is verified, the cost of the old-age-pension scheme in New Zealand, if it remains as at present constituted, will by the year 1911 have grown to about £400,000 per annum, or double what it is costing at present, while the resources of the colony are not likely to be very much greater than they are to-day. But in any case the cost of the scheme must continue to grow rapidly, and far more rapidly than the population; it is because of the small proportion of old people that it is at present as small as it is.

Though I have brought forward this reflection on the old-age-pension scheme, I would not be understood to be arguing in any way against the principle of the scheme; but it is right that its probable future cost as well as its present cost should be known. When the scheme was introduced an estimate of the growth of the cost of the scheme for at least a generation to come should have been made, so that the people of the colony might have known what was involved in the future as well as the present, and not have acted on the rough assumption that the cost of the scheme would increase only in proportion to the population and its resources. Yet there is a chance of the community being able to bear the greater cost of the future as easily as it bears the present cost, for, with a smaller proportion dependent on it by reason of immature age, it would be well able to maintain the provision recently made for a greater number of those dependent on it by reason of old age. Whether it should do so in a manner such as to discourage thrift even on the smallest scale is the question of most importance perhaps in connection with the scheme, but one of a character not falling within the province of this paper.

OTHER CONSEQUENCES OF CHANGE OF AGE-DISTRIBUTION.

The changes in age-distribution that are taking place in New Zealand and elsewhere, and the causes contributing thereto, are full of interest in connection with many other matters of very practical import.

The prospects of insurance companies must interest most of us. Now, insurance companies as a whole have hitherto enjoyed, especially in these parts, receipts from premiums greatly in excess of the outgoing payments due to deaths and maturing of policies, and this has resulted in a rapid accumulation of funds and the establishment of vast capitals. This is due to the great convergency in the age-distribution of those assured, the younger section of those assured being much more numerous in proportion than the older section, and this is, as in the case of the general population, due to continued growth. Unless this growth can be kept up, unless companies can continue to obtain, year after year, a greater volume of new business, the inequalities in receipts and payments on account of members must get less and less. It is not remarkable, then, that so many companies should be so eager to obtain new business by extending the area of their operations.

Even the humble but not altogether insignificant domestic-servant problem may be reviewed in the light of the tendencies we have been considering. For twenty years, in the case of New Zealand, the population of the ages which in the main supply domestic servants must remain about constant, whereas the population of the ages which supply the demand for service must substantially increase. Moreover, in addition to the attractions of other employments and the increasing disinclination to entering into domestic service, there is another factor tending to diminish the supply of this class of workers. Domestic servants have been largely supplied hitherto from large families. The poor man, with seven or eight or even more children, must perforce send out the elder children to any employment that offers; with a small family of two or three he can afford to keep it round him, or at least to give them some preparation for a more ambitious occupation, and one, if possible, that will permit the family to remain together. Thus as the demand increases the supply is likely to diminish, and the difficulty may become so acute as to do much to modify the manner of life of the servant-employing class.

C. Pearson, in his "National Life and Character," discussed the probability of the population of the world soon approaching a stationary state, with a large proportion of old men. With an extract from this suggestive work I shall conclude. "What we have to suppose," he writes, "is that men with the admirable vitality of Newman, Gladstone, Radetzky, Moltke, Bismarck, Littré, Chevreul, and Lesseps will become increasingly common, and that, as, in cases where exact reason is more required than quick insight and promptitude of action or alacrity of eye and ear, the best work is very often done by the old, we may get an increasing average of the best work. We may even conjecture that the predominance of experienced and reflective men in a population—for those between forty-five and ninety might easily come to be more numerous than those between twenty and forty-five—would be an important conservative force balancing the democratic tendency to impulsive change. Increased stability of political order, increased efficiency of exact thought, are possible advantages that cannot be disregarded. . . . But the most visible effect to the world will probably be the decay of energy. If youth is the season of unrest, when change is welcomed for its own sake and when orderly growth is despised, it is also the brooding-time of speculation, the maturing-time of adventure. Old men are probably best fitted for carrying on the mechanical and routine work of the world, but the artists, the poets, the explorers, the propagators of new ideas are habitually to be found among the young. . . . Therefore, if we assume men of middle and of mature age to add the influence of numbers to that which they already get from seniority, it is difficult to suppose that the history of the world will not be a great deal tamer in the future than it has been in the past. That life should be sadder and greyer than it has been may mean very little; that it should be less capable of energy and reform, more prone to entrench itself in an established order, will undoubtedly mean that it is passing into its old age, and that those whom the present does not satisfy will have nothing to hope from what is to come."

Art. LVIII.—*Maori Origins: Part II.**

By Elsdon Best.

[*Read before the Auckland Institute, 15th October, 1900.*]

Origin of Man.

The origin of man, according to the old Maori mythology, is mixed up with that of animals, birds, and fish, inasmuch as all are descended from Rangi, the Sky Father, and Papa, the Earth Mother. Tane-nui-a-rangi, son of these lordly beings, was the progenitor of the human race. His first action was to produce the various trees of the forest, after which he married Hine-rauamoa and begat man.

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                Rangi = Papa
                      |
   ---------------------------------
   |                  |            |
Tane          Tangotango = Wainui
                           |
   ------------------------------------------------------------------
   |          |            |            |             |             |
Te Ra   Te Marama   Nga Whetu   Te Hinatore   Pari-kiokio   Hine-rau-
                                                               amoa
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Here we see that two of the children of Rangi and Papa produced Te Ra (the sun), Te Marama (the moon), Nga Whetu (the stars), Te Hinatore (phosphorescent light), Pari-kiokio, and Hine-rauamoa. Pari-kiokio is the origin of the *kiokio*, a forest fern. Hine-rauamoa is the mother or origin of man.

After Tane had forced his parents apart and lighted the world he then sought to produce man. He took Hine-tu-

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* For Part I., see vol. xxxii., page 294.

maunga, who had Para-whenua-mea, the personification of flood-waters. He took Hine-wao-riki, who produced the *kahika* and *matai*, forest-trees. He took Momuhanga, who had the *totara*, a forest-tree. He took Tukapua, who had the *tawai*, a forest-tree. He took Mangonui, who had the *tawa* and *hinau*, forest-trees. He took Te Pu-whakahara (said to be the name of a star), who had the *maire*. He took Rere-noa, who produced the *rata*. He took Ruru-tangi-akau, who produced the *ake*. He took Punga, who produced the *kotuku-tuku*, the *patate*, as also all kinds of insects. He took Tutoro-whenua, who produced the *aruhe* (fern-root).

In like manner, Hine-mahanga was the origin of the *tutu* shrub; Tawake-toro, of the *manuka*; Huna, of the *harakeke* (flax); Tawhara-nui, of the *kiekie*.

(Other accounts state that Tane took to wife one Kura-waka, grandchild of Tiki.)

After Tane had long searched for a female by whom he might produce man, he went to Rangi and asked, "*Kei hea te uha*" (Where is the female)? And Rangi replied, "*Kei raro te whare o aitua e hamama ana, i runga ko te whare tena o te ora, kei raro te uha.*" Then Tane took Hine-rauamoa and begat man. They had Rongo, who is the personification of peace and the tutelary deity of cultivation and the husband-man. They had Hine-te-iwaiwa, who is the tutelary deity of the art of weaving; and Tangaroa, the Polynesian Neptune, who rules the ocean and the denizens thereof; and Tu, god of war; and Tawhirimatea, who holds the winds; and Ioio-whenua, and Putehue. The latter had Makara, who had Mahuika and Hine-i-tapeka, the origin and deities of fire.

Tane and his brethren dwelt in the primal home Auroroa. In the days of Maui Mataora was the home. In the days of Rongoatau it was Hawaiki-nui.

The Maori of yore traced his descent primarily from chaos and space, before the world was, through Rangi and Papa; and later through the personifications of the elements of fire and water, as also the sun, stars, and moon.

Sex originated in the far-distant past when chaos obtained, long ages before Rangi and Papa. The first two beings were Te Pu and Te More; the former was of the male sex, the latter of the female. They became one and were inseparable. They possessed the two names, but these were applied to the one being.

Origin of Speech.

The power of speech is derived from Rangi and Papa, and a different speech was given to man and a different speech to birds, and to dogs, and to fish, and to insects. For birds, and reptiles, and fish all possess the power of speech, although it be not understood by man. We cannot understand the words of their speech. It is only when we are dreaming that we hear dogs, and birds, and reptiles make use of human speech.

Origin of Affection.

The feeling of affection originated with the heavenly bodies. The sun and moon moved together, and a great love sprang up between them. The sun embraced the moon, and they ever greet each other, in all seasons. A time came when the sun said to the moon, "Go you to your own place, as also our brethren the stars; let us ever love our brethren." Such was the origin of affection, which we still know in the world. And it ever continues with these people of the heavens; they never quarrel, but go their ways in peace. They know not death as we, their descendants in this world, know it. They die neither in war nor yet by the house-wall. The saying is, "*Rurea taitea, ka tu ko taikaka*" (Reject the *taitea*=sapwood, and leave the *taikaka*=heart-wood, standing). Let us explain: The *taitea* represents the people of this world, who dwell in evil towards each other. They perish like the sapwood of timber. But the *taikaka* is the durable heartwood, which resembles the heavenly bodies on high. But no trees of earth equal them; they perish and decay, while the sun and moon and stars live on for ever; neither do they fall from on high.

When Tane and his brethren disputed over the question as to whether or not their parents (Heaven and Earth) should be separated or not, that was the origin of family quarrels, which are ever known on earth.

And Papa (the Earth Mother) still provides food for her descendants in this world; she produces all the foods upon which we subsist.

Origin of Karakia (Invocations).

Invocations were first used in primal chaos, long ages before man was. In the time of Te Pu and Te More their invocation to their gods (Te Ao-matinitini and Te Wherikoriko) was this:—

Te Wherikoriko, naumai koe, haere i mua ra
Te Rangi-matinitini, naumai, haere koe i mua ra
Ki o taua uri.
Haere i tua, haere i waho
Torohei.

Tangaroa-akiukiu had two daughters, Hine-raumati (*raumati* = summer) and Hine-takurua (*takurua* = winter). They are the personifications of the two seasons. They both became wives of the sun. Hine-takurua attends to the work of sea-fishing, while Hine-raumati attends to the cultivation of food (the Polynesian Ceres—for corn substitute *kumara* = sweet potato). Hine-raumati gave birth to Tanerore, who was the origin of the *haka* (posture dance). On a hot summer day you may see the *haka* of Tanerore (*i.e.*, the quivering of heated air).

Origin of cooking Food.

When Rongomaui obtained the *kumara* from Whanui he brought them down to this world and gave them to Panitinaku. And Rongo said to Pani, "Take these and prepare the sacred food in the sacred ovens" (*i.e.*, to take the *tapu* off the *kumara*). This was the first occasion on which food was cooked by man. Had it not been for Rongomaui man would still be eating his food in a raw state, as birds and dogs do, for they do not know how to cook food.

Peace and peace-making and the peaceful arts originated with Rongo-matane and Ioio-whenua. The great upholders of peace were Te Hapu-oneone. All peace and gentleness in the world of men proceeds from those remote beings.

Origin of Fire.

As stated, Mahuika and Hine-i-tapeka were the origin of fire and the tutelary deities of that element. The children of Mahuika were Takonui, Takoroa, Manawa, Mapere, and Toiti. These were represented by her fingers, and were themselves the primal fire.* When Maui went to Mahuika to obtain fire for mankind she gave him one of her fingers; but Maui the deceitful surreptitiously destroyed the borrowed fire and returned for more, until all the offspring of Mahuika were destroyed. Then rose Hine-i-tapeka, and Maui fled, pursued by the fire. But Maui, as he fled, repeated an invocation which caused rain to descend in such volume that the pursuing fire was threatened with extinction, and was only saved by concealing itself in the *kaikomako* tree—*i.e.*, it took shelter with Hine-kaikomako, the personification of that tree. Hence it is that man ever obtains fire from Hine-kaikomako.

(The *kaikomako* furnishes the best wood for the purpose of obtaining fire by friction, and the sticks carried by travellers were generally of that timber. If the *kauahi* are seasoned a competent person will produce fire in about three minutes, as I have often seen.)

The fire that burns in the underworld is said to be the fire of Tapeka.

Origin, or Prototype, or Personifications of Birds.

The *kawau* (cormorant) sprang from Noho-tumutumu, the *parera* (brown duck) from Moe-tahuna, the *weweia* from Ruku-

* These are yet the names of the fingers among the Tuhoe Tribe: Takonui (the thumb), Takoroa (the index finger), &c.

ruku, the seagull from Hine-karoro, the *pakura* from Wairua-kokako.

Rehua (a star name) is said to be the origin of the *koko* bird (*tui*), and also of the *inanga* (whitebait). The *inanga* said to Rehua, "What are we to do?" Rehua replied, "When you see a red appearance in the sky that is a sign for you to go to your ancestor Wainui (the personification of the ocean) and give birth to her grandchildren; when they are grown you will all return (to the fresh water)." Thus when men see the red light in the sky they say, "O people! The *inanga* are migrating." For the *inanga* are taking their young to their ancestor Wainui (the ocean), there to be born. The *pahore*, the *koputea*, the *porohe* (all small fish), and eels all go. The old *inanga* return to the rivers when they have parted with their young, who follow after. These fish begin to go to the sea in the moon Rakaunui. There are two other migrations afterwards, known as Takero and Te Kohi-o-Autahi-ma-rehua.

Both Rehua and Takero are star names, as also, I believe, is Naha, the origin of the *patiki* (flounder).

Stones and *pounamu* (greenstone) are descended from Tangotango (see Part I., vol. xxxii., art. xxxiv.). Kopu (the star Venus) is also another origin of rock and stones—the kinds of stone known as *mata, kiripaka, kamaka, kurutai, tuapaka*, and *turua*.

The origin of house-building was the house known as Te Tatau-o-rangiriri, built by Tane and his brethren in the far land of Mataora; and there also originated the rite of the *kawanga whare*. One Rua, an ancestor of very remote times, is said to have been the origin of the art of wood-carving.

The personified form of snow and ice is one Nganga. The origin of snow, according to Maori folk-lore, is as follows: The mountain of Tongariro is said to be a male, while Pihanga is a female. Rangi gave the latter to Tongariro as a wife, and to them were born the sleet and drifting snow. Reference to this occurs in song—

Kati au, ka hoki ki taku whenua tupu
Ki te wai koropupu.
I haria mai nei i Hawaiki ra ano e ana tuahine
Te hoa tau te pupu e hu nei i Tongariro
Ka mahana i taku kiri, na Rangi mai ano
Nana i whakamoe, ko Pihanga te wahine
Hai ua, hai hau, hai marangai ki te muri-e.

The origin of weaving is assigned to Hine-rauamoa, before mentioned, while Hine-ngaroa is credited with the invention of weaving in coloured patterns.

Art. LIX.—*Some Account of the Beginnings of Literature in New Zealand: Part I., the Maori Section.*

By Dr. T. M. Hocken, F.L.S.

[*Read before the Otago Institute, 11th September, 1900.*]

In 1894 I read a paper before this Institute entitled "Some Account of the Earliest Literature and Maps relating to New Zealand,"* bringing the subject down to the beginning of this expiring century, when Dr. Savage, in 1807, published his short work. The contributors to this literature were those who, sojourning here for a short time, described the newly discovered country, and gave us their impressions of its products and people. On this occasion I propose to speak of the beginnings of a literature that has sprung up amongst ourselves, and which has developed into that which may be characterized at least as something very extensive indeed. The subject is plainly divisible into two sections, that connected with the Maori language—first, of course, in point of time—and that when English newspapers, pamphlets, and other publications inevitably followed in the train of our colonisation. The subject is as interesting as it is extensive, and requires much better treatment than it can possibly receive in the short time properly allotted to our Institute meetings. I must thus promise to resume it at a future period, and on this occasion shall confine myself to laying before you a sketch of the Maori or first division, illustrating the same by various exhibits.

The earliest of our countrymen to take up their permanent dwelling in New Zealand were the "lay missionaries," or "lay settlers," as they were called, and in referring to them I shall go over no old ground beyond that requisite for the purposes of illustration. Amongst them sprang up the first germ of our literature. Wherever the British race has spread the translation of the Scriptures and of other religious publications has always been viewed as most important, not only from a philological point of view, but as a duty incumbent upon the British people when brought into contact with those of an inferior race. It was in 1815 that Samuel Marsden, ever to be honoured as the Apostle of New Zealand, stationed at the Bay of Islands three simple, pious men—Kendall, Hall, and King; and later on a fourth joined them—James Kemp. In accordance with Mr. Marsden's excellent theory their duties were to instruct the natives at one and the same

* See Trans. N.Z. Inst., xxvii., p. 616.

time in the arts of civilised life and the truths of Christianity, and for this their callings fitted them. One was a blacksmith, another was a flax- or rope-spinner, and the third a carpenter, occupations in which the natives were especially interested. Kendall had had some experience as a teacher in the Home-country, and he was thus able to undertake and complete within the first year of his new labours what is indeed the first literary production of this country. It is a small 12mo primer or school-book and vocabulary of fifty-five pages, printed at Sydney in 1815. It is entitled "A Korao no New Zealand; or, the New Zealanders' First Book: being an Attempt to compose some Lessons for the Instruction of the Natives." The book is, of course, extremely rare, if not unique, the only copy known to me being that in the Auckland Museum. Those of us having the least acquaintance with Maori will recognise how primitive is the first portion of the title, "A Korao no New Zealand," nay, of what dog- or pidgin-Maori it consists; and the same may be said of the contents. But it was a necessary and praiseworthy attempt to open communication between the two races, and as such it now holds its pride of place. Doubtless, too, it was quite abreast of the schooling requirements of eighty-five years ago. From the accounts which have descended to us from those early days it seems very clear that the relative position of teacher and pupil was entirely reversed, and that the latter had the former under control. The pupil came or played truant as he pleased, and it was quite as dangerous then to administer reproof or punishment as it is to-day in our own State schools. The surest method of securing the attendance and attention of these wayward ones was the promise of a meal of potatoes or some other of the new pakeha foods. But this too often sadly reduced the scanty rations of the missionary, who was too fastidious to supplement them with the roast joints of the country.

Reverting to the contents of Mr. Kendall's book leads me to remark upon the different renderings that have been imposed upon the Maori tongue since its first few words were made known to us by Captain Cook. Like other branches of the great Polynesian language, it is an oral and not a written tongue, and the first attempts to reduce it to writing were not only confused, but ludicrous. Its soft harmonious sounds when presented in English syllabary became grotesque. Each one spelt according to his fancy or untrained ear, with the result that, whilst he might recognise his word again, no one else could. An example or two will suffice: *Wai*, water, was *whi, wye, wi;* nose, *ihu*, was *eshoa, ahewh, ehoo;* come here, *haere mai*, was *iremi, harrymy, haromai, aire mai;* Hokianga was *Jokeehangar, Shukiehanger, E'Okianga;* Hauraki was

Howraggy, Howracki, Shourackie, E'Orackee. No less a person than Dr. Forster, one of Cook's companions, wrote *pooadughiedugghie* for putangitangi, the paradise duck, and *diggowaghwagh* for piwakawaka, the pretty fantail. And when words were converted into sentences the puzzle was complete. How great, then, was the advance when a fixed value was given to the consonants and the vowels were pronounced in the open or Italian way. Quite an interesting digression could be made on this portion of the subject if time permitted. The credit of this method belongs principally to the London and to the Church Missionary Societies; and the language, or rather dialect, which was thus first reduced to order was that of Tahiti, or, as Captain Cook called it, "Otaheite." The Tongan was the second, and very skilfully this was accomplished by Dr. John Martin in 1818. To this gentleman's zeal and ability we are indebted not only for a most valuable contribution to philology, but also for securing to us what must otherwise have been lost—"Mariner's Account of his Residence in Tonga as a Castaway Sailor from 1805 to 1810." This interesting and important book owes everything to Dr. Martin's editing. The New Zealand was the third in order to undergo this process of reduction to grammatical rule. "Fixing" was the term used by the Church Missionary Society. Yearly it became more important that this should be effected; for want of it the progress of the mission was seriously impeded, and so in 1820 Mr. Kendall visited England, accompanied by the great Ngapuhi chiefs Hongi and Waikato. It was the former who, upon his return to New Zealand, converted the valuable presents he had received into guns and gunpowder, and with these new and unaccustomed weapons marched through the North Island waging a cruel and relentless warfare upon his helpless countrymen, who were armed only in native fashion.

Considering the vast distance Mr. Kendall and his companions had come, their sojourn in England was very short, being of but four months' duration. Doubtless Hongi was restless to carry out the sanguinary schemes he had so long contemplated and so secretly concealed. Two of these four months were spent at Cambridge, under the auspices of the Church Missionary Society, in conference with the Rev. Professor Lee, who was known as the society's Orientalist. He was a man of remarkable linguistic attainments, and his history is well worth a moment's digression. A native of Shrewsbury, he followed the humble occupation of carpenter, but managed to devote considerable time to his favourite study of languages. His facility in acquiring them was so great that when but twenty-five years of age he had gained a very competent knowledge not only of Latin, Greek, and

Hebrew, but also of Oriental languages, Arabic, Persian, and Tamil. Accident brought him under the notice of the Church Missionary Society, who sent him to the university, where his success was signal. After taking his degree he was ordained, and speedily became Professor of Arabic. In this eminent position he rendered constant and valuable service in translating the Holy Scriptures into the various languages of those for whose welfare the society laboured. With extraordinary capacity he unravelled the structure of every tongue, and thus it was that in a very short time the previously obscure language of the savage Hongi was reduced to law and order—was "fixed." The part that Kendall undertook in the task was probably not much more than that of interpreter. The result was the publication in 1820 of the valuable "Grammar and Vocabulary of the Language of New Zealand," in 8vo, of 230 pages. It contains phrases, dialogues, translations, and some native songs. The edition consisted of 500 copies, now, of course, very rare. Some were printed on coarse, strong paper for the use of the natives.

A final word may here be said of Kendall. Like two or three others of the early missionaries, he fell from his high estate, and in 1823 was consequently dismissed from the mission. He behaved treacherously to the society, was guilty of trading with the natives in guns and powder, and sinned against morality. After his departure from New Zealand he traded in spars and other products of the country with Valparaiso and New South Wales. His schooner was, I believe, wrecked at sea when entering the Sydney Heads, and he was then drowned. This would be about the early thirties.

This system of "fixing" the language was not free from certain disadvantages, one of which may be shortly touched upon. Perhaps it was unavoidable, because much of the phonesis, or tone-sounding, of some languages is not accurately represented by the values given to the vowels and consonants of a syllable even when proper accent is added. It was this fact that explains some of the various spellings and pronunciations of which examples have been given. Every one, both Maori and English, nowadays says "Hauraki," "Hokianga," "Hongi,"—the pronunciation is "fixed"; but he who seventy years ago said "Shouraki," "Shukianga," "Shongi," as above given, was nearer the bottom of that well where truth lives. At the bottom he would have uttered a rather indescribable *sh* sound, something like a suppressed sneeze, a mixture of weak sibilant and strong aspirate—*yhou, yhong.* Take, again, the word so well known to us as "*kauri,*" and nothing else. Its liquid *r* was so lightly sounded that it might have been taken for *l* or *d*, and thus it was frequently written; nay, indeed, sometimes its presence was so slightly marked that it was all but elided, approaching in this respect so many Samoan words, where a lost consonant is represented by an apostrophe, which, as R. L. Stevenson so well put it, "is the tombstone of a buried consonant." I had the good fortune to be taught the true sounding of these words more than twenty years ago by that thorough Maori scholar Archdeacon Maunsell, whilst we were travelling together through the classic ground of the Bay of Islands, and, as is incumbent upon me, I pass on the knowledge to the younger portion of the audience, who, in turn, will again hand it on. I am not forgetful in rehearsing these pronunciations that there were dialects amongst the Maoris as with ourselves, and that they were as strongly marked.

For years the whole literature of New Zealand was solely represented by these two books. No steps had been taken towards translating even portions of the Scripture, important as the work was. It seemed as though the very existence of the mission trembled in the balance and was threatened with extinction, and this not only through Hongi's devastating wars and the restlessness and turbulence of the natives, but by dissension amongst the lay settlers themselves. Such a disaster was alone averted by Mr. Marsden's energy, sound sense, and zealous exhortations to the settlers, to whom he paid three visits, in the years 1820, 1823, and 1827. In those days a journey from New South Wales to New Zealand meant hardship and peril, especially to one who, like Mr. Marsden, was advanced in years. But his visits were always productive of the greatest good; he was a great favourite with the natives, and was always welcomed by them, and alone he travelled under their friendly escort for weeks together. Thus he insured the safety and security of those in whose lot and duties he was so deeply interested. In 1823 he brought with him from Sydney one who was a very important accession to the strength of the mission—the Rev. Henry Williams, who had been sent out by the Church Missionary Society, and who was joined three years later by his younger brother, the Rev. William Williams, well known in after years as the first Bishop of Waiapu. William Williams was an Oxford graduate and a good scholar, and to his scholarship and untiring industry, aided by the labours of others presently to be named, we are indebted for the Maori version of the Holy Scriptures. Little by little was this great work accomplished, and it was not until 1868 that the completed Old and New Testaments—"Te Paipera Tapu"—were bound and issued. This date marks the long period of forty-one years, for it was so far back as 1827 that the first instalment of the Scriptures saw the light.

So far as I am aware, no full account has been given of this interesting piece of history by those who were its makers. It is therefore important that the results of whatever information and research I have gathered from many quarters should be recorded. It was a standing instruction from the Church Missionary (or parent) Society that members of the mission should take every opportunity of extending their knowledge of the language with a special view to translation. This, however, was carried out in an ineffective way, though it is fair to state that so early as 1824 Mr. James Shepherd, whose special function was to instruct the natives in agriculture, had compiled a good vocabulary, translated some hymns, and was engaged in translating the Gospels. But after the arrival of the Williams brothers individual efforts such as these were compared and systematized. The members met at stated times and discussed whatever underwent the process of reappearance in the new tongue. This was the germ of the future translation committee. By the middle of 1827 there were ready for publication the first three chapters of Genesis, the 1st of St. John, the 20th of Exodus, the first thirty verses of the 5th of St. Matthew, and the Lord's Prayer, and, in addition, seven *himene*, or hymns, altogether forming a worthy beginning of this country's literature and an admirable selection—the story of creation, the divinity and humanity of Christ, the Ten Commandments, and the Beatitudes. This precious collection was taken over to New South Wales, or "the colony," as it was invariably called in those days, and printed at Sydney. This third contribution, which is quite as rare as Kendall's "Korao," is a small 8vo of thirty-one pages; it has no title-page, and 400 copies were printed at a cost of £41, G. F. Eagar, of King Street, being the printer.

It was in the beginning of the following year—1828—that another notable clergyman joined the increasing band of labourers. This was the Rev. William Yate, a man of considerable intelligence and observation, and the author of an excellent "Account of New Zealand." It is grievous to relate that he also, like one or two of his brethren before him, made sad default, and that, in consequence, his connection with the mission was closed in 1836. Nevertheless, his name must be recorded as one of the early translators.

Ever remembering that the chief amongst them was the Rev. William Williams, whose education and culture specially fitted him as leader in this work, this is a suitable place to refer to those others who also were contributors. Placed as nearly as possible in the order of their arrival in New Zealand, their names are: John King, one of the earliest lay settlers; James Kemp, a smith; James Shepherd, whose duties were to teach the natives agriculture, and who became proficient in the language, gathered together a large vocabulary, and commenced a translation of the Gospels so far back as 1825; W. G. Puckey, an artisan, who also had an excellent knowledge of the language; George Clarke, a smith, well known afterwards as Protector of Aborigines; Richard Davis, who conducted farming operations; Charles Davis, a carpenter; William Fairburn, also a carpenter; Charles Baker; Rev. A. N. Brown, of Tauranga; Thomas Chapman, of Maketu; James Preece, Joseph Matthews, J. A. Wilson, and Rev. G. A. Kissling. It is impossible in this long list, which extends but to 1832, to apportion to each his due share; but all were expected to do something, and were encouraged to suggest and criticize.

As the result, then, of such ceaseless labour the Rev. W. Yate proceeded to Sydney in the beginning of 1830, and carried through the press the fourth book on our list. It contained the first three chapters of Genesis, the first nine of St. Matthew, the first four of St. John, and the first six of the First Epistle to the Corinthians, all printed in double columns. Then followed, in single columns, Morning Prayer, Evening Prayer, and the Commandments. After these were the 1st and 2nd Catechisms and the hymns, now increased to nineteen in number. This interesting book, which is as rare as its predecessors, is a 12mo of 117 pages, printed by R. Mansfield for the executors of R. Howe, the Government Printer. Five hundred and fifty copies were printed, at a cost of £90. Great was the delight of the natives as well as the missionaries when this valuable freight reached the shores of New Zealand in August of 1830. The natives willingly gave a month's labour for a copy, or something equivalent in the way of pigs and potatoes, for it was wisely considered that the value of these books would be vastly enhanced in native eyes by making a substantial charge for them. On this occasion Mr. Yate brought back with him from Sydney a printing-press, the first New Zealand press. It had been sent by the Church Missionary Society at the earnest request of the missionaries, who hoped to do serviceable and economical work with it. Mr. Yate took the precaution to bring also a youth of fifteen, named James Smith, who had enjoyed some trifling experience in the *Sydney Gazette* newspaper-office. This youth was probably no more than a printer's devil, and, as Mr. Yate was not even that, it is probable that the efforts of the pair resulted in besmearing themselves and their paper and then forswearing the business as hopeless. It is certain, however, that they succeeded in printing the slips of a few hymns and also a small catechism, for in a letter to the society Mr. Yate says, after thanking them for the gift, "You will perceive, by the copy of a hymn forwarded, that we shall be able in a short time to manage it." There is something suspicious about this sentence; at any rate, I have not been able to learn from any source that their expectations of use and economy were realised. Still, this has the fame of being the first press, and Mr. Yate that of being the first printer. This fact detracts nothing from the honour of William Colenso, who, with his efficient press, arrived four years later.

What became of this old press? In a rare little pamphlet, written nearly sixty years ago at Paramatta, entitled "A Short Account of the Rev. Samuel Marsden," &c., the last paragraph reads as follows: "It is rather singular that this little work respecting Mr. Marsden should have been printed at that very press which that reverend gentleman introduced into New Zealand. The press (in consequence of the arrival of others better adapted for the Church mission) was sold by the society to Mr. Isaacs, who brought it with him to Paramatta." This Mr. Benjamin Isaacs was a printer, and, if I mistake not, printed and edited one of the earliest New Zealand newspapers—the *Bay of Islands Advocate*, which commenced publication in November, 1843, at Kororareka, and lived for about a year. The work of translation and revision now proceeded rapidly, that of final revision being left in the hands of the Revs. W. Williams and W. Yate and Mr. Puckey.

Again Mr. Yate was sent to "the colony," in November, 1832, where he remained until the following August, returning with a still more extensive freight. The scriptural portion of it contained the first eight chapters of Genesis, the entire Gospels of St. Matthew and St. John, the Acts, Romans, and First Epistle to the Corinthians, all printed in double columns, and forming an 8vo volume of 170 pages, printed by Stevens and Stokes. Separately there was a 12mo, containing four catechisms, morning and evening prayers, sacramental service, baptismal, marriage, churching, and burial services, and twenty-seven hymns. In all there were 3,300 volumes, and the cost was £500. Curiously enough, out of this large number barely one is now to be found. In one of these little books—a catechism given to me some years ago by Mr. Colenso—he writes, "Perhaps the only one existing! always for sixty years very scarce." It is plain that this more complete version did not give unalloyed satisfaction, for the Rev. Henry Williams says it "abounds in typographical errors—not less, I should think, than two to a page. It must not be offered without correction. So much for colonial work; it is a sad place. The translation is very good, and in many passages may be denominated elegant. This is principally William's indefatigable work."

The 30th December, 1834, must always be one of New Zealand's earliest red-letter days, for on that date arrived at the Bay of Islands in charge of William Colenso what, for reasons given above, must really be considered our first printing-press. Repeated applications had been made to the Church Missionary Society for one, and for a competent printer, with the result that Mr. William Richard Wade was sent out as superintendent of the press and Mr. Colenso as the printer. Mr. Wade, however, never took any active duty of the kind, so that the whole work from the first devolved upon his companion. Mr. Wade was appointed to ordinary missionary duties instead, and these he discharged until 1842, when he retired from the mission, chiefly on account of his views on baptism. He then went to Hobart, where for years he remained minister of the Independent Church. He wrote an interesting little book entitled "A Journey in the Northern Island of New Zealand," which was published at Hobart in 1842. But it is with Mr. Colenso we have to deal. The 3rd January was a day of immense rejoicing, amongst the natives especially, who shouted and danced upon the sandy beach as the *pukapuka* was safely landed. This was no easy operation, as the press and type were very heavy, and there were no facilities in the way of boats or jetty. However, the difficulty was overcome by lashing together two canoes, upon which the precious burden was placed, and dragging them ashore.

All sorts of difficulties beset the zealous printer, of which he gives an interesting account in his "Fifty Years Ago." Many necessary articles were wanting, and the printing-paper had been actually forgotten. Fortunately, a small supply was found in the store-room at Kerikeri, doubtless some that had escaped the experiments of Mr. Yate and his "devil," and the missionaries contributed a little of their writing-paper. Amidst these difficulties it was not until the 17th February that the first printing was begun, the little office being then crowded with spectators to witness the remarkable performance. The famous first book was the Epistles to the Ephesians and to the Philippians. It is a small 8vo of sixteen pages, in double columns. Twenty-five copies were first printed as presents to the mission folk—the ladies bound them in pink blotting-paper—and afterwards 2,000 were printed for general distribution amongst the natives. In December following, and uniform with the Epistles, the Gospel of St. Luke was printed, in sixty-seven pages, and the three were bound together. Of this 1,000 were printed during 1835. Mr. Colenso's hands were now quite full. With great ingenuity he constructed from very simple materials those necessary adjuncts to his press which, in such an unaccountable and careless manner, had been left behind in England. His first assistants were two or three natives, who, though at first highly honoured and delighted with their new occupation, speedily became tired of it and deserted, leaving Mr. Colenso to work alone. He, however, succeeded in getting from time to time a much better stamp of assistant, though from a very unlikely quarter—from the crews of American whalers which visited the bay to "refresh"—that is, to take in stores and water, and generally to enjoy such pleasures and excitement as Kororareka afforded. Amongst them was an occasional pressman who had turned whaler, and was but too glad to take a turn on shore and escape for a time the dangers of his wild life. Imagine these wild rough men as co-labourers in the gentle work of issuing the Gospels.

Not to interrupt the tenor of this narrative by a recital of other press operations, which will presently be considered, I shall continue the story of the Maori Scriptures to their final completion. The work of translating the entire New Testament was the one from which Mr. William Williams never stayed his hand, and in this his chief helpers were Messrs. Shepherd and Puckey, who have already been referred to as excellent Maori linguists, Mr. Puckey, who came as a youth to New Zealand, being especially reckoned by the natives as the best speaker of their language. For six years they had been engaged upon it—ever since 1829, indeed—and in July, 1836, they were enabled to commit it to the new press. On the 30th December, 1837, the work was complete, and was indeed worthy of all who had been engaged in its preparation. In Colenso's short journal, which has been found since his recent death, occurs this entry: "1837, Dec. 30.—Finished printing New Testament—5,000 copies. Glory be to God alone!" It is a large 8vo, in double columns, of 356 pages, and was bound very strongly, if not elegantly, mostly by the indefatigable printer himself. With great consideration and in a spirit of excellent brotherhood 1,000 copies were issued to the Wesleyan Mission, whose seat of operations was at Hokianga, on the west coast. A quantity of strong brown paper was forwarded at the same time, doubtless for wrappers, for in those early days most of the publications were sewn or bound in paper of this description. This New Testament is conspicuously the chief contribution to our first literature, and it is again singular that out of so large an issue so very few are extant, so few as to be absolutely rare. But the conditions of life sixty or seventy years ago did not conduce to the preservation of anything literary. The desire of the natives for the wonderful *pukapuka*—and it was great —was much of the same kind as that of the child for a new toy, and its fate was too often the same. On their journeyings it was dragged about as a valuable piece of personal property, with the inevitable result. Later on it was found that they were suitable for conversion into gun-wads and cartridge-paper, a sad application of the power of the Word.

It was impossible that the small New Zealand press and its one printer could supply the demand of the natives for the Testament. Accordingly the British and Foreign Bible Society speedily stepped to the front, accepting those duties which it views as peculiarly its own. In 1841 it accordingly sent out to New Zealand no less than 20,000 reprints, which were divided between the Church and the Wesleyan Societies; in 1842 a further 20,000 copies were forwarded; and again a similar number in 1844. This noble society circulated no less than 120,000 copies of various portions of the Scriptures in the Maori tongue by the year 1861, at a cost to itself of £6,000. An amusing specimen of pidgin-Maori occurs at the foot of the title-page of the earliest copies, where "Printed by the British and Foreign Bible Society" is rendered "Beritihi mo te Poreni Paipera Hohaiete."

So far but little had been accomplished with regard to the Old Testament. Now the time and the man came, when, in the latter part of 1835, the Rev. Robert Maunsell joined the mission. He was a graduate of Trinity College, Dublin, and was specially fitted by education and his classical tastes to undertake the work of this translation. His head-quarters were at the Waikato, where he remained for thirty years amongst his favourite Maoris. Afterwards he came to Auckland, where, for the succeeding twenty years, he held the incumbency of St. Mary's. He died in 1894 in his eighty-fourth year. He was one of Bishop Selwyn's first archdeacons, whilst Trinity College, his Alma Mater, conferred upon him the honorary degree of LL.D. in recognition of the ability he had displayed as chief translator of the Old Testament. To him I am indebted for much valuable information connected with early history. He was, it is needless to say, an accomplished Maori and Hebrew scholar, thoroughly conversant with the use of those particles and enclitics on which refined Maori so much depends. In 1842 he published a grammar of the language, which was dedicated to Captain Hobson, our first Governor. He acquired the language whilst travelling about with his Maori companions, and to insure perfection he stipulated that whoever detected him in a blunder should receive a piece of tobacco for reward. It might seem that this was rather an expensive way of learning; but not so, said the Archdeacon, for he would raise a dispute on the point, which was entered into with great zest by the natives, sure to be of great value, and was well worth an inch of tobacco. It would be tiresome here to specify minutely the work done and the order in which it was done.

Whilst Mr. Maunsell was undoubtedly the chief translator and reviser of the Old Testament, it would be as incorrect as unjust to omit reference to others who took a large share and interest in the work. The parts as they appeared, even a few chapters, underwent constant criticism and revision. A new revising committee was formed, of which Archdeacon Williams was chairman, his brother William and Messrs. Maunsell, Hamlin, and Puckey being the chief translators. As time passed on additions or alterations in this staff were made. Two Wesleyan missionaries, the Revs. John Hobbs and Thomas Buddle, were added to it; Mrs. Colenso, the daughter of Mr. William Fairburn, and an admirable speaker, was another. Mr. Colenso himself did some translation also, with Mr. Kissling and Mr. Maunsell's son George. The name of Leonard Williams, the present Bishop of Waiapu, author of many Maori works, must by no means be forgotten. The missionaries were supplied with what were called "probationary copies"—that is, interleaved copies of all new translations—which were strongly bound in canvas and suited for the pocket. In these they were expected to make their notes, and to return the whole within twelve months to the final judges, the Messrs. Williams and Mr. Maunsell.

Such is an example of the extraordinary care taken in the perfecting of this great work. I exhibit a few of these earliest translations as they proceeded from Mr. Colenso's press — all small 8vo, and all jacketed in brown- or drab-paper binding. The translations began in 1839, and as they sufficiently accumulated they were bound in rough canvassed boards and distributed. Three of these bound accumulations made up the complete Bible from Genesis to Malachi — rare to meet with, like their predecessors. Again, and with its wonted generosity, the British and Foreign Bible Society reprinted the three instalments as they appeared, which was at long intervals, and sent thousands of copies out from London. The first of these reprinted instalments, or volumes, appeared in 1848. It is an 8vo, of 343 pages, containing the first six books — Genesis to Joshua. The second volume appeared in 1855, and contained the following twelve books—Judges to the Psalms, paged from 345 to 817. In both these the old pidgin imprint has disappeared, and is replaced by "Na te Komiti ta Paipera" (the Bible-printing Committee), which is an improvement. The third and last volume was issued in 1858, and contains the last twenty books—Proverbs to Malachi, 377 pages. Here the imprint is a judicious mixture of the two languages: "I taia tenei Pukapuka mo te Bible Society" (the book printed by the Bible Society).

In 1868 appeared the first issue of the complete and perfect Bible—Old and New Testaments—a handsome, portly volume of 1,199 pages. It varies but little from the translation of the three preceding component volumes. Whilst going through the press at Ranana, or London, it was carefully supervised by competent persons who happened to be visiting the Home-country—the Rev. George Maunsell (a son of the Archdeacon), Mrs. Colenso, the Rev. W. Mellor, the Rev. W. Williams, and Bishop Selwyn.

A sad calamity befel Mr. Maunsell in 1843, when, owing to some carelessness, his house took fire, and in an hour was burnt to the ground. He lost everything, including his valuable books, the manuscript of a dictionary he was compiling, and many of his biblical translations. But with undaunted spirit he immediately commenced the work of years afresh, whilst his sympathetic friends subscribed £200 to replace his important critical library.

The barest reference only can be made here to the other religious books which were issued from Mr. Colenso's missionary press at Paihia. Amongst them were catechisms, portions of the Prayer-book, various pious addresses, tracts, and a little primer of twenty-three pages for Maori pupils. Of this latter no less than twenty thousand were issued between 1839 and 1842. It may here be stated that for some time I have been engaged in collecting and cataloguing not only these, but all publications whatsoever in the Maori language of which I have any acquaintance. But there were a few issues of quite a different character, which are of historical interest, to which further reference should be made. The first is the so-called "Declaration of Independence," which was signed in October, 1835, at the Bay of Islands by thirty-five chiefs. The occasion was that for some time rumours prevailed that France proposed annexing the Islands of New Zealand. Circumstance was given to these when the Baron Charles de Thierry formally declared himself Sovereign Chief of New Zealand, and that it was his intention to assume an authority, which would be maintained by the force of an armed vessel. Full details of this incident in our history I laid before this Institute some years ago. Mr. Busby, the British Resident, at once took steps to thwart these pretentions, and this "Declaration" was the outcome. It declared that all sovereign power and authority vested in the chiefs and heads of tribes themselves, who proposed meeting in congress once a year to frame suitable regulations for the purpose of justice, peace, and trade. A copy of this document was sent to King William recognising the good feeling between the two countries, and entreating him to become the Protector of the alliance. These are the principal features of the document, a copy of which I now show, printed by Mr. Colenso.

In February, 1840, began British government in New Zealand under Governor Hobson. The success of the effort to establish a treaty between the two races hung tremulously in the balance. It was opposed not only by the Roman Catholic priests, who had landed in the country two years before, but also by the Americans, and less openly by some of our own nationality. Four hundred copies of this "Treaty of Waitangi," as it is called, were printed and distributed amongst the natives, and here is a specimen.

From this time onwards and for a few months occasional Government notices and Proclamations were printed at the missionary press. In the latter part of June, 1840, the *New Zealand Advertiser and Bay of Islands Gazette* commenced publication at Kororareka, or, as it is now called, "Russell." It was violently opposed to the Government, and attacked the officials with a libellous vigour. In point of time it was the second newspaper issued in New Zealand, and the first to appear in the extreme north, which was then a stirring, busy place, the seat of the infant Government and the expected site of the future capital. It was perhaps with a view of giving a sop to Cerberus that the few official notifications were advertised in its columns. But matters went from bad to worse, and Cerberus not only refused to be appeased, but declined at last to advertise anything of Her Majesty's, a course that to-day no opposition paper, however virulent, would sacrifice its pocket to follow. Recourse was then had to the missionary press, which in December issued a *Gazette Extraordinary*, No. 1. This was almost the last official work it performed.

Though digressing, it will be interesting to complete this feature of a story. The Government took speedy and effective measures with the offending newspaper. It suspended it from publication by applying to it the provisions of a New South Wales Act which made short work with troublesome editors, who, if not beheaded, were at least suspended, and that usually meant extinction. The Government then proceeded to issue weekly its own *Official Gazette*, and, to complete reprisals, in addition to its own advertisements admitted those from the outside public, and gave shipping and general news. Thus it happens that in a *New Zealand Government Gazette*, published by authority, a notice appears that "a few gentlemen can be accommodated with board and lodging, or board only, by applying to Mr. O'Neill, next door to the Russell Hotel, Kororareka." Spiced beef is also offered for sale, and there is a raffle at £4 tickets. It is necessary to add that the infant newspaper died within a year of its birth. It will be noticed what a contrast there is between the excellent paper and good workmanship of Mr. Colenso's No. 1 and the rotten rags and poor execution of Her Majesty's printer. Seventeen such numbers appeared, and when the Government became fairly settled in the new capital of Auckland it issued, on the 7th July, 1841, the first number of that *Gazette* which has continued uninterruptedly to the present day.

And now for the closing history of this celebrated press. In 1843 Mr. Colenso ceased his connection with it and went to Waimate, preparatory to his being ordained deacon by Bishop Selwyn in 1844. A person named Telford was sent from England to take charge of it, but little more seems to have issued from it, at Paihia at least. I am much inclined to think that when the Bishop took up his permanent residence at Auckland the press went with him, though of this there seems no certainty. Mr. R. Coupland Harding, a well-known pressman at Wellington, who takes great interest in all details connected with his business, thinks that it was broken up in Auckland for old metal.

A word or two must be said in respect to the literature proceeding from the other two presses that were in existence before the advent of our British Government—the Wesleyan and the Roman Catholic. I do not think that much issued from either of them. The Wesleyans received their press in 1836, and printed, after the manner of their Church brethren, a few of the biblical books, catechism, tracts, pamphlets, and some hymns. The Roman Catholics, in the person of Bishop Pompallier, arrived at Hokianga in January, 1838. He was reinforced within a year with six assistants and a press, and he then moved his quarters to Kororareka, which he made the head of his whole apostolic vicariate extending throughout Oceania. The first prints of his press contained an abridged doctrine of the Roman Catholic faith, morning and evening prayers, and a method for learning reading; then followed the inevitable catechism, and a long pastoral letter refuting the errors of Protestantism. This latter was evidently considered a highly necessary publication, for the attitude of the two rival Churches was of the most bitter and controversial character. This press was sold amongst the early fifties to the *New-Zealander* newspaper, where the peculiar form of portions of its type, which is French, may be seen. Indeed, as might be generally expected, with the increased facilities for printing which followed in the wake of British government, the private presses were routed, and their work was done more effectually by those which drove them from the field.

Having thus said farewell to these faithful servants, regretfully because their remains are nowhere preserved for our veneration, we pass on to the next era, marked by the year 1840. It will preserve the order of this recital if, for the present, our first English literature—newspapers, pamphlets, &c. —remains unnoticed, and place be still given to the Maori, which becomes of increasing interest. No sooner had Captain Hobson established himself in Auckland than steps were taken to carry on that system of native instruction which the missionaries had always viewed as a prime duty. The facilities for doing this were considerably greater, and those who took an active interest in the work much more numerous. The list of these, from first to last, is a very long one, and it redounds to our credit as colonists of Great Britain that the performance of this great duty was never neglected, and that every effort was made to carry on that civilisation which Samuel Marsden began in simple homely method. No humane person can view but with deep regret the gradual disappearance of the noble people who first owned these lands, and the question has often struck the writer whether we, as their keeper, exercise at the present day as much interest in their welfare as was the case thirty years ago. Four years since I rode from East Cape to Gisborne, a distance of a hundred miles, passing through magnificent country, nearly all being native lands. It was painful to see the half-ruined kaingas, the trifling cultivation, barely sufficient for need, the squalid, idle appearance of the natives, and the general air of desolation. Coming from the south, with its rich farms and cultivations, the whole of this district seemed desolate and depressing. The valuable asset of these rich lands was certainly theirs, nor could they starve upon it, or fritter it away by a sale in which the Government had no voice. Still, these questions force themselves upon us: Cannot these people be saved from themselves, and stimulated by proper measures to practise the simple virtues of cleanliness, activity, and industry? To compass this would be a statesmanlike policy, and it might be effected by selling these lands, or a sufficient portion, and disbursing the proceeds in raising the unfortunate owners from the depth of sloth and ignorance in which they are sunk. Until some measures of the sort are taken it must appear that we are not now doing our duty. War is over, and can no longer destroy or disturb our best efforts. Amongst those former lovers of the race—men who gloried in the name of "philo-Maori"—may be mentioned Sir William Martin, the first Chief Justice, and his wife, Bishop Selwyn, William Swainson (the Attorney-General), Dr. Shortland, Mr. Mantell, and Sir George Grey. This is but a fraction of the number, but it contains the names of men pre-eminently champions of the race at a time when it had but few friends.

On New Year's Day of 1842 the first number of the *Karere o Niu Tireni*, or New Zealand Messenger, made its appearance. It was of foolscap-folio size, usually of four pages, published monthly, and diffused amongst the natives much varied and interesting information. It also contained occasional addresses and letters from the Governor of a conciliatory and judicious kind. It ceased publication, after an issue of forty-seven numbers, towards the close of 1845, in consequence of the disturbed state of the natives and the outbreak of the war in the north, but reappeared as a demy folio—the same size as the *New-Zealander* newspaper, at which office it was printed and published—in January, 1849. In other respects it was considerably altered: its title was the *Maori Messenger*, or *Karere Maori*, and it was to all intents as much a newspaper as the *New-Zealander* itself. But its great feature, and the one that makes it so valuable to us at this day, is that every alternate column consisted of an English translation of the Maori text. It was issued fortnightly until the end of 1854, and then, in January, 1855, it entered upon its third and last stage of existence as a small 4to in a bright wrapper, presenting somewhat the appearance of a magazine. It usually made its appearance fortnightly, and varied in size from eight to even seventy-nine pages, and is full of a section of history to be gained nowhere else. This valuable periodical gradually curtailed its pages, and closed its existence in September of 1863, after a life of nearly twenty years. It was always well edited, such men as Dr. Shortland, David Burn, C. O. Davis, and Walter Buller conducting it. Its influence upon the Maori race was great and good, and, though since that date a periodical of some kind has never been wanting, none has thoroughly supplied its place or been conducted on the same lines.

Throughout this comparatively long period of twenty years no efforts were wanting to elevate the Maori from his previous state of barbarism by means of the wide diffusion of literature. Time will not permit more than the barest reference to this; indeed, the subject is one so extensive and so interesting as to merit an additional chapter, which must some day be laid before you. To make this bare reference I must avoid all narrative of the numberless religious publications which the increased facilities for printing brought forth. Points of interest attach to many of these. Lady Martin, for instance, was an indefatigable bookbinder, her implements being merely thread and needle, strong brown paper, and a pair of scissors. Piles of these publications owe to her deft fingers and unwearied work their neat appearance and preservation; and it should be noted that some of the school-books were prepared by her for publication. To Governor Grey is due the chief credit of instituting these efforts. Part of his native policy was to publish interesting books in the Maori language, the chief of which were undoubtedly "Robinson Crusoe," John Bunyan's "Pilgrim's Progress," or, as the translation calls them, "Ropitini Kuruho" and "Hoani Paniana." These were translated by Henry Tacy Kemp, who was Native Secretary and Interpreter, and a special feature of them is that they contain illustrations—so far as I can recollect, the first ever done in New Zealand. These were executed by Dr. Thomas Shearman Ralph, who practised at Wellington between the forties and fifties, and who was, moreover, the secretary of the New Zealand Society, founded in 1851, the precursor of our New Zealand Institute. They were published respectively in 1852 and 1854, and as both stories were exactly suited to native taste they were in high favour, until the inevitable Killjoy made it known that they were allegories, and then all interest ceased. Hence, no more books of the kind were issued.

As something that still appealed to taste, and was much more practical, an interesting little treatise on the "History and Cultivation of Tobacco, or Tupeka," appeared, which gave such a spur to native industry that no kainga was to be found without its tobacco cultivation. In connection with this it may be mentioned how brutal a trick was played upon some natives in the Thames district just before the days of colonisation. A departing captain exchanged with them for some pigs and potatoes a packet of tobacco-seed, which they planted and carefully tended. It developed into a crop of docks, which overran the country. No wonder that base conduct of the sort was speedily followed by that Maori law of retaliation known as *utu*.

Other practical works appeared on the value of money and the use of savings-banks, some descriptive of the beneficent laws under which the English had flourished for so many generations, and some relating to the care of health and avoidance of disease. At one time there was some fear that the scourge of small-pox would find an entry to the country. Immediately a booklet was spread broadcast giving an account of the disease and the best mode of avoidance. As is so often the case in introducing new terms and new ideas, there was great difficulty in labelling the disease with a suitable Maori name; but at length, referring to one of its peculiar features, it was called "*i mate koroputaputa*" (the sickness with holes, or pits, in the ground). One of ourselves taking up this pamphlet would be hopelessly puzzled with its title-page.

Hundreds of such useful little pamphlets were printed upon a press of which so far no mention has been made—that brought out by Bishop Selwyn in 1842, and known as "the Bishop's, or the College, press" (*te Perehi a te Pihopa*, or *a Kareti*). This small press issued its publications for many years, and was longer independent of outside competition than the other clerical ones, the fact being that when the Bishop founded his College of St. John, which was a few miles out of Auckland, he was possessed with great ideas of the future, and so laid its foundations upon those of his own Eton. In early days he lived there, wishing to make it the centre of all Church work. But gradually as time progressed he saw good reason to modify his views, and one work after another had to be given up. The Maoris were provided for at St. Stephen's, Parnell, and the Melanesians removed to Norfolk Island. The hospital was a disastrous experiment, and the farming soon a failure. But in its heyday there were students, scholars, bursars, and lay associates, who, in addition to their school duties, divided the charge of the whole College appanage—farm, dairy, buttery, bakehouse, kitchen, apiary, hospital, press, and bookbinding, amongst others. Thus the departments, if not self-supporting, were worked at a minimum expenditure, and thus the press was well able to hold its own. Its fate is not quite certain. Mr. Harding, in a letter to me, thinks it belongs to himself, but is not quite certain. After purchase he leased it to a printer, who became bankrupt, and it passed into other hands. To recover it would cost more than its value, but Mr. Harding keeps a strict eye upon it, and hopes to see it some day safely in some nook of the Colonial Museum. The Rev. William Charles Cotton, who came out with Bishop Selwyn as one of his chaplains, was a great bee-master, and it was he who gave to the Maoris, through his College press, the little treatise on the bee—"*Ko nga pi.*"

Some conception can now be formed how faithful and extensive have been the earliest efforts to impart a varied knowledge to those interesting people whose heritage has almost disappeared from them. The proof of those efforts, extending over a period of forty years, forms the earliest literature of this country, and reflects honour on those who were its authors. A little of this interesting portion of our history I have shown you this evening, and must promise to return to it shortly.

Art. LX.—"*Giotto's Circle*" *and Writing.*

By H. N. McLeod.

[*Read before the Wellington Philosophical Society, 15th January, 1901.*]

By the statement that "the ability to form a perfect circle with pen or pencil is the ability to write well," by which this note might be summarised, it may appear that a similar principle underlies proficiency in handwriting to that which lay in the art of Giotto, the correctness of whose belief in the efficacy of a perfect circle as his sole testimonial to his being an expert in his art was justified not only by his receiving the commission, but, more than that, in the fame which the incident has acquired. The connection between this famous circle and handwriting, or the phase of handwriting dealt with herein, is put forth in the light that there is nothing new under the sun; for, though the point to be brought under notice is original as far as it goes, it must frequently have been acted on in principle, and probably to some extent in practice, the point being the offering for consideration a simple means by which to counteract the environment, if this term may be applied, which adversely besets many who desire to write well. If it be granted that a circle was the keynote of the art of Giotto, then I wish to suggest that a circle may also be the keynote of good handwriting.

The probability of an average writer improving by ordinary intelligent practice until his penmanship is above the average for legibility and grace is beyond question, and it is quite possible that, in some modification or other, what is herein set forth has been put into practice before.

On considering illegibility, it seemed to me chiefly caused by angularities; this, it may be stated, being the case where it occurs among the scores of handwritings which I have the opportunity of seeing in the course of ordinary daily routine. This being so, the way to meet and overcome this illegibility, or tendency towards it, is clearly to replace the angles with curves, and the most perfect curve for the purpose is a circle. Moreover, angularity in style appeared to be but the efforts of the muscles used in writing, restricted by the bones of the fingers and thumb, to take the line of least resistance, which is a straight, or nearly straight, line, to which must be added the lateral motion of the wrist; for this may be seen by the ease in making "1" well more easily than "0." Another point, too, in writing is this: that among the most legible handwritings those which have not thick and thin strokes, but those which are even in flow, are in the majority; and observation and trial lead me to the conclusion that the bias of shaded writing is towards illegibility.

Briefly, the conclusion arrived at may be stated thus: Replace the environment which results in illegible angularities by one which produces curves—that is to say, let the fingers and thumb used in writing trace a circle so often that a curve will be the line of least resistance to them. This, to my mind, is done in the simplest way by rapidly tracing in one spot circles on top of one another, of the size of an ordinary written "o," with pen or pencil. But this can be yet more effectively done by the aid of one of the simple mechanical means submitted. These provide a way of overcoming the inclination to shirk the exercise of will latent if not active in most of us, giving, moreover, an accurate circle for tracing. The aim, then, is to practise the circular motion with finger and thumb until that motion becomes pure habit.

On no account should the wrist be moved; it should be held firmly by the left hand.

The statement which, within the limitations of this paper, may be made an axiom is, the ability to form a perfect circle with finger-and-thumb motion is the ability to write well; or, in order to write well, occasionally practise forming circles until the muscles of the fingers and thumb tire.

Art. LXI.—*Survey: Practical and Precise.*

By the Honourable G. F. Richardson.

[*Read before the Wellington Philosophical Society, 12th March, 1901.*]

The survey of new lands contains more elements of interest than that of older countries; in the former case the points and lines determined mainly concern the creation of new holdings and new homes, whereas in the latter they only serve to record old ones. In these colonies especially the proportion of land occupiers and owners is so large that most of us are directly or indirectly interested in "section pegs," "trigs," and such-like, while at Home the expression of this interest is practically limited to the impersonal "beating the bounds of the parish." The subject being one of much interest and importance, I propose to consider, from my point of view, the merits and defects of our New Zealand surveys as now practically applied.

Among the noticeable defects I give first place to the want of an absolute unit of measure for the colony. The second defect, and a more serious source of confusion, is the want of any provision to ascertain and eliminate the aggregation of errors, which, though not excessive within any given square mile, may become markedly so by accumulation. To these and other points I now ask attention.

The survey system first applied by Mr. J. T. Thomson to Otago, and afterwards to the colony—a system of occupation survey under check by triangulation — was mathematically sound, and, even under the conditions of its application, has resulted in our country occupations being determined with probably as high a degree of accuracy as obtains in any other country, and with a much higher accuracy than has been attempted in most. Theoretically, a primary triangulation with sides ranging from twenty to fifty miles, and, say, a limit of error not exceeding 1 in. per mile, should have been carried over the colony; and this should have been broken down to a secondary triangulation with sides of, say, eight to twelve miles, the points of this breakdown governing the working or minor triangulation, which, with sides from two to four miles, would in turn have limited and checked the errors of the occupation surveys.

In the early days of the native troubles, and when the sea-beaches and river-beds were the only available roads, the difficulties in the way of a scientific primary survey were almost prohibitive, and, apart from that, would have required much time to effect, while the demands for occupation surveys were of pressing urgency. To meet the circumstances Mr. Thomson devised a plan of local meridian circuits, with a probable error not exceeding 2 links a mile, and with a locally measured base (being, in fact, a minor triangulation without check), but which would, however, serve for the time to fairly control the occupation surveys, it being an essential part of his scheme that subsequently the rigid primary work should be undertaken, by means of which these meridian circuits would then be brought into harmony and exactitude.

We closed page "one" in 1895–96, when the Surveyor-General reported (page xi.), "We have now a chain of triangles from the North Cape to Stewart Island," and page "two" still remains unopened. It will be easily understood that in the sixties, when Gunter's chain was used, and when the limit of error of chainage allowed was 4 to 10 links per mile according to the character of the country, a triangulation with a supposed limit of 2 links was a sufficient check.

In the last March number of the *New Zealand Surveyor*, page 184, I wrote, "When it was made, the triangulation met the requirements of the day, for its limit of error was mostly well below that introduced by the old Gunter's chain. Of late years this position has been reversed by the use of the steel band, with the result that ordinary traverse surveys often now possess a higher degree of accuracy than the triangulation which is supposed to govern them. Where close settlement has spread, and on level land, many trig. stations have become useless owing to buildings and plantations, and they require to be supplemented by standard marks at reasonable intervals, which would cost a trifle compared to the tax which the want of them now levies on the public." I may emphasize this by stating that many trig. stations have disappeared entirely, and that the number missing is on the increase, through neglect to protect or to renew the original marks.

In addition to the "chain of triangles" already quoted, standard bearings have been carried from one end of the colony to the other, from principal stations ten to twenty miles apart; so that our triangulation "bearings" are fairly good, while our "distances" are unreliable. Any so-called major triangulation we possess is but an overriding set of large triangles, the sides of which have been calculated from our faulty minor triangulation, and which necessarily contain its cumulative error.

The accuracy of lineal measurement with the steel band when used with care, but without any attempts at high exactitude, is well within 2 links per mile; that of angular measurements is not so close, but "bearing" and "distance" combined keep our field surveys to about a 2-link limit, while the accuracy of our triangulation is certainly no greater, on the average, than that of our ordinary field-work. As all careful surveyors check their work in itself, the chief use of the present triangulation is to supply the true bearing and a nominal "position value" to which to refer the work. In speaking of "accuracy of lineal measurement," I mean its approach to coincidence with the official standard chain of the district. These standard chains were laid down by the several provincial authorities with such rude appliances as were then available, and apparently on the abolition of the provinces they were not compared with each other, but were assumed to be similar. Recently it came to my knowledge that differences existed, and as a result of comparison between them and with Sydney I find that Wellington and one other are about $\frac{1}{10}$ in. short of Sydney standard, the eight other standards being nearly $\frac{2}{10}$ in. longer than Sydney. In other words, the difference between our longest and shortest official standard amounts to about 3 links per mile—no two of our standards agree—and the Sydney standard is a mean between our extremes. As all our standards disagree, it is obvious that nine out of the ten must be wrong, and that probably all ten are; also that these discrepancies must introduce a constant error through all work based upon them, apart from the inherent error of the work itself.

I have recently brought this matter under the notice of the Government, which will, I have no doubt, take steps to lay down a standard chain-length for the colony with the highest degree of accuracy obtainable; and, once a standard is determined, its exact duplication by means of instruments of precision is comparatively simple. The best appliances we possess are two Imperial-standard-yard measures, which do not agree with each other; but, even if they had been reliable, we have not the requisite apparatus to enable us to utilise them. It is clearly necessary to lay down a correct standard for the colony, and, as New South Wales and Victoria each possess a standard chain laid down with extreme care, I should propose to compare one with the other, and, if the coincidences warranted it, to establish our standard of length from theirs. The crypt below the new parliamentary library would be very suitable for its permanent resting-place.

The Brisbane standard chain (1890), which was laid down with a 10 ft. octagonal steel bar floating in mercury, has been tested with that of Sydney (1899) and with the United States American standard (1891 and 1899), the coincidences being within $\frac{1}{720}$ in.

The next step should be to bring our triangulations into harmony with the standard, and, consequently, with each other. Official objection is sure to be raised to thus eliminating error, on the ground of confusion, but such an objection will not hold water—the confusion exists, and the differences arising through its removal should not exceed the official allowance of error, and can in no way interfere with or affect title.

Having overcome the difficulty of determining a unit of absolute length, the question would arise how best to bring all important measurements into terms with it, and to do this within fine limits of error the only certain and economical plan is to give further effect to our survey system (already described) and carry out the long-postponed primary triangulation. This can be done with marvellous precision, and yet at a smaller cost than would have been possible a few years ago. Many things contribute to this result, but chiefly the modern methods of measuring base-lines and the fact that the country is now opened and its topography completed.

Looking to the necessity for a primary triangulation for our own purposes, and also to the wider interests of science, I should like to see it carried out as a geodetic work of refinement and applied to the measurement of an arc of meridian.

An interesting article on geodetic measurement appears in the October number of *Nature*, and shows that at the present time great activity is displayed and much interest shown in endeavouring to arrive at a more accurate solution of the great problem involved in determining the figure of the earth.

The Swedes and Russians (jointly) are measuring an arc of meridian in Spitzbergen, the field-work of which is now all but completed; and a well-equipped army of French experts leave shortly for the equator to measure and to lengthen the Peruvian arc.

Lacaille's arc at the Cape, first measured some hundred and fifty years ago, since corrected (in 1840), and still later largely extended, is as yet the only measurement effected in the Southern Hemisphere, the exact form of which, from want of more complete data, is largely arrived at by inference. Sir David Gill, however, proposes to carry a chain of triangulation from the Cape to Cairo, and thence by the coast of the Levant and through the isles of Greece to connect with the existing European systems. This grand conception, if given effect to, would mean an unbroken chain of geodetic measurement from the Cape to the Shetland Islands. At present the Cape triangulation extends from about 28° S. to 35°, the southern limit of Cape Colony, which is nearly on the same parallel as the northernmost point of this Island, Cape Agulhas being in 34° 50′ S. and North Cape in 34° 22′ S.

This colony covers 13° of arc, including the 45th parallel, to which (in the Northern Hemisphere) so much importance was attached when the Formentara arc was measured; and it is also exceptionally situated in this respect: that the curvature of the earth in this hemisphere cannot elsewhere be ascertained in such high latitudes, excepting in South America.

The cost of a geodetic survey is not now prohibitive, though it necessarily increases with the degree of accuracy demanded, but up to $\frac{1}{10}$ in. error per mile of base and $\frac{1}{2}$ in. error per mile of the triangulation the cost is moderate.

The elaborate apparatus formerly used in the measurement of primary bases by means of short rods or bars is now discarded in favour of steel bands ranging from 80 ft. to 500 ft. in length (the most favoured length being 300 ft.), and, by means of these, results varying from a probable error of 1 in 1,000,000 to 1 in 1,500,000 (or, say, 1 in. error in twenty miles) can be obtained. I have averaged the results of probable error in five separate bases measured by the United States Coast and Geodetical Survey in 1885 with a steel band of 300 ft., and it amounts to 1 in 840,000, or about $\frac{1}{13}$ in. per mile. Such exactitude is only possible with a measure of absolute length, the modulus of elasticity and coefficient of expansion of which have been ascertained, and with the work carried on under the best atmospheric conditions.

The two base-lines of the Spitzbergen arc were measured by a method introduced by Professor E. Jäderin, of Stockholm, in 1885. It differs, however, but little from that employed by the United States Geodetical Survey, except in respect of the length of band or wires used (Jäderin, 25 metres; United States Coast and Geodetical Survey, 300 ft.), and both processes give almost identical results, or about 1 in 1,000,000, or a probable error of, say, 1 in. in sixteen miles. This accuracy constitutes a forcible protest against our present chain-standard differences, with their mean probable error of $\frac{15}{100}$ in. per chain, or 12 in. per mile.

The modern bases used for primary triangulation average about six miles, and do not exceed four hundred miles apart; for secondary, three miles base, one hundred miles apart; and, for tertiary (commonly called minor triangulation), one mile and a half base, and thirty miles apart. The cost of measuring these bases varies from, probably, not less than £400 per mile for $\frac{1}{20}$ in. per mile error to £30 per mile for $\frac{1}{2}$ in. per mile probable error.

These detail matters, however interesting, are perhaps out of place when dealing with the main question; so also the magnetic observations now undertaken by the New Zealand Survey Department; and in the same category come tidal measurements, which are necessary to geodetic accuracy, and here as yet are inadequate. Wellington, Westport, and Greymouth represent the South at present, while it requires tide-gauges at the Bluff and Akaroa to complete the surround and establish the necessary reference to "mean sea-level" for the South Island; and the North Island would require similar attention.

The time has now arrived when the perfecting of our survey system has become necessary, and as we can, at small additional cost, largely advance the interests of science while doing so, we should endeavour to compass the two aims in one operation. Looking to what has been effected, to what is now being undertaken, and to what is in contemplation, it seems scarcely open to question that long before the middle of this century is reached all the pathways in the Southern Hemisphere available to geodesy will have been trodden, that the New Zealand arc will probably by then have been merged in a great Australasian arc extending from Cape York (11° S.) to Stewart Island (47° S.), and that the Commonwealth will also have contributed an arc of parallel from Perth to Sydney. The question now is, Is New Zealand, which takes "honours" in most subjects, prepared to seize the opportunity and step into the front rank of science.

Since writing the above I have perused quite a number of papers and reports on the question of a primary survey for New Zealand, of date 1875 or earlier, and chiefly to be found in vols. viii. and ix. of the "Transactions of the New Zealand Institute," and in the Appendices to the Journals of the House of Representatives down to and including vol. ii., 1875. All the writers agreed as to the necessity of an accurate governing triangulation, but some of them questioned the advisability of undertaking the work at that date—viz., twenty-six years ago. The two objections raised were—(1) The delays that would be caused if settlement surveys had to wait on primary surveys; and (2) the cost. The first objection has entirely disappeared, and the second is now largely modified. Mr. J. T. Thomson estimated the cost of a complete scheme of survey at £303,000; but he spoke of the work lasting seventy-five years, of the use of a 36 in. theodolite, requiring twenty-seven men for its transport, and other expensive methods, all of which have been rendered obsolete by the use of modern appliances. In 1875 Major Palmer (then late of the Ordnance Survey of Great Britain, and who came to the colony in charge of the Transit of Venus Expedition) estimated the cost at £100,000. With the scientific advances made in the last quarter of a century in the instruments required, our greatly improved means of access, our topography practically complete, and our principal points mapped, it is obvious that even the latter estimate of cost would now be deemed excessive, and also that the cost of a precise survey for New Zealand cannot be appreciably reduced by any further delay. In 1875, the date of Major Palmer's report, our uncontrolled triangulations were only in progress. They have since been carried all over the colony, thereby widely extending the area of our unascertained errors, and consequently intensifying the value of Major Palmer's advice and warnings. I cannot do better than conclude by quoting, from this high authority, his summary of our triangulations*: "The work of the triangulations has been done piecemeal, and each piece in a different way. It rests on a multiplicity of bases and standards, and on separate determinations of true meridian and geographical position. You have disjointed details of good enough quality in themselves, but as yet no means of piecing them together. To put them to their full uses it will be necessary to bring the whole within the grasp of one exact and comprehensive system, and to refer them to a single standard of length and a single starting-point."

* App. Jrnl. House of Representatives, 1875, vol. ii., H.-1, p. 24.

Art. LXII.—*On the Tracks of Captain Cook.*

By Professor E. E. Morris, M.A., Litt.D., Melbourne University.

Communicated to the N.Z. Institute by Sir James Hector.

In January last it was my good fortune to be able to take a holiday in the North Island of New Zealand. South New Zealand I knew pretty well; but, beside the fact that the ground was new to me, I had another reason for choosing the North Island. For some years, in vacations and at odd times, I have been a close student of the great voyage of Captain Cook in His Majesty's barque "Endeavour." In the North Island and in one part of the South Island most easily approached from Wellington are the places where Cook landed, where he was compelled to fight the Maori, where later he had peaceful intercourse with them, and received lessons in geography. On the first voyage he circumnavigated the South Island at topmost speed.

Perhaps I am strangely constituted, perhaps my education was neglected, but I derive no pleasure from shooting nor from fishing. A hobby makes a holiday pass pleasantly, and I determined to visit places visited by the "Endeavour," many of them well off the tourist track. Partially I succeeded in my quest for information. Being endowed with a love for history, and living in a land where it is thought nothing truly historical can be found, I have in other vacations sought scenes of Australian history now four generations old; nor has the search been wholly barren. Once I travelled to North Queensland to see the spot where the "Endeavour" was beached, the first kangaroo shot, and the first aboriginal vocabulary obtained. Some way inland from the last stopping-place of the steamer before Cooktown there is a magnificent waterfall to be seen, and the captain thought me strange indeed because I preferred Cooktown with historic memories to the Barron Waterfall.

Sydney was still making history when I left it, still splendidly celebrating the inauguration of the Commonwealth. I did not stay to witness the acting of the landing of Cook at Botany Bay. To have remained to see it would have involved me in the loss of a week, and one could not but entertain a doubt whether the acting was quite worthy of the occasion. The place itself I knew, though few Sydney residents visit the south shore, which, indeed, is difficult of access. They are satisfied with La Perouse. I trust it was not conceit to hold that my own imagination could better supply the scene of the landing than actors reciting blank verse, astonished Queensland blacks, and a crowd somewhat inclined to jeer. Accounts in the newspapers seemed to represent the affair as better than was expected ; accounts of private friends varied, some even rising to violent condemnation.

Before my luggage had passed through the Wellington Customhouse I was inquiring how to reach Queen Charlotte Sound, and a telegram was sent to a man in the sound, owner of a steam-launch. It is easy to reach Picton, easy to see Ship Cove from the deck of the Nelson steamer, but not so easy to make any closer inspection. Next morning a swift steamer of the Union Company carried me across Cook Strait, up Tory Channel, as to which the geography of some prominent Wellingtonians on board was rather at fault. A shock awaited me at Picton, where the settler with the launch was not, and at his home no telegram could reach him, so that things looked like a stay of three days in Picton. But in a few hours the settler turned up and carried me in his launch down to Dryden Bay, reaching which, shortly ere midnight, I slept at his house, and the next morning the way to Ship Cove was clear.

The part of Queen Charlotte Sound connected with the name of Cook is the part nearest to the mouth. Five times Cook visited Ship Cove—once in the first voyage, no fewer than three times in the second, when he made it his *point d'appui* for attacks on the Antarctic, and once in the third. It may well be considered Cook's special part of New Zealand. He surveyed it carefully in the first voyage. A map of it is given by Hawkesworth.

In all the eight volumes labelled "Cook's Voyages" (though one of them is an account of voyages before Cook) there is only this one chart given of Queen Charlotte Sound, at page 374 in Hawkesworth's second volume. On this chart the names given on the western side are "Canibal Cove" (*sic*), "Ship Cove," "Shag Cove," and "West Bay." Other names in the map are the two islands Motuara and Long Island, and, upon the eastern side, "East Bay," "Long Point," "Grass Cove." All names beside these nine are later than the "Endeavour" voyage. Rumour ran that the name "Cannibal Cove" is not relished by the residents ; but it would be a pity now to change a name so historical. Here is what Cook said : "Soon after we landed we met with two or three of the natives, who not long before must have been regaling themselves upon human flesh, for I got from one of them the bone of the forearm of a man or woman which was quite fresh, and the flesh had been but lately picked off, which they told us they had eat. They gave us to understand that but a few days before they had taken, killed, and eat a boat's crew of their enemies, or strangers, for I believe they look upon all strangers as enemies. [Pleasant for the listening visitors.] . . . We told one of them that it was not the bone of a man, but that of a dog; but he, with great fervency, took hold of his forearm and told us again that it was that bone, and to convince us that they had eat the flesh he took hold of the flesh of his own arm with his teeth and made signs of eating."—(Wharton's edition of Cook's Journal, p. 183.)

Another log, never yet published, and now in Mr. Alexander Turnbull's library in Wellington, says, "One of them pick'd a man's arm-bone, quite unconcerned, before us."

On the second voyage Cook named Adventure Bay from the second ship of his little squadron, the one commanded by Tobias Furneaux. This is not marked in any of the charts published by him. "What is that cape called?" I asked, as we passed Adventure Bay. "Edgecombe Head," was the answer. This was the sergeant of marines on the "Endeavour." Cook described him as "very much of a gentleman"; and on Cook's recommendation, having obtained a commission, he was lieutenant of marines on the "Resolution" in the second voyage. The corresponding point is Marine Head, at the other side of the entrance to Adventure Bay.

Adventure Bay was the scene of the slaughter of the boat's crew from the "Adventure" in the second voyage, at a time when Furneaux had been unable to find Cook. The Englishmen had been eaten by the Maoris. Lieutenant James Burney found out the grim truth when he was sent ashore to investigate. The original of Lieutenant Burney's report is in the same valuable library in Wellington. Allusion is made to the story in Gibbon,* and doubtless fear of cannibalism was the reason why New Zealand was not earlier occupied.

When the "Endeavour" had been from Cape Turnagain round the north of New Zealand, and had come southward on the western side as far as the strait, Cook desired to find some quiet bay where he could careen her, for her bottom was foul. He anchored in what he calls "a very snug cove" in Queen Charlotte Sound, which on his chart he marked as "Ship Cove." There he found "excellent water, and, as to wood, the land here is one intire forest." No less than 300 lb. of different sorts of fish were caught, and all seemed

* "If in the neighbourhood of the commercial and literary Town of Glasgow a race of cannibals has really existed, we may contemplate in the period of the Scottish history the opposite extremes of savage and civilised life. Such reflections tend to enlarge the circle of our ideas, and to encourage the pleasing hope that New Zealand may produce in some future age the Hume of the Southern Hemisphere."—(Gibbon, "Decline and Fall," chap. xxv.)

in clover, so that a stay was made in Ship Cove lasting a little more than three weeks. "The land here" is no longer an entire forest. The traveller cannot but lament the great destruction of trees all along the beautiful shores of Queen Charlotte Sound. Close settlement has made the cutting-down of the trees necessary, and much of the clearing is of very recent date. "You want scenery, we want grass," was the retort made by a settler to me on pointing out to him the harm that was being done. The Government of New Zealand has very wisely made a reserve of 20,000 acres of land round Ship Cove; but that reserve runs a great risk of destruction by fire. It would probably be judicious if a broad belt were cleared round it, especially at the back, away from the water, so as to prevent mischief from any bush-fire that may break out on neighbouring lands.

Ship Cove is, what Cook called it, "a snug cove" indeed, lying not far from the entrance to Queen Charlotte Sound, which runs fully twenty miles to the south, with varied outline and gently swelling hills, once timbered to the shore, and with many inviting coves and bays. Ship Cove is all but land-locked: from the head of it, Cook's landing-place, only a narrow opening is visible to the north-east. The Government has now rightly reserved the land close around the cove, but about a generation ago a few acres (perhaps 30) near the landing-place were partly cleared and cultivated; hence there are a few cherry-trees, and a few garden flowers run wild, together with some other trees that do not belong to the native bush. Nature, with prodigal hand, has repaired the destruction of the timber; and the tree-ferns are abundant and beautiful. At a spring not far from the shore the water is excellent. This is the place where Mr. Banks heard the bell-birds, and Hawkesworth adopted his description (with little changes that are not improvements) in a passage as famous as any in the once well-known account of the voyage. This is how it stands in the manuscript. Even Sir Joseph Hooker, in printing it, has varied the wording: "This morn I was awak'd by the singing of the birds ashore, from whence we are distant not a quarter of a mile. The numbers of them were certainly very great, who seem'd to strain their throats with emulation. Perhaps their voices were the most melodious wild musick I have ever heard, almost imitating small bells, but with the most tuneable silver sound imaginable, to which maybe the distance was no small addition. On inquiring of our people, I was told they had observed them ever since we have been here, and that they begin to sing about one or two in the morn, and continue till sunrise, after which they are silent all day, like our nightingales."

Alas, there are no bell-birds now! Between 1 and 2 in the morning I was at the neighbouring Dryden Bay, and none woke me, though I hoped they would. So unknown are the birds that the settler who guided me to Ship Cove would have me believe that the tui was the same as the bell-bird, which is not exactly correct; but it seems unfortunately true that by far the larger part of the British population of New Zealand has never heard the birds that charmed the ears of Mr. Banks. Many other New Zealand birds—the kea and the kaka parrot—are disappearing, and the most characteristic trees and flowering-shrubs threaten soon to vanish likewise.

While the "Endeavour" lay at Ship Cove Cook made a trip up Queen Charlotte Sound for the purpose, never absent from his mind, of surveying and exploring. With a single seaman (name not recorded) he climbed a hill, and came down radiant. "While Dr. Solander and I were botanising," wrote Banks, "the captain went to the top of a hill, and in about an hour returned in high spirits, having seen the eastern sea and satisfied himself of the existence of a strait communicating with it, the idea of which has occurred to us all, from Tasman's as well as our own observation." This account of Cook's "high spirits" by another is perhaps more vivid than his own account of his "abundant recompense for the trouble in ascending the hill." What a subject for a New Zealand painter or a poet! The noble lines of Keats may suggest the treatment:—

> Or like stout Cortez, when with eagle eyes
> He stared at the Pacific, and all his men
> Looked at each other with a wild surmise,
> Silent, upon a peak in Darien.

Is the glory of these lines diminished by the knowledge that Cortez never had the opportunity of staring at the Pacific from a peak in Darien? The story is true of another—Vasco Nunez de Balboa.

The hill that Cook ascended is not yet ascertained, but it must be ascertainable. May I commend the problem to Wellington men as an object for a holiday trip to the sound? A little leisure would be needed, and a disposition to scramble upon hills. My own belief is that the hill must lie between Tory Channel and Picton. Cook says that, making for the head of the sound—that is, towards Picton—they had rowed between four and five leagues, and, "finding no probability of reaching it, or even of seeing the end, the wind being against us and the day already half-spent, we landed at noon on the south-east side, in order to try and get upon one of the hills to view the inlet from thence. I took one hand with me and climbed up to the top of one of the hills; but when I came there I was hindered from seeing up the inlet by higher hills, which I could not come at for impenetrable woods." All this, and more, is to be found in Wharton at page 185. If I could fire some young men of Wellington to find the exact hill-top, I should be glad to subscribe for a cairn or other monument to mark the spot.

It was on Motuara that Cook obtained the lesson in geography from an old man, when he gained the names "Eaheinomauwe" and "Tavai Poenammoo."* These names have been explained so often that no further talk about them is needed here.

As our launch turned to leave Ship Cove a head wind arose, and it afterwards became a gale. The launch was small, so small that the man managing it could with one hand steer and with the other stoke; but she was an excellent sea-boat. The waves rose high, and things were not exactly comfortable. Sometimes for a quarter of an hour, though with full steam on, the boat made no progress. A special inconvenience introduced me to a new word—viz., the "willy waughs,"† brief gusts of wind that blew across the sound, carrying spindrift with them. Sometimes, crossing the mouth of a bay, we caught these gusts full and were well-nigh drenched. It took nearly eight hours to return to Picton; but luckily the Nelson steamer was delayed loading and I obtained the last berth on board, in the most untoward place, right up in the bows, quite a "fo'c'sle hand," but, being wet through and having naught but pyjamas to change into, early bed was necessary for me. In the middle of the night the steamer left the mouth of Tory Channel, and within one minute the tossing was such that all pride as to being a good sailor had left me, who yet have been round the world without seasickness.

In Wellington I was assured that "willy waugh" was a Scotch word, also that it was a corruption from the Maori "wirriwa," which I later found did not exist. On my return to my dictionaries in Melbourne I found the word in the Standard as Patagonian. "Willi-wa, a violent wind from mountains in the fiords of Patagonia." An this be true (and I can find no more about it), by what process, through what book, did the word pass from Patagonia to Queen Charlotte Sound? The "willie-waught" of "Auld Lang Syne" means a draught of liquor, a long drink, not a sprinkling of wet externally.

Wellington was most hospitable, but Cook was never there. I found a splendid library in the hands of a private collector (Mr. Alexander Turnbull), and I saw two or three books of Cook literature unknown to me before. From Wellington to

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* Spelling copied from Cook's chart.

† Thus was I instructed to spell.

Napier I travelled by rail. May I say here that, if any reader of this has a picture of Cape Palliser or Cape Turnagain, I should esteem it a great favour to be supplied with a copy?

At Napier a legend runs that Cook sailed round Scinde Island, a feat which, the legend is good enough to add, could be performed in those days, though now it would be necessary to drag the vessel overland. No foundation for the story can be found in any of the records about Cook, and it does not seem likely that the island was even then more than a nominal island. The most interesting place of Cook memory near Napier is Cape Kidnappers, the place where the "Indians," as he and his companions called the Maoris, as well as South Sea Islanders, aborigines of Australia, and natives of Tierra del Fuego, tried to kidnap Tayeto, the boy from Tahiti, brought by Tupaia to keep him company. An amateur photographer took for me a splendid picture of this cape.

At Napier it was my good fortune to meet the Bishop of Waiapu, who has written, in vol. xxi. of the "Transactions of the New Zealand Institute," 1888, a topographical paper which is of the greatest value for any one following the footsteps of Cook in New Zealand. If I may venture to say so, that paper should be followed by similar papers by residents at Mercury Bay, at the Bay of Islands, and by some historically minded Wellington member on Queen Charlotte Sound. A short time hence it will not be so easy as now to give full information. The bishop committed his knowledge to paper in the nick of time. Changes were even then beginning, in the nature of wharves and harbour-works, whereby the shape of the mouth of the river where Cook landed has been altered almost beyond posterity's recognition. The only drawback to the value of the paper is that, being published before the appearance of Cook's own journal, edited by Admiral Wharton, and the journal of Mr. Banks, edited by Sir Joseph Hooker, the bishop was compelled to use Hawkesworth as his main authority. For the account of the first landing of Cook in the land of the Maoris the bishop's paper is indispensable.

On my leaving Napier an incident occurred which wears a comic aspect. Napier was the home of the late Mr. Colenso, the well-known Maori scholar. Having seen sundry remarks of his about traces of Cook quoted in books, I made inquiry what had become of his papers, and found that the bulk of them had come into the hands of a friend and admirer. A visit to this gentleman won speedily from him a promise that he would look through the papers and send me any printed documents that might be of service. Most kindly he began the search at once. I went on board the steamer at 8 in the evening. There were cricketers returning northward, there was a crowd, there was cheering. After the vessel had cast off, the gentleman, it seems, came breathless on the scene with a parcel of documents, and consulted the good-natured Irish policeman on the wharf, who promptly volunteered to fling the parcel on board. He flung, and it fell into the sea. "Oh! Mr. Constable," one is tempted to exclaim, "you little know the mischief you have done"; nor, indeed, do I, for I know not what was in the parcel that wasted its lore upon the waters of "Hawkes Bay."*

Morning found our steamer in Poverty Bay, Young Nick's Head on our left. It is often said that this was the first land of New Zealand that was seen by the men on the "Endeavour." It was pointed out to me by the bishop that the land seen must have been the higher mountainous land in the interior. Nor does Cook say that the head was the first seen: "At noon the south-west point of Poverty Bay, which I have named 'Young Nick's Head' (after the boy who first saw this land)." It has been noticed more than once that in the list of the "Endeavour's" crew no such name as Nicholas Young is to be found. In the journal kept by Parkinson, the artist to Mr. Banks, published by his brother just before the official publication by Hawkesworth, it is said that Young was the surgeon's boy. In a list of the servants that Mr. Banks intended to take with him on the second voyage, had he made it, the name of Nicholas Young figures; so that it is evident that Banks liked the sharp-sighted lad who first saw the land in New Zealand, and again the land when the ship was nearing England, which proved to be the Lizard.

Two lists of the "Endeavour's" crew have been printed—the one in the "Historical Records of New South Wales" (vol. i., part i., page 334), and the other in Admiral Wharton's "Cook"—and there are many discrepancies. Neither has Young's name. Perhaps boys were not among the souls counted on board.

From Napier I desired to make a trip to the Wairoa, but found the distance too far and the place too inaccessible. My desire was in honour not of James Cook, but of Robert Browning. "How rolls the Wairoa at your world's far end?" he asked in the "Guardian Angel" of his friend Alfred Domett, poet, Prime Minister, and the lay figure from which Browning painted his "Waring." This is the highest place in literature attained by the name of a New Zealand river, and I wished to be able to answer the question about the rolling; nor was my

* Cook spelt this name without the apostrophe. Sir Edward Hawke was First Lord of the Admiralty when the "Endeavour" left England. It is not known whether Cook had ever heard the story about Hawke's emphatic refusal to confirm Alexander Dalrymple in the command of the barque, when he said he would cut off his right hand rather than sign a commission for a civilian.

desire diminished by being told in Wellington that it was all a mistake, for Domett never lived near the Wairoa. The best authority to be found in Napier assured me that Domett was well known there in the early days, and that it was he that gave the streets their striking names.

At 8 in the morning the coach started from Gisborne for Tolaga Bay. It was a strange drive—for the most part along the shore, and generally in the water. The waves harden the sand, so that it is found more easy to drive the horses through the waves just as they are spent than altogether above their reach ; but driving along the water-line produces occasionally shrewd bumps over rocks. Almost all the rest of the road is steeply uphill or steeply downhill, as the road cuts off some rocky bluff which it would not be possible to round. Cook's Gable End Foreland was conspicuous, but deserves the name perhaps better as seen from the sea than from the shore.

Here a note may be inserted as to the spelling of the name "Tolaga." It has locally two variations — "Tolago" and "Tologa"—both wrong. "Tolaga" is the spelling of "Cook's Journal," of Hawkesworth, and of both Cook's charts—the large map of New Zealand and the small one of the cove with its immediate neighbourhood. "Tolaga" is not a native name, so that the spelling cannot have been corrected by Maori use, for the letter "l" is not used in the Maori language. The best Maori scholar would not venture on a guess what the mistake was; but another gave me "*Hautarake*," meaning "the wind is off the land." The question put to some Maori by Cook or by another was not understood, and a crooked answer was given. This is, however, pure guess.

At Tolaga, as at Ship Cove, it was advised that a steam-launch should be hired, and a fine launch was ready for hire. But at 4.30 in the morning I was roused with the news that the sea was too stormy for us to put forth, and arrangements were being made to find horses for a ride of about five miles over (partly) roadless country, when later tidings came that the wind was abating. Forth we went. At the bar of the little River Uawa there was a nasty jobble of the waters, and some heavy rolling just as the launch turned into the cove—naught else to complain of.

There are two special sights to visit, "Cook's Well" and what is locally known as the "Hole in the Wall." The Maoris, as the bishop tells, call the former "Tepaea's Well." Did Tepaea, as the Maoris call him, or Tupia (with long *i*) by the English, make out that he was in command of the expedition? He was a Tahitian priest able to interpret Maori. In Hawkesworth there is a map of Tolaga Bay, and it is quite evident that Cook's watering-place was not here. The name "well" is unfortunate. It is not a well at all, but a hole scooped out, at most 6 in. deep. This may have been made, as the Bishop of Waiapu suggests, by the boys of the "Endeavour," at a loose end for something to do. It is about 12 yards up a steep hillside. On the rocks around many names have been cut, amongst others the name "Cook." Not one of the other names can be recognised as that of any one else on board the "Endeavour." The name of Cook is cut pretty deep. It is hardly probable that the ship's boys would cut the name of their captain in this bold way; but whoever cut the name of Cook cut the date just underneath it, "1778." Now, it is certain that Cook's only visit took place in 1769, and the mistake of the date settles the question about the cutting of the name, which may, indeed, be some fifty years old, but hardly more. The other names are still more modern.

Whilst we were looking at the "well" a Maori shouted to us, and, when his words were interpreted, we understood that higher up the hillside there was something else connected by Maori tradition with the visit of Cook. Perhaps 15 yards higher up the hillside we found an oak cask wholly embedded in the ground to act as a catchment, and filled by a spring, the overflow from it passing down to the "well." On my return to Gisborne I was amazed to find that the discovery of this cask had been telephoned to the evening paper. On my return to Sydney and to Melbourne I was amazed to find that telegrams had appeared in papers of both of those cities; and now papers are reaching me from England scoffing at the discovery, which I never published at all, as I was sceptical from the first. In one story the cask had become a flask. One paper, very ignorant as to the surroundings, suggested that the cask had been put there in order that it might be found! After my return to Melbourne I received information from one of the party to the effect that the best-informed Maori in Tolaga declared that the cask had been put there by Te Kooti about a hundred years after the visit of the barque "Endeavour." The connection with the story of the massacre of 1868 makes the cask historically interesting, but not so ancient nor so interesting as a veritable Cook relic. Friends seemed to think that I had unearthed the cask and would bring it home with me. Had it been genuine that would have been wicked; as I thoroughly mistrusted the find it would have been silly.

The "Hole in the Wall" is a natural arch, a picture of which, drawn by Sydney Parkinson, appeared in Hawkesworth's book, and was much admired. Banks described it "as a most noble arch or cavern through the face of a rock leading directly to the sea." As the bishop points out, the measurements of Mr. Banks are not those of to-day. Such holes and arches are not uncommon along the coast; witness one near Cape Brett, to which Cook gave a name with a play in it not generally perceived. Sir Percy Brett was one of the Lords of the Admiralty. Because of the mistaken story that Percy is "pierce eye," the name was often then spelt, as by this sailor, "Piercy." The islet opposite Cape Brett having this curious hole in the rock Cook called "Piercy."

At Tolaga, Banks says, "among other nicknacks Dr. Solander bought a boy's top shap'd like what boys play with in England, which they [the natives] made signs was to be whipped in the same manner."

At Ship Cove, Queen Charlotte Sound, the Government has wisely made a reserve. Would it not be as well to reserve the land round the cove at Tolaga? It cannot now be very valuable, but in time it will be visited more and more, and it would be a shame to permit its appearance to be altered. It is not the plough that is to be feared so much as the cutting-down of timbers, from which a reservation now might save the land. The cove is sheltered on the east by an island. Residents were calling it "the Island," and only one knew its name—"Sporing's Island." Sporing was the secretary of Mr. Joseph Banks, and the reason why Cook named the island after him is given in Banks.*

From Tolaga I returned to Gisborne, and, with the bishop's maps and paper in my hand, surveyed the scene of the first landing in New Zealand. Nothing can be added to his account. The only addition that can be made to the early history of Poverty Bay is contained in a letter that, after my return to Melbourne, I wrote to a Gisborne newspaper. For the sake of record it is worth reprinting:—

To the Editor of the Poverty Bay Herald.

When I was in Gisborne a few weeks ago I was told that the inhabitants disliked the name of "Poverty Bay," given by Captain Cook. It is not for me to say a word with respect to the propriety of the change of a name to which history is attached, and not a brief history. But it may interest your readers to know that the great sailor

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*Quoth Mr. Banks: "While Mr. Sporing was drawing on the island he saw a most strange bird fly over his head. He described it as being about as large as a kite, and brown like one. His tail, however, was of so enormous a length that he at first took it for a flock of small birds flying over him. He who is a grave thinking man, and is not at all given to telling wonderful stories, says he judged it to be   yards in length." Before the word "yards" Banks has left a gap, as if intending to go and ask Sporing whether he could not take a yard or two off; but the writer never returned to fill the gap with a number. The proximate length of the tail is not known, but it is quite evident that there was much amusement on board about the bird, and so Cook named the island after the secretary, grave and thinking. Poor Mr. Sporing was amongst those who were taken ill at Batavia, and he died at sea a month after the "Endeavour" left that fatal port.

who, in 1769, landed for the first time in New Zealand at that bay thought at first of bestowing another name. He soon changed his mind, but the name that he first wrote down was "Endeavour Bay." "Cook's Journal" is preserved in the handwriting of Orton, the ship's clerk, but it was originally written by the captain on loose sheets. Most of these have perished, but a few have been preserved, and are now in the Australian Museum, at Sydney. On the fifth page, or on the front side of the third leaf, will be found the name that Cook first thought of giving, though he changed his mind before he sent on the rough draft to be copied by the clerk. I only found this out a few days ago, and this is the first time that I am publishing the fact.

At my suggestion the editor of *Town and Country* reproduced the passage on the 4th May, 1901, Mr. Etheridge, the Curator of the Australian Museum, kindly permitting.

From Gisborne I went north and made a visit to Rotorua, but the geysers did not play for me, nor were they soaped. About a fortnight later, however, the papers were full of descriptions of magnificent play. Perhaps I ought not to have yielded to the temptation to visit the hot lakes, but to have spent my time at Mercury Bay, and to have gone northward in the "Clansman." She starts every Monday, and the only Monday that I could have gone on that expedition to the Bay of Islands proved so stormy that I listened to the advice that urged me to stay in Auckland, nor tempt the stormy waves. I paid a visit to the Firth of Thames, and obtained a general idea of the Coromandel Peninsula, but the Town of Thames is more full of shares and poppet-heads than of memories of Cook.

Earlier in these notes it has been suggested that papers, based on local knowledge, should be contributed to the Proceedings of the New Zealand Institute on the history of Cook's visits to Mercury Bay and to the Bay of Islands. Now, it is quite possible that work of this nature has been already done, and published in local newspapers. If any reader of these words can find any such essays, the help will be gratefully received.

In connection with Cook's visits to New Zealand hardly anything is of more interest than the accounts preserved of what the Maori thought of their visitors. The difficulty in dealing with the information lies in the careless manner in which those who first met the survivors took down their statements. What the Maori said is often called "evidence." Now, every one knows that in obtaining evidence much depends on the questions put. Barristers are not allowed to lead a witness—that is, to suggest to him the answer that would be satisfactory. It will be as well to examine one or two cases of this evidence. The most important is that of Taniwha.

In the "Long White Cloud," a book that gives an admirable conspectus of the story of New Zealand, a short account is set down: "Among the tribe that lived at Mercury Bay when the 'Endeavour' put in there was a boy, a little fellow of about eight years old, but possessing the name of Horeta Taniwha (red-smeared dragon)—no less. The child lived through all the changes and chances of Maori life and warfare to more than ninety years of age. In his extreme old age he would still tell of how he saw Kapene Kuku—Captain Cook.* Once he told his story to Governor Wynyard, who had it promptly taken down. Another version is also printed in one of Mr. John White's volumes. They do not differ in any important particular." It is hardly necessary to give further quotation from a book so well known in New Zealand. Mr. Pember Reeves adds, "A more delightful child's narrative it would be hard to find." It will be noticed that he adduces two authorities. Where is the story as told to Governor Wynyard? A search through the bibliography of New Zealand gives no clue. Questions asked of librarians also drew a blank. Can any reader of this paper furnish the exact reference? It would be instructive to institute a critical comparison between the two accounts. The passages in White's "Ancient History of the Maori"† do not suggest that the author possesses a keenly critical faculty. He gives as two different accounts what is manifestly the same story, nor does he drop the slightest hint that the two are one. It would be certainly passing strange that two little boys should be living at Mercury Bay, one of whom was called Hore-ta-te Taniwha and the other Taniwha-Horeta; that both of them lived to be nearly ninety, and told yarns about Captain Cook closely resembling each other. Each tells the story of the man shot by Lieutenant Gore for cheating, one on page 127 and the other on page 130. If there had been two natives, and not one, it would surely have been noticed by the English who came into contact with them—as, for instance, by Colonel Mundy. Mr. John White brings forward no authority. The whole of his fifth volume is full of stories as if taken down from the lips of Maoris, and yet he never mentions who took them down, whether the Maoris gave them forth as continuous narratives, or whether some Englishman asked questions and afterwards wove the answers into a continuous story. In order to test the value of the evidence we ought to know the questions and who put them. After reading Mr. White with a critical eye a profound mistrust of all the stories came upon me. A child of seven sees a sight, and he

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* In White's "Ancient History of the Maori," p. 128, it is "Pene Kuku."

† Mr. Reeves quotes vol. v., p. 128; it should be pages 121 to 131.

tells about it for seventy-five years at intervals. Will the story come out in its main features the same or altered? Will they be, in Mr. Reeves's phrase, "photographed upon the retina of Taniwha's mind's-eye for three-quarters of a century"? Will his proud repetition of the story have been with embellishments or not? I ask the question in all good faith, as I desire that dwellers in New Zealand who know the Maori should weigh the grounds of my scepticism, and, if they can, remove it. Goethe, when old, wrote the story of his youth, and very charming it is; but he knew how deceptive are the mists of memory, and he called it "Dichtung und Wahrheit." How much *Dichtung* was there in the mind of Taniwha.

That lively writer Colonel Mundy, in his entertaining book "Our Antipodes,"* talks about the same Maori: "Taniwha, who must be about eighty-five years old, and seems nearly imbecile, is considerably over 6 ft. in height and extremely thin, with a physiognomy strongly Jewish—a type by no means uncommon to his countrymen. This old man describes Captain Cook as he saw him in the year 1769—a distant date for a living man to look back upon—and mimics a way he had of waving his right hand to and fro whenever he walked. The veteran, then a child of seven or eight years old, has no conception of the meaning of this strange gesture. It remains for us to guess. Our great navigator was sowing the seeds of Europe in the wilds of Ahina Maui—plucking them from his pockets and casting them on promising soil. The potato has never since failed the Maori—it has succeeded the fern-root as his staple food—the munificent bequest of 'poor Cooké,' as the natives call him."

This interesting passage is worth considering in detail. Is there any evidence that the barque "Endeavour" was provided with an unlimited supply of the "seeds of Europe." The sojourn at Tahiti had been long, and, had there been originally a store of miscellaneous seeds, would it have held out until Mercury Bay was reached? Did any of the flowers or grain come up? Cook certainly gave the Maori the potato, and at Mercury Bay, but the stock of potatoes must have been larger than anything else of the kind, for the potato was wanted as a food. Further, it may be noticed that potatoes are not sown, but planted. It cannot be believed that even on the second voyage, made after much talk in England about the duty of communicating the blessings of civilisation to those lacking them, Cook went about throwing seeds promiscuously into unprepared soil. Where Cook sowed

* In the single volume edition, at page 255. The first edition was published in 1852.

he had the ground dug first, and then he made a speech to the natives explaining the purport of what had been done either in the few words of the Tahitian language that he knew or through some interpreter. In the first voyage Tupaia acted as interpreter of Cook's meaning, as it was found that the Maori understood his language. Several of the officers also picked up much of this *lingua franca* of the South Seas. If Cook had this peculiar gesture, it is strange that no Englishman has described it. It may be mentioned that by a gun accident in Newfoundland Cook had lost the greater part of the thumb on his right hand. Lastly, why "poor Cook"? Surely not because of his death coming in an inglorious scuffle with the natives of Hawaii. By the whole life is a man judged, not by its chance end. Cook is dear to the hearts of his countrymen that know, and enjoys a magnificent heritage of fame.

Nor have we yet done with Taniwha. In a footnote to Brett's "Early History of New Zealand," a book that furnishes an excellent account of Cook's voyages as far as New Zealand is concerned, as well as of the early history generally, it is written: "Mr. C. O. Davis writes, 'Taniwha said, "I was as tall as this person" (pointing to a European between fourteen and sixteen years of age) "when I visited the ship of your ancestor Cook. There were several natives in company with myself, and while we were feasting our eyes on the wonderful things we saw for the first time Captain Cook came forward and patted me on the head. We were very friendly with the people of the ship while they remained among us."'" No clue is given where Mr. Davis wrote this; but, if Mr. Davis be correct, Taniwha must have been about a hundred when Colonel Mundy saw him and thought him senile, though on seeing some English officers engaged in singlestick he challenged one, and, contrary to all the rules of the game, dealt his opponent a doughty lunge instead of a blow. It would be interesting to ascertain the truth about Taniwha, but it is probably now impossible. The carelessness of the recorder is the main difficulty standing in the way.

In Brett, at page 19, are two footnotes following each other marking the careless annalist. From the "New Zealand Pilot" (no other reference): "Several initials are cut on the rock where the artificial well exists, made by his crew." Never a doubt expressed! In the second note, from Colenso: "Here [at Tolaga], near the south-east headland of the bay, Cook dug a well for the supplying of his ship with water, which well is shown to this day by the natives." That is not written on knowledge, but is a shot based on the name "well." "Dug" here is hopeless.

This carelessness and the omission of references is most bewildering to the student, who only desires to reach the truth. Another instance of a Maori's evidence is given in a footnote to Brett at page 28: "Patuone stated that he was at the Bay of Islands when Cook was a visitor. His statement was"—and then it follows; but the author who adduces that statement does not tell us where he found it, when it was made, how old Patuone must have been, whether he was truthful or not. For my part, I have no desire to pose as a Niebuhr destroying the value of the Maori evidence, but the constant carelessness with which it is cited is a drawback to its use.

May I finish with a bold suggestion? The Government of New South Wales has been enlightened enough to issue a series of volumes of "Historical Records of Early Australian History," which will prove invaluable to the future historian. In the case of New Zealand there is so great a gap between the early voyages and the later occupation that a single volume would probably suffice for all the records that can now be secured prior to 1820. But a volume of value could be made, including the parts of Tasman's Voyage, in Dutch and translated; extracts from the various logs and journals of the "Endeavour," as far as New Zealand is concerned; the same for Cook's two later voyages; the accounts of Marion's voyage, and of De Surville's. A nation should, at national cost, publish its *origines;* and there are several residents of New Zealand more than competent to edit a volume like vol. i., part i., of the "Historical Records of New South Wales." Copies of the logs would have to be taken in London, and New Zealand is fortunate in being represented there by a man of letters, who would assuredly help in the matter.

In many respects the Government of New Zealand is the most enlightened and progressive in these southern seas, and I feel the impropriety in one not subject to it making suggestions as to what it should or should not do, especially when they imply expenditure. But I have ventured to make suggestions in this paper, and should like now with due respect to recapitulate them. They are three:—

(1.) To clear a belt against fire round Ship Cove.

(2.) To reserve the land round Cook's Cove, Tolaga Bay.

(3.) To publish a volume on the earliest history of New Zealand, with extracts from the logs of the ships that visited it, especially between 1769 and 1780.

ART. LXIII.—*Hand-list of certain Papers relating more or less directly to the Maori Race, and published in various Publications.*

By A. HAMILTON.

[*Read before the Otago Institute, 9th October, 1900.*]

THIS collection of titles of papers and publications of one kind and another makes no pretence to be a bibliography of the subject. A proper and complete bibliography would be an undertaking far beyond the scope of this list. So far as I have been able during the preparation of "Maori Art," I have noted down for reference the various articles which bear more or less directly on the subject, and at the close of the work it occurred to me that subsequent workers in the same field might deem it an advantage to have a reference-list of those authors who have contributed items of information, very often of considerable value, but which, perchance, lie buried in the dusty depths of the local "Eatanswill Gazette." Some of these I have dug up and recorded in their place, and I have, as far as possible, gathered together the titles of the ethnological papers in the "Transactions of the New Zealand Institute" and in other serial publications. It is in these Proceedings and Transactions of learned societies that we have to look for the work of many of the best workers in the field of ethnology. As a typical instance, we may take the case of the late Rev. W. Colenso, F.R.S., who, although he was a most voluminous writer on many subjects, never published any book on the Maori lore with which his mind was stored, all his Maori writings being scattered up and down in the pages of various Transactions and newspapers.

At some future date it would be a convenience to research to have a subject-index compiled from these papers, but at present it is out of my power to attempt such a task. As a rule I have excluded anything that might be called a "book," as these are to be found in various library catalogues and bibliographies. I have included, however, some small local and private publications which might come under this heading, for various reasons which seemed to me sufficient. There are, besides the items listed, many interesting "Notes and Queries," with their replies, in the volumes of the "Polynesian Journal," and a number of articles in home magazines such as the *Leisure Hour*, *All the Year Round*, &c., which I have not read, but of which I have a list extracted from the volumes of Poole's Index. There are also numerous letters and notices in colonial newspapers, parliamentary papers, &c. I now offer my list to the Institute as a small contribution towards the furthering of the study of the Maori race.

[NOTE.—In the following list "Trans." means the Transactions of the N.Z. Institute.]

Author.	Title.	Volume.
Adams, J. ..	Polynesia	Trans. ix. 44.
Agate, A. T. ..	In the Narrative of the ..	U.S. Exp. Exp. ii. 279, 1845.
Allen, F. A. ..	The Original Range of the Papuan and Negrito Races	Jrnl. Anthrop. Inst. viii. 38, 1879.
Alexander, General Sir J. E.	Incidents of the Maori War, 1860–61	1863.
	Bush Fighting in the Maori War from 1863–66	1873.
Angas, G. F. ..	Savage Life and Scenes in Australia and New Zealand	2 vols. 1st ed. Lond.; 2nd ed. Lond. 1847
Anonymous Reviewer	The Mythology of Polynesia ..	Quart. Rev. April, 1862.
Atkinson, A. S. ..	What is a Tangata Maori? ..	Jrnl. Pol. Soc. i. 133.
	The Aryo-Semitic Maori ..	Trans. xix. 552.
	Criticism on Mr. E. Tregear's Maori-Polynesian Comparative Dictionary, Parts I., II., and III. (Titles only)	" xxv. 567.
	Appendix to Notes on above (Title only); also Resolution as to	" xxvii. 692.
Aro, Te	Te Patunga o Mokonui (the Slaying of Mokonui): Transl. by Elsdon Best	Jrnl. Pol. Soc. iii. 170.
B (Exeter) ..	New Zealand Topographical Nomenclature	N.Z. Jrnl. i. 133.
Haker, W. B. ..	On Maori Popular Poetry ..	Trans. Ethn. Soc. Lond. n.s. i. 44.
Bennett, G. ..	Uber eine bituminose Substanz, welche von N.Z. *Mimiha* gennant, und von ihnen als ein Kaumittl gebraucht wird (Transl.)	Froriep: Notizen, xxxi. 260, 1831.
Hest, Elsdon ..	Stockades and Earthworks in New Zealand	American Antiquarian, xvii. No. 3.
	Waikare Moana, the Sea of Rippling Waters . . . with a Tramp through Tuhoe-land (Wellington, New Zealand)	Govt. publication, 1897.
	The Tree-fort of the Muaupoko Tribe of Maoris at Whakahoro	Jrnl. Pol. Soc. ii. 86.
	Notes on Maori Mythology ..	" viii. 93.
	Te Rehu o Tainui	" vi. 41.
	The Maori and the Moa ..	" v. 121.
	Omens and Superstitious Beliefs of the Maori, Part I.	" vii. 137.
	Ditto, Part II.	" vii. 233.

Author.	Title.	Volume.
Best, Elsdon ..	The Kiore Maori, or Native Rat	Jrnl. Pol. Soc. vii. 47.
	Tuhoe-land: Notes on the Origin, History, Customs, and Traditions of the Tuhoe or Urewera Tribe	Trans. xxx. 33.
	The Art of the Whare Pora: Notes on the Clothing of the Ancient Maori, &c.	„ xxxi. 625.
	Maori Origins	„ xxxii. 294.
	Sketches from Tuhoe-land: "How we Fought the Pakeha at Orakau," and many other sketches	Otago Witness, 18/2/1897.
	A series of valuable papers full of valuable information on forest lore, &c.	Canterbury Times, 1898–1900.
Broughton, W. G.	Visit to New Zealand, with an Account of the Church Mission	1840.
Beecham, Rev. J.	On the Association for colonising New Zealand	1838.
Bourke, Sir R. ..	Despatch to Lord Glenelg on the affairs of New Zealand	1838.
Barstow, R. C. ..	Stray Thoughts on Mahori Migrations	Trans. ix. 229.
	Our Earliest Settlers ..	„ xv. 421.
	The Maori Canoe	„ xi. 71.
Brown, Rev. G. ..	Papuans and Polynesians ..	Jrnl. Anthrop. Inst. xvi. 311.
Brown, W. ..	New Zealand and its Aborigines	(See Turton), 1845
Bruce, R. C. ..	On a Maori Waiata	Trans. xxv. 426, 533.
Brulfert, M. ..	Sur l'Origin et la Disparition de la Race Polynésienne	Le Chirurgie, Paris, 1872.
Blyth, W. H. ..	On the Whence of the Maori ..	Trans. xix. 515.
Buckland, F. T...	New Zealand Warrior Chiefs ..	Curiosities of Natural History, 2nd ed. 57
Buller, Sir W. ..	The Decrease of the Maori Race	N.Z. Jrnl. Sci. ii. 55.
	The Story of Papaitonga, or a Page of Maori History	Trans. xxvi. 572.
	Note on a Remarkable Maori Implement in the Hunterian Museum at Glasgow	„ xxvi. 570.
	Presidential Address, Feb., 1884	„ xvii. 443.
	Note on a curious Maori Flute n the Collection of the late Dr. Shortland	„ xxvi. 570.
	Eels, from a Maori Point of View (see discussion on a paper on eels by E. O'H. Canavan)	„ xxv. 525.
	Notes on *Mus maorium*, Hutton	„ xxv. 49.
	Notes on a *Kapu*, or Carved Funnel, and a *Kaea*, or Maori War-trumpet	„ xxv. 527.
	On the New Zealand Rat ..	„ iii. 1.

Author.	Title.	Volume.
Buller, Sir W. ..	Sir Walter Buller at the Bar of the House, and the History of the Horowhenua Block	Wellington, 1895.
Bunbury, Major..	Report on the Middle Island of New Zealand and other Parts of New Zealand (28th June)	N.Z. Jrnl. i. 233, 1841.
Chamerozow, L. A.	The New Zealand Question and the Rights of Aborigines, with Appendix	London, 1848.
Cameron, A. M. ..	On the Rock-paintings in the Weka Pass	Trans. xi. 154.
Campbell, R. E. M.	Cremation among the Maoris	Jrnl. Pol. Soc. iii. 134.
	The Captive's Escape: Told by Takurua to Tangiharuru	„ iii. 140.
Chapman, F. R. ..	On the Working of Greenstone, or Nephrite, by the Maoris	Trans. xxiv. 479.
	Further Notes on Greenstone..	„ xxv. 560.
	Remarks on Te Puohu's Raid..	„ (Proc.) xxxii. 439.
	Koruru, the Maori Game of Knuckle-bone	Jrnl. Pol. Soc. vii. 114.
	Governor King's Visit to New Zealand, 1793	„ vii. 42.
Chaffers, E. M. ..	Chart of Port Nicholson, New Zealand, 1839	Publ. by J. Wyld, Charing Cross, 1840.
Cheeseman, T. F.	Description of a Collection of Maori Articles bequeathed to the Museum by the late Mr. C. O. Davis	Trans. (Proc.) xx. 458.
	Description of the Carved House at Maketu (now in the Auckland Museum)	„ xxvii. 674.
Clarke, F. E. ..	Triangular Teeth amongst Maoris	Jrnl. Pol. Soc. No. 2, ix. 121, 1890.
Colenso, W. ..	On the Maori Races of New Zealand (New Zealand Exhibition Essay, 1865)	Trans. i. n.e. 339.
	On the Day when Captain Cook took Formal Possession of New Zealand	„ x. 99.
	On the Ignorance of the Ancient New-Zealanders of the Use of Projectile Weapons (see also remarks by F. C. W. Sturm, "Proceedings," p. 570)	„ xi. 106.
	Contributions to a Better Knowledge of the Maori Race. Part I.: Legends; Myths and Fables; The Ideality of the Ancient New-Zealander	„ xi. 77.
	Contributions towards a Better Knowledge of the Maori Race. Part II.: On the Ideality of the Ancient New-Zealander; Proverbs and Proverbial Sayings	„ xii. 108.

Author.	Title.	Volume.
Colenso, W. ..	A Few Remarks on a Cavern near Cook's Well, at Tolaga Bay, and on a Tree (*Sapota costata*) found there	Trans. xii. 147.
	On the Vegetable Food of the Ancient New-Zealander before Cook's Visit (see "Proceedings," p. 456)	" xiii. 3.
	Contributions towards a Better Knowledge of the Maori Race. Part III.: On their Poetic Genius	" xiii. 57.
	Historical Incidents and Traditions of the Olden Times, &c., Part I.	" xiii. 38.
	Ditto, Part II. (see p. 565: bone spade)	" xiv. 3.
	Contributions towards a Better Knowledge of the Maori Race. Part IV.: On their Myths; *re* Kumara Plant	" xiv. 33.
	On the Fine Perception of Colours possessed by the Ancient Maori	" xiv. 49.
	Addendum to the above (see "Proceedings," p. 566)	" xiv. 477.
Colenso, Rev. W.	Address on the various Legends and Stories current among the Maoris relating to the Sea and Sea-monsters	" xviii. 434.
	Ancient Tide-lore and Tales of the Sea from the Two Ends of the World. (Also published, with additions, under same title at Napier.)	" xx. 418.
	Vestigia, Reminiscences, Memorabilia of Works, Deeds, and Sayings of the Ancient Maoris	" xxiv. 445.
	Observations on Mr. T. White's Paper "On the Native Dog of New Zealand"	" xxv. 495.
	Remarks on the Anniversary of Cook's Arrival at Hawke's Bay	" xxvi. 683.
	Notes and Reminiscences of Early Crossings of Lake Waikaremoana, &c., 1841 and 1843	" xxvii. 359.
	The Modern History of a Block of Greenstone	" xxvii. 598.
	Fiat Justitia, being a few Thoughts respecting the Maori Prisoner Kereopa	Privately published, Napier, 1871.
	Fifty Years Ago in New Zealand, &c.	Ditto, 1888.

Author.	Title.	Volume.
Colenso, Rev. W.	"In Memoriam," being Two Papers on various Crossings of the Ruahine Mountains in 1845 and 1847	Published by subscription at Napier, 1884.
	The Authentic and Genuine History of the Signing of the Treaty of Waitangi	Government publication, Wellington, 1890.
	Three Literary Papers: I. and II., Nomenclature; III., On "Macaulay's New-Zealander"	Privately printed, Napier, 1883.
	Memorabilia of certain Animal Prodigies	Trans. xxviii. 87.
Collingridge, G. ..	Supposed Early Mention of New Zealand	Jrnl. Pol. Soc. v. 123.
Collinson ..	Plan of Ruapekapeka ..	United Service Magazine, 1846.
	Plan of Ruapekapeka, by a Native	The New-Zealander, Dec. 27, 1845.
Crawford, J. C. ..	On Maori Ancestry	Trans. xx. 414.
	The Maori Language, with Remarks on the Reform of English Spelling	" xviii. 46.
	Notes on the Miramar Peninsula, Wellington. (Maori History of the Peninsula, by Manihera.)	" v. 396.
	On the Orthography of the Maori Language (Abstract)	" i. 444.
Crawford, J. ..	On Cannibalism in Relation to Ethnology	Trans. Ethn. Soc. n.s. iv. 105.
	On an Ancient Hindu Sacrificial Bell with Inscription, found in the North Island of New Zealand	Ditto, v. 150.
	The Malayan and Polynesian Languages and Race	Jrnl. Ethn. Soc. Lond. i. 330, 1848
Curl, Dr. ..	Australian Cave-paintings (W.P.S., Feb., 1885)	N.Z. Jrnl. Sci. ii. 399.
Dalrymple, A. ..	A Scheme of a Voyage for the Conveyance of Domestic Animals, Corn, Iron, &c., to the Cannibals of New Zealand, with Dr. Benjamin Franklin's Sentiments on the Subject	1771.
Darnell, B. H. ..	Note on the Remains of a Stone Epoch at the Cape of Good Hope (to point out the Similarity of the Chert Flakes, found in New Zealand with Moa-bones)	Trans. iv. 157.
Davis, Rev. R. ..	Thirty-nine Years a Missionary in New Zealand, 1823–63	1865.

Author.	Title.	Volume.
Dieffenbach, Dr...	Extract from a Report by, to the New Zealand Company respecting the Physical Condition and Natural History of Queen Charlotte Sound, Cloudy Bay, Tory Channel, Port Nicholson, &c. (Sec., The Aborigines)	N. Z. Jrnl. i. 6, May 5, 1840.
Eccles, A. ..	On the Discovery of New Zealand (Abstract)	Trans. (Proc.) iii. 65.
Enys, J. D. ..	An Account of the Maori Manner of preserving the Skin of the Huia	„ viii. 204.
D'Estrey, Meyners	Étude Ethnographique sur le Lézard chez les Peuples Malais et Polynésiens	L'Anthropologie, No. 6, iii.
Fairburn, E. ..	On the Analogy of the Maori and Indo-European Languages (Abstract)	Trans. iii. 313.
Fenton, F. D. ..	On the Necessity for a Good Maori Lexicon	„ xxvi. 667.
	Important Judgments delivered in the Compensation Court and Native Land Court, 1866–1879	Published by direction of the Chief Judge, Native Land Court, Auckland, 1879.
	The Native Race of New Zealand	Jrnl. Statis. Soc. xxiii. 508, 1860.
Field, H. C. ..	On the Shifting of Sand-dunes	Trans. xxiv. 561.
	Discoveries of Moa-bones ..	„ xxiv. 561.
	The Date of the Extinction of the Moa	„ xxvi. 560.
	On some Ancient Aboriginal Caches near Wanganui	„ ix. 220.
Fitzroy, Governor	Correspondence: Heke's Attack on Kororareka, with Plans	English Parl. Papers, 15th July, 1845.
Fitzroy, Admiral..	Outline Sketch of the Principal Varieties and Early Migrations of the Human Race	Trans. Ethn. Soc. Lond. i. 1.
Forbes, H. O. ..	Note on the Disappearance of the Moa	Trans. xxiii. 373.
Fox, Colonel A. L.	On Early Modes of Navigation	Jrnl. Anthrop. Inst. iv. 399.
	Notes on the Use of the New Zealand *Mere*	Jrnl. Ethn. Soc. Lond. n.s. ii. 106.
Fox, W. ..	Speeches of, before the Native Land Court at Otaki	1868.
	Rangitikei-Manawatu Purchase	Wellington, 1868.
Fraser, Rev. J. ..	The Malayo-Polynesian Theory, Part I.	Jrnl. Pol. Soc.
	Ditto, Part II.	Ditto, v. 72.
	„ Part III.	„ vii. 1.
Giglioli, Professor E. H.	Appunti intorno ad una Collezione Etnografica fatta durante il terzo viaggio di Cook, Part I.	Archiv. per l'Antrop. e l'Etnol. Firenze, xxiii. 173, 1893.
	Ditto, Part II.	Ditto, xxv. 1895.

Author.	Title.	Volume.
Giglioli, Professor E. H.	Le Età della pietra, nell' Australasia e specialmente alla Nuova Zelanda	Archiv. per l'Antrop. e l'Etnol. Firenze, xxiv. 99, 1894.
	Ossa umane portate come ricordi o per ornamento e usate come utensili od armi	Ditto, xviii. 1888.
	Di un singolare *tiki* Maori fatti con un frammento di cranio umani	„ xxvii. 381, 1897.
	La Lucertola . . . della Polinesia	„ xxi. 1891.
	Gli Heitiki dei Maori della Nuova Zelanda	„ xxii. 191, 1892.
	Su due nuovi Hei-tiki litici della New Zealand	„ xxiii. 1893.
Gibb, Sir G. D. ..	On a patoo-patoo from New Zealand (Abstract)	Jrnl. Anthrop. Inst. iii. 266.
Goodall, J. ..	On the Discovery of the Cut Stump of a Tree, giving Evidence of the Existence of Man in New Zealand at or before the Volcanic Era	Trans. vii. 144.
Grey, Sir G. ..	On the Social Life of the Ancient Inhabitants of New Zealand, and on the National Character it was likely to form	Jrnl. Ethn. Soc. Lond. n.s. i. 332, 1869.
	The Loves of Takarangi and Rau-mahora	Auckland Weekly Herald, Dec. 1896.
Gudgeon, W. E. (Judge)	The Maori Tribes of the East Coast of New Zealand, Part I.	Jrnl. Pol. Soc. iii. 208.
	Ditto, Part II.	„ iv. 17.
	„ Part III.	„ iv. 177.
	„ Part IV.	„ v. 1.
	„ Part V.	„ vi. 177.
	Maori Traditions as to the Kumara	„ ii. 99.
	Notes on the Paper by Timi Wata Rimini "On the Fall of Pukehina" and other Pas	„ ii. 209.
	A Maori Generation	„ ii. 113.
	Paoa	„ i. 76.
	Maori Deities (see Note 33, vol. ii., p. 127)	„ i. 30.
	A Sketch of the History of the Ngati-tama Tribe	„ ii. 157
	The Tangata Whenua, or Aboriginal People of the Central Districts of the North Island of New Zealand	„ ii. 203.
	Maori Migrations to New Zealand, No. 1	„ i. 213.
	Ditto, No. 2	„ iii. 46.
	Nga Tangata Maori : *Mana* ..	Monthly Review, No. 14, i.
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	„ VI.	„ iv. 161.
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	„ IX.	„ v. 131.
	„ X.	„ v. 195.
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	Barat or Barata Fossil Words	„ xi. 157.
	Pronouns and other Barat Fossil Words compared with Primæval and Non-Aryan Languages of Hindustan and Borders	„ xii. 23.
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	On the Track of a Word ..	„ xix. 482.
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	Curious Polynesian Words ..	„ xxiii. 531.
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	Maori Spirals and Sun-worship	Trans. xxxii. 284.
	A Name for a Spider ..	„ xxxii. 298.
	Notes on Maya and Malay ..	Jrnl. Pol. Soc. viii. 101.
	Kiwa the Navigator (collected by —— from Wi Pere)	„ viii. 111.
Travers, W. T. L.	Notes upon the Historical Value of the Traditions of the New-Zealanders, as collected by Sir George Grey	Trans. iv. 51.
	On the Traditions, Manners, and Customs of the Morioris	„ ix. 15; pt. ii. 621.
	On the Destruction of the Aborigines of Chatham Islands	Trans. Ethn. Soc. Lond. n.s. iv. 352.
	On the Life and Times of Te Rauparaha	Trans. v. 19.
	Notes on the Extinction of the Moa, with a Review of the Discussions on the Subject	„ viii. 58.
Turumeke, Ema ..	Narrative of the Battle of Omihi (Transl. by C. J. Harden)	Jrnl. Pol. Soc. iii. 107.
Turton, Rev. H. ..	Three letters to Bishop Selwyn on the native question	In N.Z. and its Aborigines, W. Brown, *q.v.* 1845.
Tylor, E. B. ..	Remarks on the Geographical Distribution of Games	Jrnl. Anthrop. Inst. ix. 23.
	Notes on the Asiatic Relations of Polynesian Culture	Ditto, xi. 401.
Vaux, W. S. W. ..	On the Probable Origin of the Maoris, or Native Inhabitants of New Zealand	„ v. 1875, 451.
	On the Probable Origin of the Maori Races	Trans. viii. 3.
Wade, Rev. W. R.	A Journey in the Northern Island of New Zealand, with Information about the Country and People	1842.
Wake, S. C. ..	The Papuans and the Polynesians	Jrnl. Anthrop. Inst. xii. 197.
Walton, J. ..	Twelve Months' Residence in New Zealand, containing a Correct Description of the Customs, Manners, &c., of the Natives of that Island, . . . by J. W., who resided in the Island during the Years 1837–38 (Glasgow)	Review of, in N.Z. Jrnl. i. 171. 1839.

Author.	Title.	Volume.
Wakefield, E. J. ..	Accounts of the New-Zealanders	Aborigines Protection Soc. (Third Rep.), 1846.
Walsh, Rev. P. ..	Maori Preserved Heads ..	Trans. xxvii. 610.
White, J. ..	A Chapter from Maori Mythology	Proc. Aust. Assoc. Adv. Sci. iii. 359, 1891.
Whitmer, S. J. ..	Mr. Wallace on the Ethnology of Polynesia	Contemp. Review, 1873.
	The Ethnology of Polynesia ..	Jrnl. Anthrop. Inst. viii. 261.
Tama-rau and Tutaka-Ngahau	Ko Hape-tu-ma-ki-te-rangi: the Story of Hape the Wanderer (Translated by Elsdon Best)	Jrnl. Pol. Soc. viii. 49, 1899.
Tutaka-Ngahau ..	He kupu mo runga i ta T. Tarakawa korero nei "Te Haerenga mai o Mata-atua i Hawaiki"	Jrnl. Pol. Soc. vii. 30.
	Translation by Elsdon Best ..	" vii. 32.
Tu Whawhakia ..	Te korero mo Whaki-tipua; mo Tu-taia-roa Hoki: the Story of Whaki-tipua and Tu-taia-roa	" v. 163.
	Translated by S. Percy Smith	" v. 155.
Te Whetu ..	Te patunga o Ngarara-Huarau: How Ngarara-Huarau was killed	" ii. 211.
	Te haerenga mai o Kupe i Hawaiki: the Coming of Kupe from Hawaiki to New Zealand	" ii. 147.
Te Whetu, Kaupa	Ko te patunga o te Kaiwhakaruaki: the Slaying of Kaiwhakaruaki (Translated by Elsdon Best)	" iii. 16.
	Kama-Tara and his Ogre Wife	" vi. 97.
White, T. ..	On the Relics of Captain Cook's Last Voyage	Trans. xxi. 397.
	On the Wild Dog of New Zealand	" xxii. 327, 552.
	On the Native Dog of New Zealand	" xxiv. 540.
	On the Maori Dog and the Dog Philological	" xxv. 564.
	Te Kuri Maori (the Dog of New Zealand): a Reply to the Rev. W. Colenso	" xxvi. 585.
	A Maori Pa at Lake Te Anau	" xxvi. 513.
	Extract from a Paper on the Rahui	Jrnl. Pol. Soc. i. 275.
	The Fleeing Maru-Iwi walk over the Glenshea Cliff at Night (Title only)	Trans. xxx. 586; xxxii. 363.
	The Ceremony of Rahui, Part I.	Trans. xxviii. 54.
	Ditto, Part II.	" xxxii. 352.
	A Maori Earthwork Fortification	" xxxi. 750; xxxii. 398.

Author.	Title.	Volume.
White, T. ..	A Maori Stronghold ..	Trans. xxxi. 750; xxxii. 397.
	Are they Old Kumara-pits? ..	" xxxi. 750; xxxii. 396.
	Moa and Toa—the Bird and the Tree	" xxxii. 344.
	About the Native Names for Places	" xxxii. 347.
	Te Reinga	Jrnl. Pol. Soc. vii. 178.
Williams, T. C. ..	A Letter to the Right Hon. W. E. Gladstone; being an Appeal on behalf of the Ngati-raukawa Tribe	1873.
	A Page from the History of a Record Reign (Wellington)	1899.
Williams, Rev. H. W.	Notes on the Construction of a Maori House	Jrnl. Pol. Soc. v. 145.
Williams, Archdeacon W. L.	On the Visit of Captain Cook to Poverty Bay and Tolaga Bay	Trans. xxi. 389.
	The Story of John Rutherford	" xxiii. 453, 618.
	Notes on a Paper by Mr. A. S. Atkinson, "What is a Tangata Maori?"	Jrnl. Pol. Soc. ii. 63.
	Names of Kumara (*Ipomœa batatas*) cultivated in New Zealand before the Arrival of Europeans	" iii. 144.
Williams, Bishop W.	Christianity among the New-Zealanders	Account of Marsden and Heke's War, &c., 1867.
Wilson, J. A. ..	Sketches of Ancient Maori Life and History	Reprinted from Auckland Star, 1894.
Wilson, Major ..	On the Korotangi, or Stone Bird	Trans. xxii. 499, 522.
Wohlers, Rev. J. F. H.	On the Mythology and Traditions of the Maori in New Zealand (Title only, Trans. N.Z. Inst. vi. 440)	" vii. 1; viii. 108.
	Maori Traditions in the Native Language (Title only)	" vi. 446.
	On the Conversion and Civilisation of the Maoris in the South of New Zealand	" xiv. 123.
	Myth of the Creation in New Zealand	Unitarian Review, vii. 557, 1876.
Winkelmann, H.	Notice of the Discovery of an Old Maori Wood Comb on the Great Barrier Island	Trans. xxii. 541.
..	..	Church Missionary Intelligencer, i. and ii. 1850–51.
..	Reports on New Zealand Missions at various Stations, with a number of illustrations.	
..	..	Church Missionary Atlas, 1873.

Author.	Title.	Volume.
..	Statistics of the New Zealand Mission from 1810 to 1873.	
..	Letters and Journals of Bishop Selwyn, 1842–48, including Account of the Kororareka Disturbance in 1845, Nos. 4, 7, 8, 12, 20	Church in the Colonies, the S.P.G. publication, 1846, *et seq.*
..	..	Missionary Register, 1836.
..	Many Details about the various Missions, but little of Ethnological Value.	

NEW ZEALAND INSTITUTE

NEW ZEALAND INSTITUTE.

Thirty-second Annual Report.

Meetings of the Board were held on the 20th February and 4th September, 1900.

Messrs. W. T. L. Travers, T. Mason, and Sir James Hector retired from the Board in compliance with the Act, and were all renominated by His Excellency the Governor. The following gentlemen were elected by the incorporated societies to represent them on the Board for the current year—viz., Messrs. S. Percy Smith, Martin Chapman, and the Hon. C. C. Bowen.

To the list of honorary members are added the names of Lord Avebury, Dr. J. G. Agardh, and Mr. George Massee, elected at the beginning of the year for distinguished service in connection with scientific work relating to New Zealand.

The members now on the roll are — Honorary members, 27; Auckland Institute, 153; Hawke's Bay Philosophical Society, 59; Wellington Philosophical Society, 144; Philosophical Institute of Canterbury, 70; Otago Institute, 107; Nelson Philosophical Society, 16; Westland Institute, 60: making a total of 636.

The volumes of Transactions now on hand are—Vol. I. (second edition), 230; Vol. V., 7; Vol. VI., 12; Vol. VII., 98; Vol. IX., 95; Vol. X., 125; Vol. XI., 25; Vol. XII., 29; Vol. XIII., 29; Vol. XIV., 50; Vol. XV., 163; Vol. XVI., 162; Vol. XVII., 162; Vol. XVIII., 130; Vol. XIX., 154; Vol. XX., 154; Vol. XXI., 87; Vol. XXII., 89; Vol. XXIII., 163; Vol. XXIV., 167; Vol. XXV., 163; Vol. XXVI., 172; Vol. XXVII., 170; Vol. XXVIII., 175; Vol. XXIX., 400; Vol. XXX., 400; Vol. XXXI., 450; Vol. XXXII., not yet fully distributed.

The volume last published (XXXII.) contains fifty-three articles, and also addresses and abstracts which appear in the Proceedings. The volume consists of 494 pages and twenty-six plates. The following gives a comparison of the contents of the present volume and that for last year:—

	1900. Pages.	1899. Pages.
Miscellaneous...	162	100
Zoology	62	262
Botany	102	220
Geology	68	72
Chemistry ... ... / Physics	16	50
Proceedings	38	48
Appendix	46	50
	494	802

It should be noted that Vol. XXXI. (1898), owing to an unavoidable delay in the publication of the plates, represents a period considerably exceeding the year, so that it included papers that properly belonged to Vol. XXXII.

The cost of printing Vol. XXXI. was £539 6s. 3d. for 802 pages, and that for the present volume (XXXII.) £338 11s. 6d. for 494 pages. This amount includes the preparation and printing of the plates.

The Treasurer's statement of accounts, appended, shows the amount received for the year as £1,098 7s. 3d. (including balance brought forward) and the expenditure £666 1s. 4d., leaving a balance in hand of £432 5s. 11d. This balance has already been appropriated for the completion of the great work by Mr. Hamilton, illustrating "Maori Art," and other publications now in hand. Part IV. of "Maori Art" has been issued, and Part V., which completes the work, is now well advanced for publication. After this final part is issued to subscribers, the work can only be obtained in its complete form in one volume, handsomely bound, and binding-covers can be supplied to those who possess the work in separate parts at cost price.

A dictionary of the Mangareva language, by Mr. E. Tregear, has been published by the Institute. The following extract from Mr. Tregear's introduction will explain why the Board went to the expense of this work :—

The Gambier or Mangareva Islands consist of a small group situated within the Paumotu Archipelago, in the Eastern Pacific. They are generally known as Mangareva, that being the native name of the principal island (Peard Island); but on their discovery by Captain Wilson, of the "Duff," on the 25th May, 1797, he named them after Admiral Lord Gambier.

Mangareva Island is about four miles in length, and rises in two peaks in the form of wedges, the greatest height being 1,315 ft. The large village on the east side of Mangareva is in latitude 23° 7′ 34″ S., longitude 135° 0′ 20″ W. The other chief islands are Akamaru, Aukena, and Taravai. The inhabitants of the group number about a thousand. The whole of the islands are within an encircling coral reef. They form part of the French possessions in Oceania.

The interesting matter to the linguist and anthropologist in the following dictionary is that the language is pure Polynesian. Generally the inhabitants of the Paumotu Archipelago speak a dialect containing some element foreign to the Polynesian tongue; but in Mangareva the speech is nearly identical with the Maori of New Zealand, thousands of miles distant to the westward.

I trust that many a riddle of Maori scholars may be solved by this dictionary of Mangareva.

A second edition of the catalogue of the library of the Colonial Museum has been published. This is a work of 160 pages, and the supplement, which will contain the recent additions, is well advanced for press, and also an alphabetical index of authors' names. This library contains books belonging to the New Zealand Institute, the Geological Survey Department, the Colonial Museum (acquired either as donations or deposits), and the Wellington Philosophical Society. Books belonging to the Wellington Philosophical Society are marked with S. after date of publication. As some delay has occurred in the printing of this the second edition of the Museum catalogue, a very considerable number of additions have been made to the library since the manuscript was sent to press. These additions will be published in a supplementary catalogue as soon as possible after the rearrangement of the books has been completed. Owing to the occupation of the shelves by the large Patent Library (which has now been removed), it was impossible until the present time to arrange this very valuable scientific library in a proper manner for reference. The Manager wishes to express his cordial thanks to friends in many parts of the world who have aided in the collection, which when properly arranged should prove of immense value to the colony as a means of reference.

The library is now undergoing complete rearrangement in accordance with the new catalogue. The room, which is also the lecture-hall, has ample accommodation for readers who desire to study the works of reference.

Museum.

Since last report 107 entries have been made in the register of collections added to the Museum, comprising about five hundred specimens, a full list of which will be published in the usual form in due course. The whole of the collections, and especially the birds and fishes, which are most liable to suffer from damp, have been thoroughly cleaned and fresh preservatives applied. The work of renaming and relabelling in a more distinct manner is also in progress. The large relief model illustrating the geological structure of New Zealand has been cleaned and recoloured, and is now enclosed in a glass frame. On the whole, the Museum is now in good order, and has been made as accessible to the public as the cramped space provided for such extensive collections will permit.

It has been arranged that the Lecturer on Geology for the Victoria College shall have temporary use of the herbarium-room for his class-work, and that he may also have free access to any geological and mineral specimens he may require for illustration of his lectures on condition that they are not to be removed from the Museum building.

Meteorological.

The results of the meteorological observations taken at the principal stations for 1899 have been forwarded to the Registrar-General for incorporation with his annual report. The complete monthly returns for Wellington, and the monthly rainfall from 165 stations in New Zealand, have been published regularly in the *Gazette*. The monthly return for the vital statistics has also been furnished. The weather exchange, by telegraph, is carried on as usual between this colony and Australia.

Colonial Time-ball Observatory.

Mr. Thomas King, the officer in charge, reports as follows: The time service has been carried out as in former years. New Zealand mean time has been distributed daily by telegraph throughout the colony; whilst special signals for the use of navigators in rating their chronometers have been sent weekly to the chief seaports on the mornings after meridian observations have been taken. Hourly clock signals have, as heretofore, been automatically given from the Observatory to the Wellington Telegraph-office (operating-room and public office), to the Colonial Museum, and to the business premises of those watchmakers in Wellington who are on the galvanometer circuit. The time-ball is now dropped on every day of the week except Sunday; and for the guidance of ship-masters a flag is displayed on the ball tower on those days on which, as the result of transit observations, the time may be employed for close-rating purposes. Acknowledgments are due to the Wellington Harbour Board for the readiness it has shown to make the necessary arrangements for carrying out this plan. I should like to be allowed to record my thanks to Mr. William Ferguson, Secretary of the Board, and to Mr. G. F. Smith, the Assistant Secretary, for their courteous co-operation with the department in the matter. The telegraph authorities have been at all times obliging in promptly taking any steps which were required for insuring the proper working of the electric circuit which controls the time-ball and the galvanometers. The clocks have, on the whole, maintained satisfactory rates and have not called for more than the customary amount of regulating. The adjustments of the transit instrument have been regularly tested.

James Hector, Manager.

Approved.—Thomas Mason, Chairman.—Wellington, 4th September, 1900.

New Zealand Institute Accounts for 1899–1900.

Receipts.	£	s.	d.	*Expenditure.*	£	s.	d.
Balance	492	9	6	Printing Vol. XXXII...	338	11	6
Vote for 1899–1900 ..	500	0	0	Publishing "Maori Art"	265	12	10
Contribution from Wellington Philosophical Society	12	5	0	Printing Mangareva Dictionary ..	23	12	0
Sale of Transactions of New Zealand Institute	4	14	0	Temporary clerical assistance	16	0	0
Sale of "Maori Art" ..	88	5	9	Miscellaneous items ..	22	5	0
Refund of exchange on cheque	0	13	0	Balance*	432	5	11
	£1,098	7	3		£1,098	7	3

* This balance is already appropriated for the completion of "Maori Art" and other works.

Wm. Thos. Locke Travers,
3rd September, 1900. Honorary Treasurer.

PROCEEDINGS

WELLINGTON PHILOSOPHICAL SOCIETY.

First Meeting : *19th June, 1900.*

Mr. G. V. Hudson, President, in the chair.

New Members. — Professor Easterfield and Mr. E. W. Petherick.

The following publications were laid on the table: Vol. XXXII., "Transactions of the New Zealand Institute"; Proceedings of Wellington Philosophical Society for past year; copy of Catalogue of Library of the Institute and Society.

The President read his address "On Entomological Fieldwork in New Zealand." (*Transactions*, p. 383.)

Mr. Travers, in proposing a vote of thanks to the President, thoroughly indorsed his remarks, and dwelt briefly on the great importance of the study of insect life, and of the enormous extent to which man depended upon insects for many valuable products. The study was useful and instructive, as well as interesting.

Sir James Hector congratulated the Society on its selection of a President for the current year, and on the fact that Mr. Hudson was now taking a more prominent part than hitherto. It was evident that he was of distinguished parts, and a thorough master of his subject. Sir James seconded the motion, which was carried by acclamation.

Mr. Hudson returned thanks to the Society.

Sir James Hector exhibited a large collection of specimens lately added to the Museum.

Prominent among the exhibits were those collected by Mr. A. Yuill, taxidermist to the Colonial Museum, during a visit which he recently paid to the islands lying to the south of New Zealand. Among these were specimens of the great spider-crab of the Auckland Islands; a rabbit from the Auckland Islands almost as large as a hare, and illustrating the tendency of the fur to become white; a three-months-old albatros chick, which is like a ball of fluffy down, from Campbell Island; a king penguin, a royal penguin (*Catarrhactes schlegeli*), and a Gentoo penguin, from the Macquarie Islands; a golden-crested Antarctic penguin, from the Auckland Islands; a little blue diving-penguin and two scrub paroquets, from the Antipodes Islands. There were also a group of paradise ducks (the painted duck of Captain Cook), from Milford Sound; a flightless teal, from the Auckland Islands; and a kiwi, presented by Mr. George Fisher, M.H.R. A specimen of the Californian quail and one of the Tasmanian quail were also tabled, together with an old English rat (now the bush rat of New Zealand), a silver-eel caught in Wellington Harbour and presented by Mr. W. Hamilton, and a black swan from Wairarapa Lake, presented by Dr. Adams. On the walls were hung a collection of water-colour sketches of South Island scenery by Mr. H. G. Lloyd.

The exhibits were explained by Sir James Hector, who mentioned that the Government very kindly gave Mr. Yuill a passage by the "Hinemoa." Although the steamer's movements were hampered by other engagements, Mr. Yuill had been able to make what was on the whole a very valuable and important collection, selections from which were before the society that evening. A few of the specimens on the table were obtained on a previous voyage, but all of them had been prepared by him, and they were really examples of the most wonderful and tasteful taxidermist's work which he (Sir James) had ever seen. In his detailed references to the exhibits Sir James said that they included almost a complete set of all the known species of penguin that had yet been found in the New Zealand area, which included the outlying islands.

The selections of sketches from the portfolio of Mr. H. G. Lloyd were much admired.

Note.—Great spider-crab (*Paramicippa grandis*), n.s.: This genus was founded by Professor Milne-Edwards in 1834 (Hist. Nat. Crust., i., p. 332). One species is mentioned by Miers (Cat. N.Z. Crust., 1876) as *P. spinosa*, but is of small size ($\frac{3}{4}$ in. in length), and differs in the form of the carapace and rostrum. This species has been figured by Dr. Filhol in the "Zoology of the Campbell Islands" under the name of *Prionorhynchus edwardsii*. The following notes refer to the largest specimen out of twenty obtained in Carnley Harbour, Auckland Island: Carapace tumid, with strong median lobe and bold posterior tubercle; surface minutely tuberculate, four blunt tubercles, four lateral spines on anterior margin. Dimensions: Carapace, 10 in. long, 11 in. wide. Legs, prehensile, length 18 in.: ambulatory, I., 15 in.; II., 13 in.; III., 11 in.; IV., 9 in. Forceps, 4 in., meet only at point. Male—Telson, 4 in. Antennæ, minute.

Second Meeting: *24th July, 1900.*

Mr. G. V. Hudson, President, in the chair.

New Members.—Messrs. H. J. Babbage, Wanganui; H. H. Travers, Wellington; and J. H. Lewis, Otago.

Paper.—"On the Chemistry of the New Zealand Flora: Part I., the Tutu Plant," by Professor Easterfield and Mr. B. C. Aston; illustrated by lantern-slides. (*Transactions*, p. 345.)

Sir James Hector proposed a vote of thanks to Professor Easterfield for his admirable and instructive paper. He hoped we should have many more from the same source. He himself cited instances showing the strength of the tutu poison. While most poisons had no effect on pachyderms, tutin was equally deadly on all animals, even an elephant having died through an overdose, the skeleton being now in the Museum.

Mr. Hustwick, in seconding the vote, which was carried, said he had listened with great pleasure to the paper. It required great patience and care to work out a subject of this nature.

Mr. H. Travers said that at the Chatham Islands the natives drank the juice of this plant, and, indeed, made wine of it.

Mr. Harding said the juice was drunk by the old Maoris—the seed was the poison.

Mr. Tregear exhibited some curios from the islands, and gave an interesting account of them and the trip he had just taken in the "Tutanekai."

Third Meeting: *28th August, 1900.*

Mr. G. V. Hudson, President, in the chair.

New Members.—Dr. Fyffe and Mr. J. A. Gilruth.

Papers.—1. "On *Metacrias strategica* at Invercargill," by George Howes; communicated by Mr. G. V. Hudson. (*Transactions*, p. 188.)

Sir James Hector said this was a most interesting paper, and he hoped to hear more from the author.

2. "On the Fog in Wellington on the 19th June last," by H. N. McLeod. (*Transactions*, p. 380.)

Mr. Harding, in referring to the above subject, added some interesting information regarding observations by his father on recent rainbows at Napier.

Mr. Hogben also made some remarks on rainbows.

Sir James Hector had observed peculiar fogs over the Hutt Valley. Sea-fogs were beneficial, but those from the mountains were sometimes injurious to vegetation.

3. "On the Papatu Cave, at Ormondville," by H. N. McLeod. (*Transactions*, p. 343.)

Sir James Hector referred to the probability of finding valuable relics of natural history in newly discovered or little-explored caves of this Island. He said he did not look on the searching for and removal of such relics as vandalism; in fact, he regarded their careful collection as most meritorious.

Mr. Travers mentioned the recent find of moa-bones at Mauriceville. Instead of being carefully preserved, they had apparently been wantonly destroyed—almost pulverised.

Mr. McLeod remarked that in his belief the cave in question, which had not been much disturbed, would be found to be a very valuable one in the direction mentioned.

4. "On Rats and Plague," by Mr. H. C. Field. (*Transactions*, p. 443.)

Sir James Hector remarked that there was something in the periodic seven-year illness, for it had been experienced in America, the animals at these periods suffering from some form of plague.

Mr. Tregear said that if rats died in large numbers every seven years it was a point of great interest and should be investigated; it was not generally known. There was no proof, however, of their having died of plague.

Mr. Harding did not think the paper bore out what it tried to prove.

5. "Notes on late Additions to the Museum," by Sir J. Hector.

New exhibits at the Colonial Museum include a fine specimen of the king penguin, from Macquarie Island; groups of the orange- and blue-wattled crows, with albinos of both species (*Glaucopis cinereus* and *G. wilsonii*), a specimen of the very rare New Zealand snipe, from the Auckland Islands; a godwit (kuaka), a dabchick, and a bell-bird, from the Auckland Islands; and a diving-petrel, from Antipodes Island.

Explaining the exhibits to the Philosophical Society, Sir James Hector said the bell-birds had in the past ten years greatly diminished—probably because of the spread of the humble-bee, which entered into competition in obtaining honey from flowers. At the Auckland Islands, however, the bell-bird now existed in large numbers. A peculiar feature about the godwit was that every second year it went to Siberia to do its nesting. He urged that every effort should be made to preserve the New Zealand snipe, which was becoming very rare indeed. This bird, he said, was one of the smartest game-birds that could be got. It retained all the characteristics of the English snipe—flew in a zig-zag manner, was difficult to shoot, and afforded capital sport.

Fourth Meeting: *25th September, 1900.*

Mr. G. V. Hudson, President, in the chair.

Papers.—1. "On the *Lepidoptera* of Mount Ida District," by Mr. J. H. Lewis; communicated by Mr. G. V. Hudson. (*Transactions*, p. 186.)

Specimens illustrating the paper were exhibited.

Sir James Hector considered this a most useful contribution, which he hoped would be followed by others.

2. "Early Explorations and Colonisation of Western Canada," by Sir James Hector.

Abstract.

Sir James briefly sketched the early history of Canada, formerly a comparatively insignificant portion of the British possessions in that region, and the adjacent country, millions of square miles of which had been chartered to the Hudson Bay Company, who established a line of small fortified trading-centres, and worked the country solely for its furs. Casual adventurers penetrating this region brought back reports of its vast and fertile plains, its favourable climate, and immense undeveloped wealth. The company, on the other hand, represented it as a desolate and frigid waste, valuable only on account of the wild fur-bearing animals it produced. Agitation for the opening of the country led the Home Government to appoint the Palliser Expedition, which started in 1857. The lecturer—then a young man who had just completed his university course—was selected by the University of Edinburgh for the post of naturalist and medical officer to the expedition, and one of his first duties on arriving in Northern America was to nurse his leader through a sharp attack of typhoid. Subsequently, in the occasional absence of the head from the scene of operations, the whole charge and responsibility fell upon Dr. Hector, who had to act many parts—as geologist, naturalist, surveyor, physician, diplomatist (having negotiated a treaty with a native tribe), besides bearing his own share of the "pack" in those parts of the journey where the party carried their belongings and provisions on their backs.

The expedition started from Lake Superior, on which much of the

ice still remained, and the explorer for the first time "camped out" on a small island off the British shore. Owing to the ice, it had been necessary to charter a steamer; but from here they conveyed their bark canoes by water and "portage" across the intermediate country to Lake Winnipeg. These canoes, weighing $2\frac{1}{2}$ cwt., could only be set down on the water, and the burden on the two boatmen who conveyed these awkward articles on their shoulders, sometimes four miles at a time over steep ridges and rough country, was heavy. Dr. Hector's own pack—"quite an insignificant one"—was 80 lb. His recollections of the country are still vivid—its innumerable cataracts and grand waterfalls, the vast natural rice-fields of Lake Winnipeg, the enormous flocks of geese and ducks of many species, pelicans, and other wild birds, feeding on the rice and the fish of the lake. Then he described the fertile prairies, with their herds of buffalo, extending a thousand miles from the lake to the Rocky Mountains; of the excellent French botanist, whose taste for "le sport" sometimes led him, in defiance of strict orders, to diverge from the direct track, whereby the odometer attached to his vehicle, from which the "log" of distance traversed was taken, would sometimes register more than was warranted. The Grand Plateau was described—the "Thunder-breeding Hills," where a stratum of moist air continually flowing over a dry layer below charged with electricity of the opposite kind caused terrific displays of thunder and lightning almost daily. Sitting one day in his tent, he sketched a small approaching cloud of curious form, the nature of which he did not suspect, when a sudden discharge of lightning stunned him for several minutes. Recovering, he saw a thin column of smoke ascending from an Indian wigwam some 3 or 4 chains away. Hastening to the spot, he found the central support splintered, and the native inmates—four men and two women—all dead. Wintering at Fort Carlton, he made solitary journeys on snow-shoes in various directions, and concluded a treaty with the Blackfoot Indians, whose chiefs affixed their signatures by impressing their thumbs in soft sealing-wax. The treaty obligations, he added, were duly observed, and the signatures were treated almost reverentially by the natives.

Much of the energy of the expedition was devoted to the task of finding a pass through the Rocky Mountains. Here they were hampered by two conditions insisted on by the Home Government—they must take the horses through, and the pass must be above the 49th parallel. Unfortunately, this geographical boundary just cut off an excellent pass, through which there ran an ancient Indian trail. However, the best pass in the range (the Kicking-horse Pass) was discovered, and through this, since renamed the "Hector Pass," the railway-line now runs. The adventure which gave the pass its name was nearly a tragic one. Dr. Hector was kicked so severely in the chest that when he recovered consciousness he found that his mates had dug his grave, and it was only by winking his eyelids—the sole signal he was able to give—that he escaped premature interment. On the further side of the Rockies lies the wonderful valley of the Columbia River, up which salmon come to spawn twelve hundred miles from the sea. Here the native goats are woolly, and the large sheep, being covered with hair, are like deer. He told how, stooping to drink from the Saskatchewan Lake one night, he saw a wondrous light in the water—the reflection, as he soon found, of a comet—the great comet of 1858.

The explorer at times suffered severe privations. He narrated vividly how, when half-famished in the snow, his native comrade tracked a moose, and how anxiously he sat awaiting the preconcerted signal—a third shot—announcing that the game was slain; and how, in the extremity of hunger, they were driven to take their first meal without cooking the flesh. Subsequent surveys have made no important change in the map of the vast district then explored.

The work of the expedition occupied three years, and the results appeared in 1860, when, for the first time, the outside world had the opportunity of forming an idea of the wealth and value of the territory locked up by the Hudson Bay Company. Nothing, however, was done for five years, when this territory and British Columbia were annexed by Canada. Agitation to open up the region, however, was fruitless, until, after a stormy debate in the Canadian Parliament, permission was given to a syndicate to carry a railway through to Vancouver, concessions of land being given, and the line to be completed in ten years. The syndicate had money and "grit"; it bought out the rights of the Hudson Bay Company for £300,000 cash and one-twentieth of the produce of the land-sales and set to work. Within a few days of five years, half the stipulated time, the last rail was laid, and trains ran across the continent. The company made no elaborate surveys. It showed the purchasers of land their two pegs facing the railway-line, and gave them the measurements and bearings of their boundaries. He contrasted the condition of the country he explored forty years ago with its present state, and said he knew of no parallel in the world to its progress. Perhaps a hundred and fifty Europeans might then be found in the whole region—now its population was reckoned by hundreds of thousands, and along its railway-line were great cities with every appliance of civilisation.

During the five months and a half in the year in which the lakes were open to navigation they conveyed from this territory 30,000,000 tons of goods, which he contrasted with the 9,000,000 annually conveyed through the Suez Canal. In other respects the changes had been enormous. The populous Indian tribes had almost vanished, those that remained having taken to the woods. Of the countless herds of buffalo, he believed about thirteen individual specimens survived. Many of the species of native birds had wholly or partly disappeared. He spoke of the barbarous and wanton destruction of the native fauna. The last great buffalo hunt was in 1890, when thirty thousand head were killed, and the race practically exterminated.

Mr. W. T. L. Travers, in moving a vote of thanks to Sir James Hector for his address—which was rendered the more interesting because of the production of his original large-scale map—said the eminent services of Sir James Hector in connection with pioneer work in Canada had never been properly recognised in New Zealand, but his name would always be associated with the discovery of the only practicable pass (the Hector Pass) through the Canadian portion of the Rocky Mountains. Mr. Travers also gave an interesting description of the rapid settlement of the country referred to by Sir James Hector in his paper.

A very remarkable plant was exhibited by Sir James Hector.

By the last English mail Sir James received a peculiar root from Sir Walter Buller, who is at present travelling abroad, and which had been picked up in a cave at Mexico. The accompanying instruction was to "place it in water." Sir James did so, and within twenty-four hours a plant of the genus *Lycopodium* came to life and developed in an astonishing manner, shooting out leaves and giving every indication of a thriving existence. The plant was thrown back a little by being placed in the sun, but looked quite healthy when placed on exhibition. Sir James said that some held that it was probable that life had lain dormant in this plant for a hundred and eighty years until suddenly revivified by contact with water in the manner stated.

Mr. Kruger's signature and two Transvaal coins bearing the ex-President's head were exhibited.

They were sent from South Africa by Trooper Gillespie, a member of one of the New Zealand contingents, to his brother in Wellington.

Fifth Meeting : *16th October, 1900.*

Mr. G. V. Hudson, President, in the chair.

The President referred to the loss the Society and science in general had sustained by the death of Mr. W. Skey.

Sir James Hector moved, That a record be made on the minutes of the Society, and a letter of sympathy forwarded to Mr. Skey's widow. Mr. Skey, he said, joined his department in 1862, and, with a natural bent for chemistry and diligent labour and study, he had attained such a position as to be recognised as one of the world's foremost authorities in certain branches of science. In Mr. Skey the colony had lost a good servant and an able scientific man.

Mr. G. C. T. Richardson seconded the motion, and Mr. Hustwick added his testimony to the value of Mr. Skey's researches.

The motion was unanimously adopted.

Papers.—1. "Motions of the Atmosphere in the Southern Hemisphere," by Major-General Schaw, C.B., R.E.; read by Sir James Hector, in the absence of the author through illness. (*Transactions*, p. 376.)

Even in his hours of illness, said Sir James, General Schaw still followed his scientific pursuits on the lines in which he had so distinguished himself. The paper, which was highly technical and was illustrated by diagrams, dealt with generalised conclusions from a long series of observations with the balanced wind-vane, devised by the author some years ago, by which ascending and descending currents were indicated. Sir James Hector added that a device somewhat similar was used some forty years ago in Switzerland, but more minute observations were now being made in Europe by means of captive balloons. Investigations of this nature, systematically carried out, were tending greatly towards a precise knowledge of this difficult and intricate subject.

2. "The Regrowth of Totara," by Mr. J. Rutland, of Pelorus Sound. (*Transactions*, p. 324.)

Sir James Hector said the paper was an important and valuable contribution to the subject. He thought the author scarcely made sufficient allowance for difference of soil. All experience confirmed his conclusion as to the permanent injury inflicted on forest-trees by transplantation. He instanced a number of blue-gums grown by him from seed years ago. In some places two or three seeds had been planted in the same hole and came up together, in which case he removed and replanted the superfluous trees. Those left undisturbed had grown to 45 ft. or 50 ft. in height, and he could not span them with his arms; the others never throve, and were now not more than 16 ft. or 20 ft. high and 12 in. or 15 in. in diameter.

Two other papers, "The *Lepidoptera* of Southland," by Mr. A. Philpott (*Transactions*, p. 167), and "Seals as Navigators," by Mr. R. Henry (*Transactions*, p. 439), were taken as read.

The natural-history specimens shown included specimens of the fast-disappearing native thrush or piopio (*Turnagra hectori*), and examples of the ferocious carnivora—stoats, ferrets, and weasels—imported by the Government to keep down the rabbits, but which have, with inexcusable perversity, devoted themselves to the extermination of our beautiful native birds and our domestic poultry. An alarming circumstance—the abnormal development of these creatures—was pointed out by Sir James Hector. A colonial-bred ferret exhibited measured 26 in. in length, his British progenitors measuring only 16 in.

Sixth Meeting: *15th January, 1901.*

Mr. G. V. Hudson, President, in the chair.

New Member.—Mr. A. Quail.

Papers.—1. "Hymenopterous Parasite," by A. Quail. (*Transactions*, p. 153.)

2. "On obtaining *Lepidoptera* in Southland by the Sugaring Process," by Mr. A. Philpott; communicated by Mr. G. V. Hudson. (*Transactions*, p. 166.)

3. "On Giotto's Circle and Writing," by H. N. McLeod. (*Transactions*, p. 491.)

Mr. Hudson agreed that the illegibility in writing was due to the angular form; it was more easy to read the up-and-down and circular forms.

Mr. Mestayer said the subject was not new. Thirty years ago, in an engineer's office, the leading draughtsman had the same idea, based on the theory of circles. All the letters of his beautiful writing could be resolved into circles; he could draw a perfect circle without difficulty.

Mr. Harding doubted whether the circular curve is the sign of artistic beauty, but, rather, the elliptic. The latter was used now instead of the circle. Every one had their own particular curve in writing or drawing, and his work could be told by the curves and angles.

Mr. Joynt could not quite see the connection between the title and the mode of treatment adopted in the paper. If it was meant to imply that in drawing a circle Giotto intended to give the weight of his authority to a particular principle in art, the assumption was quite false, and was contradicted by the general character of his work. So, too, there was a danger of confusion in advocating the circular form in handwriting: was it as being the most desirable form in itself, or as most suitable for giving freedom and pliancy to the muscles of the hand? As to legibility, he held that it did not depend on any particular form of handwriting, but on the degree of resemblance of a piece of writing to the form with which the reader was most familiar.

Dr. Fyffe said the Phœnician circular form was not used as an O, but an ellipse. An artist's work could be detected by his mannerism, not by curves or angles.

Mr. McLeod still thought the circular form would be the best for writing.

4. "On the Bite of the Katipo," by Dr. Fyffe. (*Transactions*, p. 436.)

Sir James Hector said this was the second recorded case from the same locality. The first case was that of a local police constable, who succumbed to the poison. He understood that, as in cases of snake-bite, prompt application of ammonia had been found to have a powerful effect. The katipo was abundant on beaches and sandhills, infesting driftwood, old bones, &c. The thanks of the society were due to Dr. Fyffe for taking up the subject.

Mr. Travers said that, common as the spider was, cases of its bite were rare. He had only met with one instance. This was at Massacre Bay, where a man was bitten in the thigh. No skilled assistance was available. Though the results were very serious for a time, the man recovered.

Mr. Mestayer said there was a New South Wales spider much resembling the katipo, though the red mark was differently situated. Its bite was said to be fatal. The Curator of the Museum, who had live specimens in confinement, allowed them to run over his hand, but could not allow them to do it long, as, though they did not bite, their mere contact with the skin caused a numbness of the nerves.

Sir James Hector said the same thing had been observed of the katipo.

Dr. Fyffe said the knee-jerks and reflexions of the arm showed the specific effect of the poison on the nerve extremities, producing peripheral neuritis, and the numbness referred to was a confirmation. Ammonia, unless applied at once, he thought, would be of little or no use. At one time strychnine had great repute as an antidote to snake-bite, but, as a matter of fact, it had no such property. Its use in such cases was simply its ordinary use in medicine—to keep up the action of the heart.

5. "Notes on *Salmonidæ* in New Zealand," by A. J. Rutherfurd, President of the Wellington Acclimatisation Society. (*Transactions*, p. 240.)

Sir James Hector showed some specimens of *Hydridæ*, with other sea-snakes from various parts of the world.

The sea-snakes, he explained, inhabited the Pacific Ocean and tropical seas, but had been captured as far south in New Zealand as Catlin's River. It was singular, too, that while none of the land-serpents of the Pacific islands were poisonous—those, for instance, that were sometimes found in the bunches of island bananas were perfectly harmless—the sea-serpents, of which there were some seventy species, were, without exception, fanged, and provided with glands that secreted a virulent poison. The species belonging to New Zealand were all yellow-banded; all the Fijian species were black-banded, and those of Australia grey-banded. They were all characterized by the flattened tails, which they used as steering-oars. They were often found asleep on the surface of the water, but to eject the air from their lungs had to turn on their backs. In this state they were easily and safely captured, being powerless to strike.

Mr. Travers said they were exceedingly abundant in the coral islands. They were commonly eaten by the natives, who took the precaution of cutting off the head as soon as the animal was captured. He related the case of a shipwrecked crew on an atoll who lived on these sea-snakes for six weeks, having saved no provisions from the wreck, except a little farinaceous food. They called them "eels," and said they were very good eating. Like the natives, however, they carefully cut off the heads.

The following exhibits were on view :—

A small Holothurian from Lyall Bay, cast up in the late gale.

A sea-slug, or the *bêche-de-mer* of the Pacific islands.

A *Phylosoma*, or glass-crab—a curious and much-discussed Crustacean, of which eight species had been described, and which now turn out to be larvæ of crayfish.

Two owls—the smallest and largest species known.

One was a pigmy owl from Sir Walter Buller, who obtained it in Vancouver; a number were sent from the Rocky Mountains by Dr. Hector in 1859. Its large companion was the great horned owl from Norway.

A beautiful tropic bird.

This bird had its breeding-ground in Sunday and Kermadec Islands, arriving, it is affirmed, punctually to the day each year. The egg is laid in a hole in the tufa rock, and the parents take turns in the incubation, and abandon the growing fledgling to live on its own fat during the growth of its quill feathers, until it is able to take flight to the tropics.

Some sponges from the Chatham Islands.

Note by Sir James Hector.

I have received about eighty New Zealand and Chatham Island specimens from various sources, representing twelve species, mostly fan and finger sponges, and a few of *Euspongia*, which is a toilet sponge. The two specimens now submitted are fair samples of the latter genus, which includes the velvet sponge, and would, no doubt, have a commercial value. All I have seen are cast-up specimens from the beach, and most of them appear to have been for a long time tossed about on the shore and exposed to the weather.

Sponges in commercial terms are classified as "sheep-wool" or "Turkey" sponge (which is the most valuable of all kinds), "white reef," "velvet," "black reef," "boat," "hard head," "grass," "yellow," and "glove" or "finger" sponge. Sailors and fishermen also give familiar names to sponges, such as "feather," "fan," "bell," "lyre," "trumpet," "distaff," "peacock's tail," and "Neptune's glove." Three hundred species are known to science, and are classed under the following groups: (1) Pedicellated and non-pedicellated; (2) foliaceous; (3) globular; (4) concave; (5) digitaled.

The best quality of sponges in the market are obtained on the Syrian coast, the next best from the Grecian Archipelago and coast of Barbary. In Greece over seven hundred boats are employed in these fisheries, and three thousand men, two hundred of whom are expert divers using the modern diving-dress. The coarser and inferior varieties are gathered in shallow waters by the aid of three-pronged harpoons. The marketable sponges form colonies in from 5 to 25 fathoms of water. The finer kinds are only obtained by diving, the divers being armed with a long, broad knife, with which the sponges are carefully detached. The value of sponges so obtained is usually much greater than that of those torn off the rocks with harpoons.

Sponges are now successfully reared by artificial propagation. A fresh-gathered specimen of a good variety is cut into small fragments from the centre outwards, each having a portion of the outer surface with its covering of dark-coloured slime or tar-like gelatinous substance, as on this the vitality of the sponge depends. The fragments are then strung on copper wire at about 14 in. apart, and the strings are sunk or attached to the bottom of the sea in suitable situations for their growth, the essential conditions being calm, sheltered rocky coves with sufficient depth of clear water and moderate tidal current. In about seven years a crop of high-class sponges has been grown for the market at Key West, Florida. On the American coast, and especially at the Bahamas, the trade is very extensive, employing several thousands of persons, and producing sponges for export to the value of £120,000 per annum.

A series of immature flat-fish, which were submitted for opinion by the Marine Department.

They represented—(1.) The flounder, or patiki, wrongly named "plaice," about one-tenth adult size. (2.) The turbot sole, wrongly named "brill," about one-fortieth its adult size: this is a most valuable fish. (3.) The lemon sole, wrongly named "flounder," about one-twentieth adult size. (4.) The New Zealand sole, but a very young specimen, about one-twentieth adult size.

Letter from Professor Newton, of Magdalen College, Cambridge, addressed to Sir Walter Buller, at whose request it was read by Mr. Travers:—

I have received from New Zealand the report of the Surveyor-General for 1897–99, which contains some interesting particulars as to the preservation of birds in the islands lying off the coast. But it seems to me that there is some danger of these islands being overstocked, for as many kakapos, kiwis, and others as can be got seem to be turned out; and overstocking would be sure to produce many evils. I do not like reading that on one of the islands hawks, which have come over from the mainland, have been destroyed because they naturally preyed upon the introduced birds! Now, I feel pretty sure that the presence of the hawks would be the best safeguard against one at least of the mischiefs to be expected from overstocking—that is, the outbreak of some disease which might carry off a large proportion of the bird population which it is desired to encourage.

When we begin to interfere with the workings of nature we cannot be too careful, for we really know so little about them that something unexpected is almost sure to turn up. Bacon said we can only conquer nature by obeying her, and it is certainly not in accordance with her laws to abolish the checks that she has instituted.

Far be it from me to say what ought to be done in circumstances of which I am so very ignorant. I would only ask you, if you have the opportunity, to put the people concerned on their guard as to what may come to pass in this matter.

I am rather sorry to see that there is an acclimatisation society still in full swing. I look with grave suspicion upon all the doings of acclimatisers, though after rabbit and sparrow experience perhaps they have grown a little wiser. I notice, too, that on one of the islands pigs (feral, I presume) are spoken of as existing. They would be the great enemies of all birds that breed on the ground; and, indeed, I quite believe that it was the wild hogs that extirpated the dodo in Mauritius. I well know how hard it is to persuade people, even in this country, that such birds as hawks have their use, not only farmers, gamekeepers, and the like, but even men who have some knowledge of natural history—and actually bird-protectors! Thus the local association for protecting the birds of the Faroe Islands destroys, or a year ago did destroy, the great black-backed gulls because they took the eggs and perhaps the young of the other birds, wholly forgetful of the fact that for untold ages these birds had managed to get along very well notwithstanding the existence of the "plunderers," and that it was only when "cheap trippers" and so-called naturalists began to multiply that the numbers of other birds began to dwindle.

Annual Meeting: *12th March, 1901.*

Mr. G. V. Hudson, President, in the chair.

New Members.—Mrs. Longton, Hon. G. F. Richardson, Mr. C. H. Weyergang, and Mr. E. G. Brown.

Abstract of Annual Report.

During the past year the Society has held seven general meetings, at which twenty-eight papers were read.

Eight new members have been added to the roll during the past year, and we have lost by death a most valuable member of the Society, the late Mr. W. Skey.

The balance-sheet shows that the receipts for the year, including the balance carried forward, amount to £164 17s. 6d., and the expenditure to £87 2s. 1d., leaving a balance in hand of £77 15s. 5d.

The Research Fund fixed deposit now amounts to £35 9s. 10d., which increases the credit balance to £113 5s. 3d.

Election of Officers for 1901.—*President*—Mr. G. V. Hudson; *Vice-presidents*—Mr. H. B. Kirk and Sir James Hector; *Council*—Messrs. G. Hogben, R. C. Harding, H. N. McLeod, R. L. Mestayer, E. Tregear, Martin Chapman, and George Denton; *Secretary and Treasurer*—Mr. R. B. Gore; *Auditor*—Mr. T. King.

Sir James Hector congratulated the President on his re-election, and spoke of the very efficient manner in which he had conducted the business of the Society during the past year.

Mr. Hudson briefly thanked the members for the honour conferred upon him.

Papers.—1. "Description of a New Ophiurid (*Amphiura aster*)," by Mr. H. Farquhar; communicated by the Secretary. (*Transactions*, p. 250.)

The specimen was found near Timaru by Mr. A. Haylock.

2. "On Seismograms of Distant Earthquakes," by G. Hogben, M.A.

Mr. Hogben said he wished to place on record what he took to be a notable event in the history of seismology in Australasia—that was, the identification of two or three of the tracings of the Milne seismograph in Wellington with those of somewhat similar instruments at European stations. On the recommendation of Sir James Hector, the New Zealand Government ordered two horizontal pendulums for recording one element of the minute or microseismic vibrations that passed round or through the earth. One of these was placed under his (Mr. Hogben's) charge, and it was now installed in a specially constructed room under his private house. Several months were occupied in allowing the masonry column on which the instrument was placed to settle, and in testing and adjusting the instrument. It was not, therefore, until October of last year that it was in full working-order. The instruments at the central Imperial station for Germany, which was also the headquarters of the International Seismological Association, appeared to have been in working-order on the 1st July, 1900. They were somewhat more sensitive than the Milne seismograph, and were of the type known as the Rebeur-Ehlert. The essential principle, however, was the same. He had received from Dr. Gerland, of Strasburg, and from Dr. Schutt, of Hamburg (where Rebeur-Ehlert pendulums were also installed), abstracts of the records of their instruments for the month of October, 1900. Of the fourteen shocks or series of shocks recorded at Strasburg, Mr. Hogben noted clear coincidences with shocks recorded in Wellington in three cases, and more doubtful coincidences in two other cases. One of the earthquakes, from the evidence available so far, seemed to have come from some place in the eastern Pacific, probably from the coast of Peru, though that was pure conjecture. Another was a very considerable earthquake that took place in the territory of Alaska. It was recorded also at Victoria, British Columbia, and at Toronto, in Canada, by Milne instruments, and at all the more important European stations. It lasted for over three hours altogether. The Wellington record was consistent with the idea that the vibrations travelled hither along great circles of the earth's crust. The third earthquake was probably from a centre nearer to New Zealand than to Strasburg. It also was probably a Pacific earthquake. There was no difficulty in identifying these by means of the particulars as to time, &c., which he had received from Strasburg. Mr. Hogben, who exhibited to the meeting originals and copies of seismograms taken in Wellington, added that it was proposed to issue monthly reports here. Permission had been given to have them printed. They would be distributed to other stations. The weak point of the British Association's system was that it did not print its records for two years. If records were printed and distributed month by month they could be worked out and compared with less labour. To go through them at the end of two years was a very arduous and, in some respects, almost hopeless task. It was hoped that there would be an opportunity of publishing a synopsis of the Wellington records in the "Transactions of the New Zealand Institute." Unfortunately, there was no station in Australia as yet. A promise had been given that an instrument would be set up in Melbourne when funds were available. One was promised for Honolulu without the condition as to funds, and it would probably be erected when the United States authorities had got their scientific affairs in Hawaii into working-order. The nearest station to Wellington was Batavia. It was desirable that there should be one nearer. Two or three of the records which he exhibited agreed with records taken at Batavia. It might be better if the British and International Associations co-operated in regard to the class of instruments used, and in other matters. Probably, however, good, and not harm, would result from comparing observations made by means of two kinds of instruments.

Sir James Hector thanked Mr. Hogben for giving so clear and early an account of such important observations. A semi-annual movement of the earth's crust recorded by the instrument in Wellington was, Sir James thought, very easy of explanation. Mr. Hogben's house in Tinakori Road was situated right on a major geological fault that traversed New Zealand. The movement referred to by Mr. Hogben had been noticed in connection with transit observations in Wellington since 1867. It was to be hoped that the other instrument, now lying in the Museum, would be put in a place not so liable to be affected by geological faults. In conclusion, Sir James said he was extremely glad that a first effort had been made in this matter, and that it was so well advanced under Mr. Hogben's care as to promise that in future they would get something like accurate information about earthquakes occurring here and elsewhere.

Mr. R. C. Harding expressed the opinion that there should be no difficulty in improving the method of duplicating records of earthquakes by electricity.

Mr. Coleman Phillips referred to the character of the numerous earthquakes in the Pacific, and said they would have to be carefully studied before any deductions could be drawn from their movements.

Mr. Hogben, in reply, said that fortunately the position of these instruments was not dependent upon such movements as fault movements, as observers could, after a little time, distinguish one kind of movement from another to a very considerable extent. The same remark held true in regard to certain earthquakes in the Pacific. A point which observers wished to settle was whether the first intimation of an earthquake came along the arc or along the chord. In the case of the Alaska record there were overlapping records. An electric system of obtaining numerous seismograms simultaneously had been tried, but it was pronounced a failure, as the lower seismograms were not accurate.

The President (Mr. G. V. Hudson) thanked Mr. Hogben for his address, and the thanks were emphasized by the meeting.

3. "Survey: Practical and Precise," by the Hon. G. F. Richardson. (*Transactions*, p. 492.)

4. "Researches into the Action of Fusible Cutouts," by E. G. Brown, A.I.E.E. (*Transactions*, p. 356.)

5. "Note on Vapour-density of Mercury," by Douglas Hector, student in Victoria College; communicated by Professor Easterfield. (*Transactions*, p. 382.)

6. "Embryological Structure of New Zealand *Lepidoptera*," by A. Quail, F.E.S. (*Transactions*, p. 159.)

The following exhibits were laid on the table by Sir J. Hector:—

A great eel, as big as a conger—5 ft. 6 in. in length, and weighing probably over 20 lb.

The big fish, which, as Sir James Hector remarked, would no doubt account for the disappearance of a good many trout, was caught in the Hutt River near Silverstream. It is rare in the scientific sense, though Sir James had no doubt that numerous examples lurked in dark places in the Hutt River. It is known to science as a New Zealand fish, under the name of *Anguilla latirostris;* but, though the British Museum possesses a specimen, this is the only one in any collection in the colony. Four or five species of New Zealand eels required careful study and description, and could give plenty of work to some of our young naturalists.

Sir James Hector gave interesting details of the habits of eels. Their method of reproduction had, he said, long been a mystery, careful examination always failing to detect eggs in the body of the female. It was now known that they retired to the ocean for the breeding-season, and at great depths—under the enormous pressure of some thousand fathoms of water—deposited their eggs. A small, thin, translucent fish, the *Leptocephalus*, had now been proved to be the fry of the conger, and a flood of light had been thrown on the subject. Large eels like this were rarely seen except when streams or ponds were drained. This one got into a backwater, and was killed in somewhat unsportsmanlike fashion with a pitchfork. There was another great fresh-water eel in New Zealand, found in the Waikato, the Buller, and in Lake Wakatipu, but differing from this one in important respects. In that species the jaws were equal, while in this one the lower jaw projected considerably beyond the upper; the Waikato eel was steel-blue, and this one was a brownish-olive above and below.

A pair of skulls, male and female, of a leopard-seal (genus *Stenorhynchus*, species doubtful), from Macquarie Island.

One of the animals, Sir James Hector explained, had suffered the agonies of toothache, one of the tusks showing signs of extensive caries. A curious habit of this species, who dived with difficulty on account of their fat, was to swallow rounded stones for ballast. On dissection their stomachs were usually found loaded with stones.

A supposed true specimen of *Salmo salar* in the smolt stage, taken in the entrance of the Motueka River, Nelson.

Sir James Hector said the specimen was received on 10th December, and was submitted for examination by Mr. J. R. Macdonald, hon. secretary of the Nelson Acclimatisation Society, who wrote that it was supposed to be the young of some true salmon turned out in the Motueka River two years ago, their length being then from 4 in. to 11 in. and their age two years, and that they had been reared from the eggs in the Nelson ponds. Some apparently similar fish have been caught in the Maitai River, in Nelson, which is thirty miles distant from the Motueka River, alongside of which are the breeding-ponds of the Nelson society. The specimen was in bad condition. The spirit used was too strong, and the delicate scales were stripped. It was the nearest approach to the smolt of the true salmon he had seen, except a few from Whanganui. It was desirable that good specimens should be preserved next November, when these fish might probably reappear, and perhaps also a run of grilse later on in the season. Specimens for examination should be most carefully handled, and at once wrapped in butter-cloth that had been soaked in a 5-per-cent. solution of formalin, and packed lightly in a jar or kerosene-tin containing a similar solution reduced to 3 per cent. Total length of specimen submitted, 14 in.; of head, 3 in.; of gill-opening, 2 in. Anal rays, 10 (the Californian salmon has 14); L.L., 108; L.T., $\frac{22}{28}$. Opercular spots, 4. Covered with pearly-white scales, with a few minute black × spots. Back fins, black; belly fins, white. Ray formula: B, 11; D, 11; A, 10; P, 13; V, 9.

A beautiful specimen, sent by Mr. W. Timperley, of Wairoa, Hawke's Bay, of the coral lichen, with which the ground in the beech forests of that district is densely covered.

A series of six photographs (Plates XVIII.–XXIII.) of the reserves at Dusky Sound.

These pictures, said Sir J. Hector, were received from Mr. Henry last year, but too late for inclusion in the volume. The most interesting is that of Captain Cook's camp on what he named "Astronomer's Point," and where the stumps of the large-sized trees which he there cut down to secure a solid foundation for his observing-instruments still remain. One of these was removed in 1863 and placed in the Otago Museum.

AUCKLAND INSTITUTE.

First Meeting: *4th June, 1900.*

Professor H. W. Segar, President, in the chair.

New Members.—W. Aubin, M.B., W. H. Baker, D.Sc., A. Millar, H. Suter, E. E. Vaile.

The President delivered the anniversary address, taking as his subject "The Population of New Zealand; an Examination and a Forecast." (*Transactions*, p. 445.)

Second Meeting: *25th June, 1900.*

Professor H. W. Segar, President, in the chair.

Mr. J. A. Pond gave a popular lecture, illustrated by limelight views, entitled "The Rotomahana of To-day."

He gave an account of a recent visit made to Rotomahana by himself and Dr. H. Haines, when the lake was reached for the first time since the eruption of 1886. A full description was given of the present appearance of the lake and the ashfields surrounding it, also of the remarkable belt of thermal activity stretching southwards in the direction of Lake Okaro.

At the conclusion of the lecture a vote of thanks was moved by Mr. T. Peacock, and carried by acclamation.

Third Meeting: *9th July, 1900.*

Professor H. W. Segar, President, in the chair.

New Members.—Dr. Marsac, E. C. Purdie, M.A., Dr. H. Swale.

Papers.—1. "Notes on the Ti Pore, a Food-plant formerly cultivated by the Maoris," by the Rev. Canon Walsh. (*Transactions*, p. 301.)

The author writes that since the paper was read one of Mr. Reid's specimens has flowered for the first time.

2. "Remarks on the Food-plants of the Polynesians," by T. F. Cheeseman, F.L.S. (*Transactions*, p. 306.)

3. "A Nation's Ingratitude," by E. A. Mackechnie.

Fourth Meeting: *23rd July, 1900.*

Professor H. W. Segar, President, in the chair.

Mr. D. Petrie gave a popular lecture on "The Sexual Theory in Plants."

Fifth Meeting: *13th August, 1900.*

Professor H. W. Segar, President, in the chair.

New Members.—C. E. Fox, J. Hume, Rev. Mr. Webster.

Papers.—1. "On the Occurrence of Crystallized Native Copper on Mine-timbers at Kawau," by W. H. Baker, B.Sc. (*Transactions*, p. 336.)

2. "On the Geology of the Auckland Domain," by P. Marshall, D.Sc.

Sixth Meeting: *27th August, 1900.*

Professor H. W. Segar, President, in the chair.

Dr. A. Macarthur delivered a popular lecture on "Democracy and Popular Government."

Seventh Meeting: *10th September, 1900.*

Professor H. W. Segar, President, in the chair.

New Member.—S. A. R. Mair.

Mr. E. V. Miller gave a lecture, illustrated by numerous experiments, entitled "The Relation between Light and Electric Force."

Eighth Meeting: *24th September, 1900.*

Professor H. W. Segar, President, in the chair.

Professor A. P. W. Thomas gave a popular lecture, with numerous lime-light illustrations, on the Waitakarei Ranges.

Ninth Meeting: *15th October, 1900.*

Professor H. W. Segar, President, in the chair.

New Member.—W. H. Tucker.

Papers.—1. "Descriptions of New Plants," by T. F. Cheeseman, F.L.S. (*Transactions*, p. 312.)

2. "Contributions to a Knowledge of the Geographical Distribution of the New Zealand Land and Fresh-water Mollusca," by H. Suter. (*Transactions*, p. 151.)

3. "Maori Origins," by Elsdon Best. (*Transactions*, p. 467.)

4. "Why not prepare Students for Technical Schools," by James Adams.

TENTH MEETING: *29th October, 1900.*

Professor H. W. Segar, President, in the chair.

Professor F. D. Brown gave a popular lecture, illustrated by numerous carefully prepared experiments, on "The Surface of a Liquid."

ELEVENTH MEETING: *12th November, 1900.*

Professor H. W. Segar, President, in the chair.

Paper.—Mr. J. A. Pond read a paper "On a Hot Spring in the Rotomahana Rift," and showed some lantern-views of geysers and hot springs in the vicinity.

ANNUAL MEETING: *25th February, 1901.*

Professor H. W. Segar, President, in the chair.

New Members.—A. Hunter, C.E., C. E. Smith.

ABSTRACT OF ANNUAL REPORT.

Seventeen new members have been elected since the last annual meeting, a number considerably above the average of the previous eight or ten years. The losses have been by death four, and otherwise ten. The number on the roll at the present time is 155, being three more than in the previous year.

The Council have much regret in announcing the death of Mr. E. A. Mackechnie, who for many years has been intimately associated with the affairs of the Institute. Mr. Mackechnie became a member in 1870, and from the time of his election took a steady and consistent interest in the welfare of the society. He was elected to the Council in 1880, and served as President in 1882. In 1886 he was appointed a trustee of the Institute, a position which he occupied up to the time of his death. He has contributed numerous papers or lectures to the meetings of the Institute, many of which have appeared in the Transactions. The Council are specially desirous of expressing their high appreciation of the many services he has rendered to the Institute, and the advantages which it has derived from the soundness of his judgment and constant devotion to its best interests.

In the balance-sheets appended to the report full details are given of the financial position of the Institute, but it is perhaps advisable to give a brief synopsis here. The total revenue of the working account, excluding the balance of £61 6s. 1d. in hand at the beginning of the year, has been £897 7s. 4d., a very close approximation to last year's amount, which was £900 18s. 2d. Examining the separate items which make up the year's income, it will be seen that the receipts from the invested funds of the Costley bequest have been £436 5s., as against £328 5s. for the previous year, the apparent increase being mainly due to the receipt of interest, which, if paid in time, would have appeared in last year's accounts. The Museum endowment has yielded £333 11s. 7d., the amount for 1899–1900 being £444 1s. 4d. The decrease has been caused by the paying-off of several mortgages, which have not yet been reinvested. The members' subscriptions stand at £118 13s., precisely the same amount as that credited last year. The total expenditure has been £822 11s. 11d., leaving a balance of £136 1s. 6d. in the Bank of New Zealand. The Council have no change of importance to report respecting the capital account of the Institute, the total amount being the same as last year—£13,590. A few mortgages have expired, and have been paid off, the funds now waiting reinvestment. There is every reason to believe that the invested funds are in a satisfactory condition, and the securities good and ample.*

No change has taken place under the head of Museum Endowment. The interest on the capital sum invested has been regularly received, and from time to time the Crown Lands Board have paid over the rents received from those endowments that are leased. How to utilise the remainder of the endowment is not an easy question to solve, there being little demand for country lands except under perpetual lease.

Eleven meetings have been held during the session, at which nineteen papers were read.

The Museum has been open to the public throughout the year during the usual hours—from 10 a.m. to 5 p.m. on week-days, and from 2 to 5 p.m. on Sundays. The attendance has been satisfactory. Visitors to the Museum on Sundays have been regularly counted, the total number being 12,371, an average of 237 for each Sunday; the total for the whole year being estimated at 43,671. The greatest attendance on any one day was 520 on the 24th May (Queen's Birthday). The chief work done in the Museum during the year has been the rearrangement of the greater part of the Invertebrata. The New Zealand shells have been remounted and relabelled, and a considerable number of additional species placed on exhibition, the collection being now as complete as any in the colony. The foreign shells have received considerable attention, with the view of rendering the collection tolerably representative of the chief families. Several minor pieces of work have been carried out in the mineral and ethnological departments, and at the present time good progress is being made in overhauling and relabelling the collection of New Zealand birds. The donations received during the year have been numerous and valuable, as may be seen from the appended list, but few of them require special mention in the body of the report. One of the most interesting is a specimen of the rare and curious mole-like marsupial *Notoryctes*, from the deserts of Central Australia, obtained in exchange from the Melbourne Museum. Colonel Seton-Karr has very liberally presented a series of prehistoric stone implements collected by him a few years ago in Somaliland, being a set similar to those which he has contributed to the chief European Museums. From Mr. Elsdon Best the Museum has received a further consignment—the third—of Maori ethnological specimens, obtained in the vicinity of Ruatahuna and Lake Waikaremoana, most of which are very acceptable additions.

The growth of the Museum, satisfactory in some respects, is in others

* For full details of finance, see pamphlet issued by Institute.

much hampered by the small and insufficient funds available. The zoological department is practically at a standstill from the inability of the Institute to employ a taxidermist. Another serious matter is the slow growth of the whole of the New Zealand collections. The primary object of any local museum of natural history should be to obtain, and to exhibit in as full a manner as possible, a complete series of the natural productions of the country or district in which it is situated. But, with the exception of the birds and shells, small progress has been made in this direction. Take, for instance, the fishes, where it is highly important that there should be a good named collection, especially of the edible species. But the cost of preserving and mounting the larger varieties, and of the glass jars and alcohol required for the exhibition of the smaller ones, has effectually prevented a proper advance from being made. Hardly anything has been done towards forming a collection of New Zealand insects, and this is altogether due to the want of proper cabinets for their reception, for several collectors would gladly assist if there was a reasonable prospect of their specimens being placed in safety. How these checks to the progress of the Museum can be removed is not at all obvious. In the past the Museum has benefited so largely by private liberality that the Council entertain the hope that its further development may receive some assistance from the same source.

About fifty volumes have been added to the library by purchase during the year, a full list being given in the appendix. The usual exchanges and presentations from foreign institutions have also been received. The importance of extending the library, and of rendering it more useful to students and scientific workers, is fully recognised by the Council, and it is hoped that means may shortly be available for the purchase of another instalment of books.

The management of the Little Barrier Island as a reserve for the preservation of the avifauna of New Zealand still remains in the hands of the Institute, the Government contributing an annual grant to defray the necessary expenses. The curator, Mr. Shakespear, reports that no attempt has been made to interfere with the birds, and that no unauthorised persons have landed on the island. The usual annual inspection was made a few weeks ago, when everything was found in a satisfactory condition. The secretary reports that birds are everywhere plentiful, and are apparently increasing in numbers. During the course of a week's stay he observed the whole of the species recorded by Professor Hutton and Mr. Reischek. Now that the visits of collectors have ceased, and the birds are not molested, they have become much tamer, and frequent the lower parts of the island, which was not the case four or five years ago, when the Institute first assumed control. Several were even noticed nesting in close proximity to the curator's house. Altogether there is every reason for believing that the island will long remain a secure home for the avifauna of New Zealand.

Election of Officers for 1901.—*President*—J. Stewart, Esq., C.E.; *Vice-presidents*—Professor H. W. Segar and J. Batger; *Council*—C. Cooper, H. Haines, A. Hunter, C.E., E. V. Miller, T. Peacock, J. A. Pond, Dr. H. Swale, Professor Talbot-Tubbs, Professor A. P. Thomas, J. H. Upton; *Secretary and Treasurer*—T. F. Cheeseman; *Auditor*—W. Gorrie.

PHILOSOPHICAL INSTITUTE OF CANTERBURY.

First Meeting: *2nd May, 1900.*

Captain F. W. Hutton, President, in the chair.

New Members.—Messrs. E. B. R. Prideaux, A. Sims, and W. L. Scott.

Address.—Mr. R. M. Laing delivered an address on "The Geological Structure of Lyttelton Harbour," illustrated by lantern-slides.

Second Meeting: *6th June, 1900.*

Captain F. W. Hutton, President, in the chair.

New Member.—Mr. A. Gray.

Address.—Mr. J. L. Scott delivered an address on "Some Modern Applications of Electricity."

Third Meeting: *4th July, 1900.*

Captain F. W. Hutton, President, in the chair.

New Members.—Miss C. V. Longton, Messrs. T. T. Thomas, and F. W. Hilgendorf.

Papers.—1. "On the Seaweeds of Norfolk Island," by Mr. R. M. Laing. (*Transactions*, p. 299.)

2. "On a New Zealand Leech," by Professor A Dendy and Miss M. Olliver. (*Transactions*, p. 99.)

3. "On a Collection of *Hymenoptera* from Wellington," by Mr. P. Cameron; communicated by Captain Hutton. (*Transactions*, p. 104)

4. "On *Lysiphragma howesii*," by Mr. A. Quail; communicated by Captain Hutton. (*Transactions*, p. 154.)

5. "Note on *Chrysophanus feredayi*," by Captain Hutton. (*Transactions*, p. 96.)

Professor Dendy exhibited a newly imported auxanometer and growth lever, and a clinostat, used for investigations in vegetable physiology, and explained their use.

Fourth Meeting: *1st August, 1900.*

Captain F. W. Hutton, President, in the chair.

Mr. C. Coleridge Farr exhibited and explained a set of instruments used for the magnetic survey of New Zealand.

Captain Hutton exhibited a New Caledonian stone axe dug up in Christchurch, and another from New Caledonia in comparison.

Mr. Carlisle exhibited a Maori greenstone axe from Okain's Bay, and a totara vessel dug up near Christchurch; also a copy of a Maori-English dictionary.

Professor Dendy exhibited and made remarks upon a pair of live kiwis from the Bay of Islands, obtained through Mr. Pyecroft, who spoke on the subject.

Captain Hutton exhibited a kiwi's egg.

Professor Dendy exhibited a black rat (*Mus rattus*), obtained near Sumner by Mr. France.

Mr. R. Brown exhibited a number of hyacinth-bulbs, and showed how they might be made to multiply by exposure to sunlight.

Fifth Meeting: *3rd October, 1900.*

Captain F. W. Hutton, President, in the chair.

New Member.—Mr. A. E. Flower.

Papers.—1. "Synopsis of the *Diptera brachycera* of New Zealand," by Captain Hutton. (*Transactions*, p. 1.)

2. "Description of the Caterpillar of *Epirranthis alectoraria*," by Mr. G. R. Marriner; communicated by Professor Dendy. (*Transactions*, p. 147.)

3. "Life-history of *Plutella cruciferarum*," by Mr. F. W. Hilgendorf. (*Transactions*, p. 145.)

Captain Hutton exhibited a specimen of the little whimbrel (*Mesoscolopax minutus*), shot at Lake Ellesmere, and not hitherto recorded from New Zealand, and a specimen of the Lord Howe Island woodhen (*Nesolimnas sylvestris*).

Mr. L. Cockayne exhibited flowers of *Iris bismarckiana*, *Saxifraga peltata*, and Siberian crabs.

Professor Dendy exhibited flowers of a shrub from Governor's Bay (subsequently proved to be *Osteospermum*), and a monstrous flower of *Narcissus odorus*.

Sixth Meeting: *7th November, 1900.*

Captain F. W. Hutton, President, in the chair.

Address.—Professor Dendy delivered an address on "Bacteria," illustrated by experiments, specimens, &c.

Papers.—1. "An Inquiry into the Seedling Forms of New Zealand Phanerogams and their Development: Part IV.," by Mr. L. Cockayne. (*Transactions*, p. 265.)

2. "Note on the Distribution of some Australasian *Collembola*," by Professor Dendy. (*Transactions*, p. 97.)

Mr. George Hogben exhibited a series of photographic tracings of earthquake records made by the seismograph under his charge at Wellington.

Seventh Meeting: *27th February, 1901.*

Captain F. W. Hutton, President, in the chair.

On the motion of Professor Dendy, the following resolution was passed: "That the Philosophical Institute of Canterbury desires to place on record its deep sense of the loss sustained through the death of Mr. H. R. Webb, F.R.M.S., who for many years took a leading part in the affairs of the Institute and in every way encouraged its objects."

The President, on behalf of the meeting, welcomed Dr. Charles Chilton on his return from Europe.

Papers.—1. "Note on the Occurrence of the Genera *Gunnera* and *Myosotis* in Chatham Islands," by Mr. L. Cockayne. (*Transactions*, p. 298.)

2. "On Ancient Maori Relics," by Mr. W. W. Smith. (*Transactions*, p. 426.)

3. "Notes on New Zealand Land Planarians: Part IV.," by Dr. Dendy. (*Transactions*, p. 222.)

4. "Notes on Some Artesian Waters," by Messrs. S. Page and E. B. R. Prideaux. (*Transactions*, p. 335.)

5. "Notes on New Zealand *Musci*," by Mr. R. Brown. (*Transactions*, p. 330.)

Professor Dendy exhibited living specimens of a species of *Lygosoma* from Pitt Island, and remarked that, though abundant on Pitt Island, it was doubtful whether this lizard occurs on Chatham Island proper.

Annual Meeting: *3rd April, 1901.*

Captain F. W. Hutton, President, in the chair.

Abstract of Annual Report.

Since the last annual meeting seven ordinary meetings have been held, at which fifteen papers have been submitted. These papers may be classified as follows: Zoology, 9; botany, 4; chemistry, 1; anthropology, 1. At three of these meetings special addresses of general interest have been delivered, viz.: "On the Geological Structure of Lyttelton Harbour," by Mr. R. M. Laing; "On some Modern Applications of Electricity," by Mr. J. L. Scott; "On Bacteria," by Professor Dendy.

The attendance at the ordinary meetings has averaged 20·5.

On the 11th July Professor T. H. Easterfield, M.A., Ph.D., F.C.S., delivered a popular lecture, under the auspices of this Institute, on "Modern War Explosives," in the hall of the Canterbury College, which was very largely attended, and proved a great success.

It is with deep regret that we have to place on record the death of Mr. H. R. Webb, F.R.M.S., one of the oldest members of this Institute, who had always taken an active part in its proceedings and the keenest interest in its welfare.

The Council of the Institute has met six times since the last annual meeting.

The Hon. C. C. Bowen continues to represent this Institute on the Board of Governors of the New Zealand Institute, and the Council wishes to express the indebtedness of this Institute to him for his services, as well as to Mr. George Way, F.I.A., N.Z., for his valuable services as auditor.

The total number of members for the year was seventy-two, as compared with seventy in the preceding year.

The balance-sheet shows that the finances of the Institute are in a very satisfactory condition. The total receipts for the year have been £72 19s. 6d., and the total expenditure £51 19s. 3d., the balance on current account having thus been increased to £25 15s. 3d., as compared with £4 15s. last year; but £10 is still due to the Canterbury College for rent. The sum of £29 0s. 10d. has been expended upon the library during the year.

Election of Officers for 1901.—*President*—Captain F. W. Hutton; *Vice-presidents*—Mr. J. B. Mayne, Dr. W. P. Evans; *Hon. Secretary*—Professor A. Dendy; *Hon. Treasurer*—Dr. Charles Chilton; *Council*—Dr. W. H. Symes, Mr. L. Cockayne, Mr. R. M. Laing, Mr. C. C. Farr, Professor Scott, Mr. A. E. Flower; *Hon. Auditor*—Mr. George Way, F.I.A., N.Z.

Paper.—A paper on "Kauri Gum and Oils," by Mr. E. B. R. Prideaux, was taken as read. (*Transactions*, p. 368.)

Presidential Address.—The President, Captain Hutton, delivered an address on "Our Migratory Birds." (*Transactions*, p. 251.)

OTAGO INSTITUTE.

First Meeting : *8th May, 1900.*

Mr. E. Melland, President, in the chair.

The President announced that Dr. Colquhoun had been elected as a member of the Council, in the place of Mr. F. B. Stephens, who had left New Zealand.

New Members.—W. Powell and A. Durrand.

Mr. A. Wilson gave an account of some recent excavations at Olympia, illustrated by maps, plans, and photographs of temples and statuary.

Second Meeting : *12th June, 1900.*

Mr. F. R. Chapman in the chair.

New Members.—J. Logan, S. F. Woodhouse, W. Fels, C. O. Lillie.

Dr. Hocken laid on the table a monograph of the New Zealand *Hepaticæ*, written by Dr. Berggren, of Lund University, and gave a short account of Dr. Berggren's scientific research in New Zealand twenty-five years ago.

Professor Benham exhibited several specimens of cartilaginous fishes recently added to the Museum, referring to the excellent method of their preparation in glycerine, which had been perfected by the late Dr. Parker. He also gave an account of the curious lung-fish, or *Ceratodus*, of North Queensland, which had been presented by Mr. Sargeant, a former student of our mining school.

Dr. Benham then made a few remarks on the natural history of some of the lower forms of animal life in New Zealand, the result of observations made during a recent holiday at Moeraki and Warrington.

He referred to a small pink worm, 2 in. long, burrowing and creeping along the sand, and emitting a very strong smell of rotten eggs, which probably protected it from its enemies. Another example mentioned was *Pectinaria*, an annelid which dwelt in a conical tube, formed from mucous secretion, with which particles of sand became incorporated. He found crabs of three species which burrowed in the mud, and gave an account of their habits and the value of the spines and hair upon their body, which, although they might seem so unimportant to the lay mind, were of so much value to the naturalist.

Mr. G. M. Thomson then gave an account of the trawling operations recently undertaken by the Government to examine our shores for marketable fish.

He and Mr. Hamilton and Dr. Benham accompanied at different times the various expeditions of the small boat of 19 tons as scientific supervisors. The coast of the South Island was examined from Golden Bay down the east coast as far south as Stewart Island and Tewaewae Bay. The fish were abundant up to about 25 fathoms, but from that to 50 scarcely any were found. This might have been due to seasonal causes, and was certainly very different from trawling as carried on in other parts of the world. The best results were perhaps obtained at Tewaewae Bay, where in two hours 48 dozen of flat-fish, brill, and other good fish were trawled. In other parts king-fish in abundance, red-cod, soles, and flounders were found, and large numbers of elephant-fish, gurnard, and schnapper; and, last of all, oysters were found in Golden Bay. The existence of the latter was not previously known to the Nelson folks. The hake fish was found for the first time near Wanganui, and a very good market fish hitherto unknown in New Zealand (*Macrurus*). Zoological material was collected which will form an additional report to that of the Government. The abundance and variety of food for fish was something enormous. Operations were to be resumed in January next on the west coast of the North Island. Mr. Thomson considered that these should always be accompanied by a scientific person.

Mr. Thomson also gave an account of the negotiations which had been entered into with the Government regarding the proposed fish-hatchery, which he hoped would be an accomplished fact by the end of the year.

Third Meeting: *10th July, 1900.*

Mr. E. Melland, President, in the chair.

The President called the attention of members to the fact that Part V. of "Maori Art" was in the course of publication.

Mr. A. Hamilton exhibited a living specimen of the caterpillar of the rare tiger-moth *Metacrias strategica*, and a specimen of the moth itself, reared in captivity.

Mr. G. M. Thomson read a paper on the "Acclimatisation of Plants in New Zealand." (*Transactions*, p. 313.)

The modes by which plants now naturalised have been introduced may be: (1) The deliberate scattering of seeds in the open ground or in selected localities; (2) escapes from cultivation in gardens, &c.; (3) accidental importation along with other seeds, or with hay, straw, packing, &c., with introduced plants or animals, and so forth; (4) by birds, winds, and other "natural" agencies.

Very few seem to have become established under the first of these means; many more, such as are not fertilised by specialised insects, come under the second head, especially where the seeds are dispersed by birds, like the elder, gooseberry, &c. But cultivated plants are not well fitted to compete unaided in the struggle for existence. The bulk of naturalised forms seem to come in the third category, notably weeds like shepherd's purse, chickweed, and groundsel. But within historic times none are positively known to have been introduced by "natural" agencies, though there is no inherent improbability of the occurrence.

Some comments were made by F. R. Chapman.

Mr. C. W. Chamberlain read an account of a trip by a new track to the West Coast, which was subsequently published in full in the *Otago Daily Times*.

Fourth Meeting : *14th August, 1900.*

Mr. E. Melland, President, in the chair.

Professor Benham opened the business of the evening by giving particulars of a young whale which had been caught near the Otago Heads by some fishermen, was towed up to Dunedin, and secured for the Museum.

The whale was 10 ft. long. As would be readily recognised, it was not often that a freshly caught whale was available for dissection and examination. This specimen was a rorqual (*Balænoptera rostrata*), and one of its characteristics was a series of furrows in the skin covering the throat and chest, which distinguished it from the ordinary whalebone whale. The rorqual fed on fish, and not on the minute organisms that served for the food of the ordinary whale; and the gular furrows were related to the distension of the throat. The rorqual was practically of no commercial value, and did not yield an abundance of blubber.

Professor Benham laid on the table a paper on "The Marine Annelids of the New Zealand Shores."

In doing so he said that, although most groups of our native animals had been studied more or less, the marine annelids had been entirely neglected. A few had been described by early zoologists in the sixties, but since then only one new species had been described in the Transactions of the Institute—that was *Lepidonotus giganteus*, described by Mr. Kirk in 1878. The speaker had gathered together a considerable amount of material, some of which he found in the Museum, collected by Captain Hutton, others by Professor Parker, and a good quantity he had collected himself from time to time.

Mr. T. D. Pearce gave an interesting and philosophical account of "The Knowledge of Animals in the Sixteenth and Seventeenth Centuries."

He showed how slavishly the doctrines of Pliny and Aristotle were adhered to till Bacon arose, and that, if Bacon made no discoveries, he, at any rate, impressed upon the coming scientific men the absolute necessity of observation in drawing their conclusions. Having done that, Mr. Pearce gave several very interesting examples of the curious theories held by scientific men in the period referred to regarding animals.

Mr. A. Wilson expressed a hope that Mr. Pearce would bring the subject up to the present time at a future meeting of the Institute

Fifth Meeting : *11th September, 1900.*

Mr. E. Melland, President, in the chair.

Professor Benham exhibited a large specimen of a spider-crab (*Prionorhynchus edwardsii*), one out of a haul that had recently been obtained by the fish-trawler "Express," off the Otago Heads, in 23 fathoms of water.

Hitherto the species had only been recorded from the Auckland and Campbell Islands.

Dr. Hocken read a paper entitled "The Beginnings of Literature in New Zealand." (*Transactions*, p. 472.)

In this paper an account was given of the early efforts of the missionaries to reduce the Maori tongue to writing, and to translate and to print the Scriptures, hymns, and simple lesson-books. A number of rare specimens of these earliest publications in the Maori language was exhibited.

Sixth Meeting : *9th October, 1900.*

Mr. E. Melland, President, in the chair.

Mr. A. Hamilton laid on the table a "Hand-list of certain Papers relating more or less directly to the Maori Race, and published in various Publications." (*Transactions*, p. 515.)

Mr. C. O. Lillie presented an article "On the New Zealand *Ephemeridæ*," and exhibited drawings of the nymph of an undescribed species. (*Transactions*, p. 149.)

Mr. H. T. Matthews then read a report on the present condition of forestry in New Zealand, giving details as to the work carried on at the various stations.

The paper was published *in extenso* in the *Otago Daily Times*.

Dr. Truby King gave an interesting address "On the Undue Weight attached to the Training of certain Intellectual Faculties."

Annual Meeting : *13th November, 1900.*

Mr. E. Melland, President, in the chair.

Papers.—1. "List of the Scientific Papers and Addresses by the late Sir Julius von Haast," by Mr. A. Hamilton.

2. "On the New Zealand Lancelet," by Professor Benham. (*Transactions*, p. 120.)

3. "An Account of *Acanthodrilus uliginosus*, of Hutton," by Professor Benham. (*Transactions*, p. 122.)

4. "An Account of some Earthworms from the Neighbouring Islands," by Professor Benham. (*Transactions*, p. 129.)

Abstract of Annual Report.

Eight meetings of Council and seven of members have been held.

Six new members have been elected.

It is a matter for regret that the meetings have gradually become almost limited to biology, which appeals to a very few members. The remedy lies in the hands of members themselves, for if they would contribute original articles on other branches of knowledge a wider interest might be awakened in the meetings; and this would be still more the case if subjects affording opportunity for discussion were brought forward.

The Council express a hope that a greater general interest will be taken in the meetings next session.

With regard to the fish-hatchery, the Council regret that the scheme still hangs fire. In the early part of the year there seemed a probability that the matter would be settled during the parliamentary session just ended. Meetings of your representatives and of those of the Acclimatisation Society with the Inspector of Fisheries were held for the purpose of explaining our views and the position of affairs financial. The site originally fixed upon—at Purakanui—has been abandoned, and a spot has been selected at the end of a small peninsula, Quarry Point, just below Portobello, which, in the opinion of those who have investigated it, is in all respects suitable.

At the beginning of the year the Government despatched a small steam-vessel—the "Doto"—to conduct a series of trawling experiments round the coast in connection with the Fisheries Department. Permission was granted for a member of this Institute to accompany the Inspector of Fisheries and to collect zoological material. The material collected, containing many interesting animals, forms the subject of a preliminary report by Messrs. Thomson, Hamilton, and Benham, just published by the Government as part of the report of the Inspector of Fisheries.

The delay in issuing the fifth part of "Maori Art" is regretted; but the printing is now proceeding, and it is expected that it will be issued shortly. This part will complete a work of very great value to students and others interested in the arts of the Maori race; and the author (Mr. Hamilton) deserves every praise for his industry and gratuitous labour in making the work as thorough as possible.

It was with pleasure that the Council heard that Mr. Cheeseman had undertaken the preparation of a complete "Flora of New Zealand" for the Government.

The balance-sheet shows the receipts for the year to be £125 18s. 9d., including the balance from last year. The expenditure during the session amounts to £109 18s. 3d., leaving a balance at the bank of £16 0s. 6d.

Election of Officers for 1901.—*President*—Mr. G. M. Thomson; *Vice-presidents*—Mr. E. Melland and Mr. F. R. Chapman; *Hon. Secretary*—Professor Benham; *Hon. Treasurer*—Mr. W. Fels; *Council*—Messrs. A. Bathgate, S. Barningham, C. W. Chamberlain, A. Hamilton, T. D. Pearce, Dr. Hocken, and Dr. Colquhoun; *Auditor*—Mr. D. Brent.

The retiring President then gave his address, of which "Cremation" was the subject.

HAWKE'S BAY PHILOSOPHICAL INSTITUTE.

First Meeting: *14th May, 1900.*

President's inaugural address, "The Science of the Nineteenth Century."

Second Meeting: *11th June, 1900.*

Paper.—"Bacteria: Benevolent and Malevolent, with Special Reference to the Plague, and to the Treatment of Sewage," by Dr. Leahy; illustrated with lantern-slides.

Third Meeting: *9th July, 1900.*

Papers.—1. "Scinde Island from a Naturalist's Point of View," by F. Hutchinson, jun. (*Transactions*, p. 213.)

2. "Mars and its Canals," by the Rev. W. G. Parsonson.

Both papers were illustrated by diagrams.

Fourth Meeting: *13th August, 1900.*

Paper.—"An Interesting Chapter of Early New Zealand History," by H. Hill, B.A., F.G.S.; illustrated by lantern-slides. (*Transactions*, p. 407.)

Fifth Meeting: *10th September, 1900.*

Paper.—"An Optical Illusion," by G. W. Tiffen. (*Transactions*, p. 434.)

Lecture.—"The House-fly and other Common Insects," by Rev. Dr. Kennedy, M.A.; illustrated by lantern-slides.

Sixth Meeting : *26th October, 1900.*

Papers.—1. "Hybridism," by Taylor White. (*Transactions*, p. 199.)

2. "Breeding Black Sheep: a Study in Colour," by Taylor White. (*Transactions*, p. 191.)

3. "Fresh-water Shells of Rissington, Hawke's Bay," by F. Hutchinson, jun. (*Transactions*, p. 207.)

4. "Vivisection," by T. C. Moore, M.D.

Papers 3 and 4 were illustrated by diagrams.

Annual Meeting : *4th February, 1901.*

Abstract of Annual Report.

Your Council are pleased to report a quiet but successful year's work. At the six ordinary meetings during the winter session one lecture was delivered and six papers were read. The lecture and many of the papers were illustrated by lantern-slides, the Institute's new lantern proving a great acquisition.

Early in July Mr. Wragge, the Queensland Government Meteorologist, paid a visit to Napier, and two lectures dealing with meteorological subjects were delivered by him under the auspices of the society. Both lectures were well attended, and proved most interesting and instructive.

There were eight Council meetings during the year, all of which were well attended. The vacancy caused on the Council by the removal of Mr. Tregelles to Wellington was filled by the election of Mr. J. S. Large.

The membership is one less than that of last year, there having been four new members elected; but five old members severed their connection with the branch, one of these being Mr. J. Ringland, whose death your Council regret to record.

Owing to the lack of support during the previous year, the Council did not consider it advisable to continue the science classes. Their place was to a certain extent supplied by series of literary and musical lectures, promoted by Misses Spence and A. Large. To encourage the efforts of these ladies your Council granted the use of the hall free of charge; but the experiment proved so successful that the promoters donated twelve pounds' worth of books (eighteen volumes) to the library of the Institute. Including these, thirty-two books were added to the library during the year.

The balance-sheet showed the total receipts (including a balance of £22 13s. 7d. from the preceding year) were £76 19s. 7d., and the expenditure £55 5s. 3d., leaving a balance of £24 11s. 4d. in hand. The total assets are valued at £932 6s. 4d. Of the Colenso bequest, a balance of £80 17s. remained in hand.

Election of Officers for 1901.—*President*—W. Dinwiddie; *Vice-president*—F. Hutchinson, jun.; *Council*—J. E. H. Jarvis, M.R.C.S., T. Hall, H. Hill, B.A., F.G.S., J. S. Large, T. Tanner, A. Ronald, M.B., Ch.B.; *Hon. Secretary*—James Hislop; *Hon. Treasurer*—J. W. Craig; *Hon. Auditor*—G. White.

WESTLAND INSTITUTE.

The annual meeting was held in the library, Mr. A. J. Morton in the chair.

ABSTRACT OF ANNUAL REPORT.

The trustees stated that the year had been a more progressive one, and they had made some alterations to increase the institution's utility and add to its popularity.

The balance-sheet showed the Government subsidy had been a great boon. The trustees' thanks are also due to the Borough Council and Harbour Board for their generous assistance. An abstract of income and expenditure showed receipts, £111 5s. 7d., payments, £101 5s. 7d., leaving a credit balance of £10.

There are now fifty-three names on the members' roll.

The trustees held four ordinary meetings, which were well attended.

The library, being the mainstay of the society, has been receiving the most attention this year, over a hundred volumes having been placed on its shelves, all of modern and attractive literature, and a further supply has been ordered, whilst it is in contemplation to compile and shortly publish a full catalogue.

The public reading-room has been kept well supplied with papers, and is largely patronised. The trustees take the present opportunity of thanking those proprietors who kindly donate their papers for its use.

ELECTION OF OFFICERS FOR 1901. — *President* — Mr. A. Mahan; *Vice-president* — Dr. Teichelmann; *Hon. Treasurer* —Mr. G. K. Sinclair; *Trustees* — Messrs. T. W. Beare, W. Heinz, J. J. Clarke, J. S. Dawes, J. B. Lewis, D. Macfarlane, R. McNaughton, J. Park, H. L. Michel, A. J. Morton, G. Perry, and Dr. Macandrew.

NELSON PHILOSOPHICAL SOCIETY.

First Meeting: *18th March, 1901.*

The Bishop of Nelson, President, in the chair.

The question of amalgamation with the Nelson Institute, in the event of its becoming affiliated to the New Zealand Institute, was considered.

After considerable discussion the following amended resolutions were agreed to:—

1. That the Nelson Institute affiliate with the New Zealand Institute.
2. That when this is done the Nelson Philosophical Society amalgamate with the Nelson Institute.
3. That a scientific branch, to be managed by a special sub-committee, be formed from members of the Nelson Institute, with an extra subscription of five shillings per annum.
4. That the property belonging to the Nelson Philosophical Society, including the specimens in the Museum, the material and apparatus of the School of Mines, and the books and magazines in its library, be handed over to the committee of the Nelson Institute, but that certain books be reserved for the use of the scientific branch only.
5. That the cash balance in hand of the Nelson Philosophical Society at the time of amalgamation be reserved for Museum expenditure.
6. That the subscriptions to the scientific branch over and above any special expenditure be reserved for Museum expenditure.

Resolved, That Dr. Hudson and Mr. Kingsley be a committee to determine what books shall be reserved under recommendation 4.

Resolved, That the present officers of the Society be re-elected for the ensuing year, or until the proposed amalgamation is effected.

Election of Officers for 1901.—*President*—The Bishop of Nelson; *Vice-presidents*—A. S. Atkinson and Dr. Mackie; *Hon. Secretary*—R. I. Kingsley; *Hon. Treasurer*—Dr. Hudson; *Hon. Curator*—R. I. Kingsley; *Assistant Curator*—E. Lukins; *Council*—The first five *ex officio*, and F. G. Gibbs, E. Lukins, J. S. Chatterton, and J. G. Bartel.

APPENDIX

METEOROLOGY.

Comparative Abstract for 1900 and Previous Years.

Stations.	Barometer at 9.30 a.m.		Temperature from Self-registering Instruments read in Morning for Twenty-four Hours previously. Fahr.					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...	30·009	1·040	59·6	11·7	38·0	144·0	36 0	0·356	68	39·150	197	...	...	5.5
Previous 36 years ...	29·998	...	58·8	...	...	...	...	0·380	71	41·889	180	...	...	...
Wellington	29·955	1·464	55·0	12·3	45·0	137·0	27·0	0·304	70	51·000	191	237	820 on 29th Oct.	4·6
Previous 36 years ...	29·928	...	54·8	...	...	...	...	0·330	72	51·029	161	...		...
Dunedin	29·950	1·793	50·2	13·0	55·0	...	...	0·279	76	43·378	153	183	580 on 11th April and 7th Aug	5·9
Previous 36 years ...	29·952	...	49·9	...	...	...	...	0·274	73	36·915	157	...		...

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.	
	1899.	1900.	1899.	1900.	1899.	1900.	1899.	1900.
Auckland	57·0	57·4	65·7	64·6	60·6	62·9	51·6	53·6
Wellington	54·3	53·6	60·9	60·0	56·8	57·4	46·9	48·6
Dunedin	50·3	51·4	56·5	55·2	51·0	51·2	41·7	42·9

REMARKS ON THE WEATHER DURING 1900.

January.—Generally fine weather in North and over centre, but showery in South.

February.—In North fine weather, rain much below average, and moderate winds; showery and cold in South, and westerly winds.

March.—Fine in early part of month in North, but latter part showery, with prevailing N.W. winds and strong; showery and changeable weather in South, with S.W. winds.

April.—Showery but small total rainfall in North; heavy rain over centre, and prevailing N.W. and S.E. winds and often strong; in South showery weather, winds N.E.

May.—Heavy rain in North, with prevailing N.E. and S.W. winds and strong; also heavy rain over centre, wind prevailed from N.W.; showery weather in South, chiefly from S.W.

June.—In North and over centre generally showery, but rain not in excess; in South very slight rain and fine weather.

July.—In North very showery, and frequent thunder, prevailing S.W. wind; over centre very heavy rainfall, and strong S.W. winds, frequent fogs, and hail. Showery weather in South; winds chiefly S.W.

August.—Heavy rain and strong E. and N.E. winds in North; over centre showery during latter part of month, and some strong N.W. winds. In South showery weather, except fine during middle of month; moderate winds, chiefly N.E.

September.—In North rain in excess, and strong winds from S.W. and N.W.; wet weather over centre, with moderate winds. In South wet, especially latter part; N.E. and S.W. winds generally.

October.—Wet weather in North and over centre; strong winds from N.W. and S.W. In South variable weather.

November.—Fine weather in North and over centre, but strong winds from S.W. and N.W.; in South heavy rain during middle of month, moderate winds.

December.—In North showery, and strong N.E. winds prevailed; over centre a wet month, with moderate winds; and in South changeable, cold, and showery weather.

EARTHQUAKES reported in NEW ZEALAND during 1900.

PLACE.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Napier ..	..	..	..	..	..	..	..	..	..	21, 26*	19*	..	3
New Plymouth	..	..	20	..	..	..	..	..	..	..	..	..	1
Wanganui ..	..	20	..	..	..	..	..	..	..	..	..	..	1
Masterton ..	20	..	..	..	..	..	..	..	..	16	..	..	2
Carterton ..	..	..	..	..	..	..	..	..	..	16	..	..	1
Featherston..	..	..	..	..	..	..	..	..	..	16	..	..	1
Pahiatua ..	..	..	..	..	..	..	..	..	..	16	..	..	1
Wakataki ..	..	..	..	..	..	..	..	..	..	16	..	..	1
Castlepoint ..	..	..	..	..	..	..	..	..	..	21	..	..	1
Mangaweka..	..	..	..	..	..	..	..	..	..	21	..	..	1
Wellington ..	..	10,* 20	..	..	21, 28	..	..	..	..	16, 21	..	..	6
Farewell Spit	..	..	..	..	..	..	..	..	..	21	..	..	1
Hokitika ..	4	..	..	..	..	..	..	..	..	..	..	..	1
Dunedin ..	..	..	..	29	..	..	..	..	..	..	..	..	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, except in Wellington, which is the only station at which a seismograph records the shocks. 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.

HOOKER, Sir J. D., G.C.S.I., C.B., M.D., F.R.S.

1873.

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.

1883.

Lord KELVIN, G.C.V.O., D.C.L., 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.

1890.

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.

1894.

DYER, Sir W. T. THISELTON, K.C.M.G., C.I.E., LL.D., M.A., F.R.S.

CODRINGTON, Rev. R. H., D.D.

1895.

MITTEN, WILLIAM, F.L.S.

1896.

LYDEKKER, RICHARD, B.A., F.R.S.

LANGLEY, S. P.

1900.

AGARDH, Dr. J. G.

AVEBURY, Lord, P.C., F.R.S.

MASSEE, GEORGE, F.L.S., F.R.M.S.

ORDINARY MEMBERS.

WELLINGTON PHILOSOPHICAL SOCIETY.

[* Life-members.]

Adams, C. E.
Adams, C. W., Blenheim
Adams, Dr.
Allen, F.
Aston, B. C.
Atkinson, A. R.
Babbage, H. J., Wanganui
Baldwin, P. E.
Barker, G. H.
Barnes, R. J.
Barraud, W. F.
Barton, W.
Batkin, C. T.
Beetham, G.
Beetham, W. H.
Bell, E. D.
Bell, H. D.
Best, E., Hadfield
Blair, J. R.
Bothamley, A. T.
Brandon, A. de B.
Brown, E. G., A.I.C.E.
Brown, W. R. E.
Buller, Sir W. L., K.C.M.G., D.Sc., F.R.S.
Caldwell, R.
Campbell, J. P.
Chapman, Martin
Chapple, Dr.
Chudleigh, E. R.
Cohen, W. P.
Connal, E.
Davy, Dr. T. G., Kumara
Dawson, B.
Denton, George
Drew, S. H., Wanganui
Easterfield, Prof., M.A., Ph.D.
Elliot, Major E. H. J.
Evans, W. P., M.A., Ph.D.
Ewart, Dr.
Ewen, C. A.
Farquhar, H.
Ferard, B. A., Napier
Ferguson, W., C.E.
Field, H. C., Wanganui
Fraser, F. H.
Freeman, H. J.
Fyffe, Dr. K.
Gifford, A. C.
Gilruth, J. A.
Gordon, H., F.G.S.
Gore, R. B.
Grace, Hon. M. S., C.M.G., M.D.
Hadfield, E. F.
Hanify, H. P.
Harcourt, J. B.
Harding, R. Coupland
Hastie, Miss J. A.*
Hawthorne, E. F.
Haylock, A.
Hector, Sir James, K.C.M.G., M.D., F.R.S.
Henley, J. W.
Herbert, W. H.
Hislop, Hon. T.
Hogben, G., M.A.
Holmes, R. L., F.R. Met. Soc., Fiji*
Holmes, R. T., Masterton
Hudson, G. V., F.E.S.
Hustwick, T. H.
Inwood, D., Canterbury
Jenkins, Digby A.
Johnson, G. Randall*
Joynt, J. W., M.A.
Kenny, Hon. Captain C.
Keys, B.
King, T.
Kirk, H. B., M.A.
Kirk, T. W., F.L.S.
Krull, F. A., Wanganui
Lambert, T. S.
Lee, H. M.

Lewis, J. H., Otago
Liffiton, E. N., Wanganui
Litchfield, A. J., Blenheim
Lomax, H. A., Wanganui
Longton, Mrs. C. V.
Mackenzie, F. Wallace, M.B.
Maclaurin, Prof. R. C., M.A.
Marchant, J. W. A.
Martin, Dr. A.
Mason, Thomas, Hutt
Maxwell, J. P., M.Inst.C.E.
McDougall, A.
McKay, Alexander, F.G.S.
McLeod, H. N.
McWilliam, Rev. J., Otaki
Mestayer, R. L., M.Inst.C.E.
Moore, G.
Moorehouse, W. H. S.
Morison, C. B.
Murdoch, R., Wanganui
Nairn, C. J., Hawke's Bay
Newman, Alfred K., M.B., M.R.C.P.
Newman, E. W.
Orr, Robert
Park, R. G.*
Pearce, E.
Petherick, E. W.
Pharazyn, C., Wairarapa
Phillips, Coleman
Pierard, C. H.
Pollen, Hugh
Powles, C. P.
Poynton, J. W.
Prendergast, Sir J.
Pringle, T.
Purdy, Dr. J. S.
Quail, A., Palmerston N.
Reid, W. S.
Richardson, C. T.
Richardson, Hon. G. F.
Rowse, Rev. W., Greytown
Roy, R. B., New Plymouth*
Rutherfurd, A. J.
Rutherfurd, W. G.
Rutland, Joshua, Marlborough
Samuel, E.
Schaw, Major-General, C.B., R.E.
Simcox, W. H., Otaki
Sinclair, J.
Singer, J., F.C.S.
Skerman, Dr. Sydney, Marton
Smith, Charles, Wanganui
Smith, M. C.
Smith, S. Percy, F.R.G.S.
Stewart, J. T., Wanganui
Stowell, H. M.
Stuart, A. P.
Tait, P. W.
Talbot, Dr. A. G.
Tanner, Cyril
Travers, H.
Travers, W. T. L., F.L.S.
Tregear, E.
Turnbull, A. H.
Turnbull, R. T.
Turnbull, Thomas
Waley, A. S., London
Wallace, James
Waterhouse, G. M., F.R.G.S.
Welch, W., Palmerston N.
Weyergang, C. H., Taranaki
Wilton, G. W.
Woodhouse, Alfred James, London
Young, J.

AUCKLAND INSTITUTE.

[*Honorary and life members.]

Adams, J., B.A., Thames
Aickin, G., Auckland
Aitken, W. ,,
Argall, W. H., Coromandel
Aubin, E. D., M.D., Thames
Bagnall, L. J. ,,
Baker, W. H., D.Sc., Thames
Bakewell, R. H., M.D., Auckland
Ball, W. T., Auckland
Bartley, E., Devonport
Bates, T. L., Newcastle, N.S.W.*
Batger, J., Auckland
Beere, D. M., C.E., Auckland
Berry, W., Auckland
Best, Elsdon, Te Whaiti
Boscawen, H., Auckland
Brain, W. B. ,,
Brett, H. ,,
Brigham, J. M., F.R.G.S., F.I.S., Auckland
Broun, Captain T., F.E.S., Drury
Brown, Prof. F. D., Auckland
Brown, J., Epsom
Buchanan, J., Auckland
Buckland, A., Auckland*
Burgess, E. W., Devonport
Burton, Colonel, Lake Takapuna*
Busck, A., Auckland
Cameron, R., Auckland
Campbell, H. ,,
Campbell, J. L., M.D., Auckland*
Carnie, A. R., Auckland
Carr, R. A. ,,
Chambers, J., Parnell
Cheal, P. E., Auckland
Cheeseman, T. F., F.L.S., Auckland
Ching, T., Remuera
Cochrane, W. S., Auckland
Colbeck, Captain, Epsom
Combes, F. H., Auckland
Cooper, C., Auckland
Cooper, T. ,,
Cowie, Right Rev. W. G., D.D., Bishop of Auckland
Cozens, G., Auckland
Craig, E. ,,
Cussen, L., Hamilton
Dannefærd, S., Auckland
Darby, P. ,,
Dignan, P. L. ,,
Dufaur, E. T. ,,
Duthie, D. W. ,,
Eastham, S., Devonport
Edson, J. ,,
Egerton, Prof. C. W., Auckland
Ewington, F. G., Auckland
Farmer, J., London
Fowlds, G., Auckland
Fox, C. H., St. John's College
Girdler, Dr., Auckland
Goldie, D. ,,
Gorrie, W. ,,
Haines, C. H., M.D., F.R.G.S., Auckland
Haines, H., F.R.C.S., Auckland
Hardie, J., Auckland
Harding, S., C.E., Auckland
Haszard, H. D. M., Thames
Henton, J. S., Auckland
Herbert, T., Parnell
Hill, W. J., Auckland
Hume, J., Remuera
Hunter, A. J., Parnell
Johnson, H. D., Te Aroha
Kenderdine, J., Auckland
Kidd, A. ,,
Kirker, J. ,,
Kitt, T. W., London*
Lennox, J. M., Auckland
Lennox, N. G., Sydney*
Leys, T. W., Auckland
Mackellar, E. D., M.D., Auckland
McMillan, C. C., Auckland

Mahoney, T., Auckland
Mair, Captain G., Thames
Mair, R., Whangarei
Mair, S. A. R., Rangitikei
Mair, Major W. G., Auckland
Major, Rev. H. D. A., Hamilton
Marsac, A. E., M.D., Parnell
Marshall, P., F.G.S., Auckland
Martin, J., F.G.S. ,,
Masefield, T. T. ,,
McArthur, A., LL.D., Auckland
McCullough, W., Auckland
McDowell, W. C., M.D., Auckland
McLachlan, J. M., Auckland
Maclaurin, J. S. ,,
Millar, A. ,,
Miller, E. V., Chelsea
Moody, T. P., Hikurangi
Morton, H. B., Auckland
Morrin, T. ,,
Montgomery, A. ,,
Mueller, G. ,,
Munro, G. C., Sandwich Islands
Murdoch, D. L., Auckland
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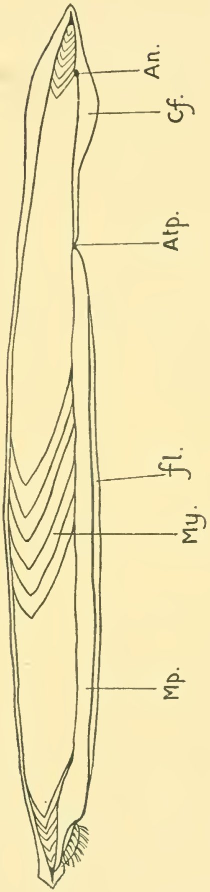

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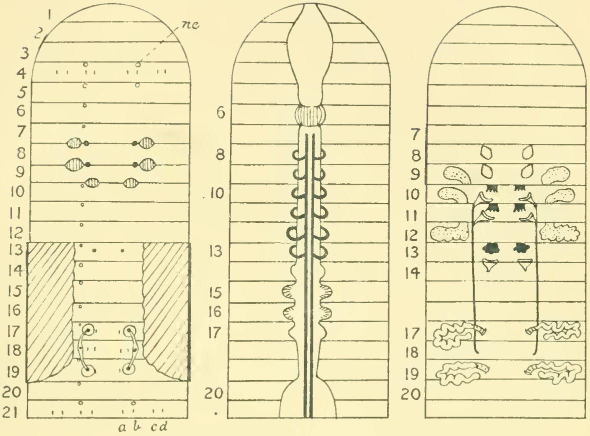

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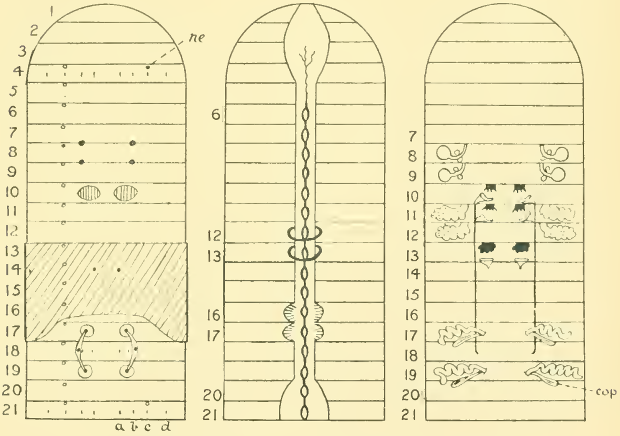

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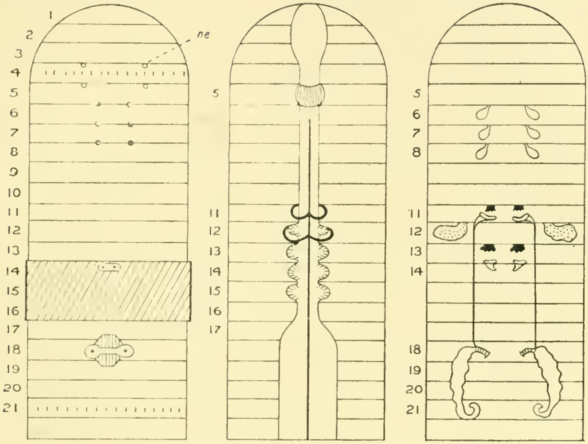

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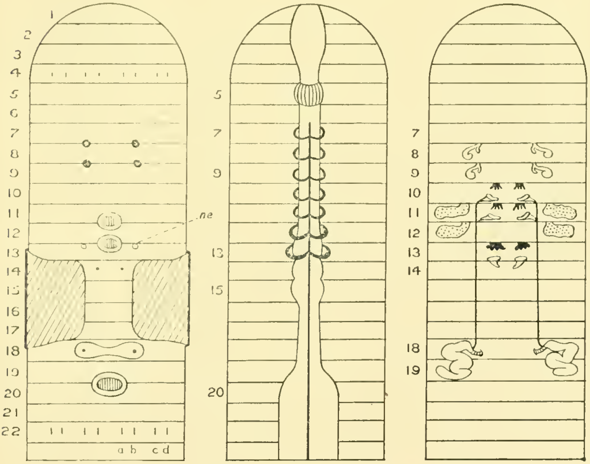

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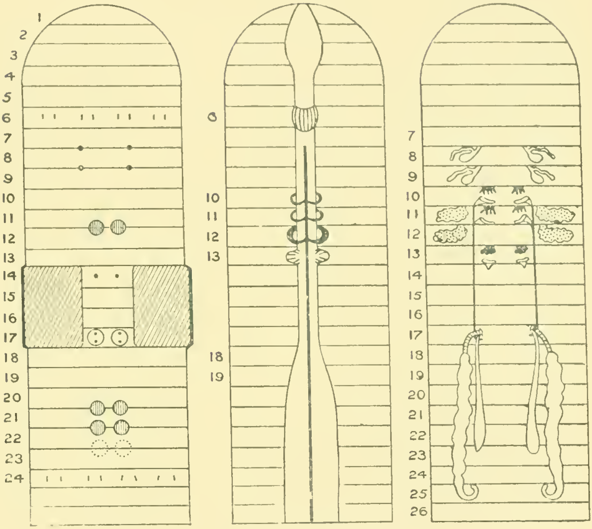

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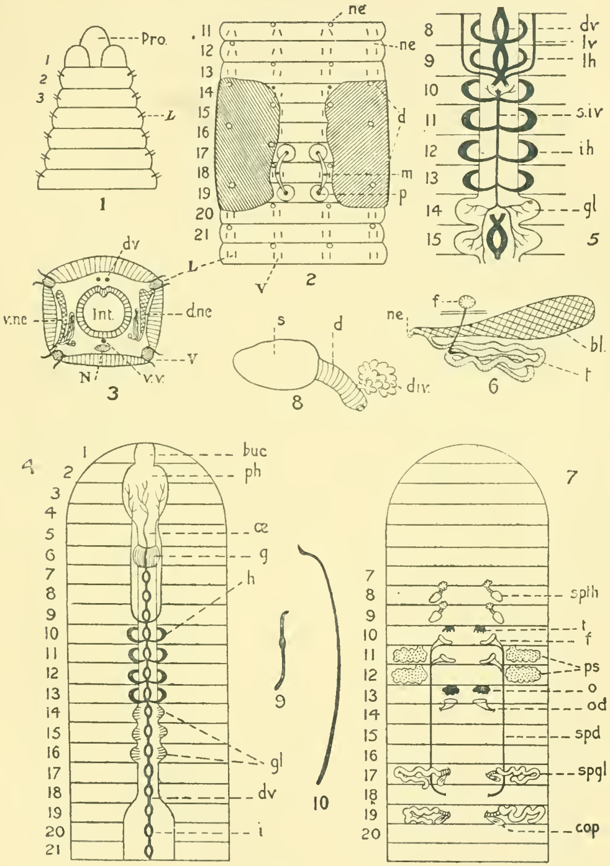

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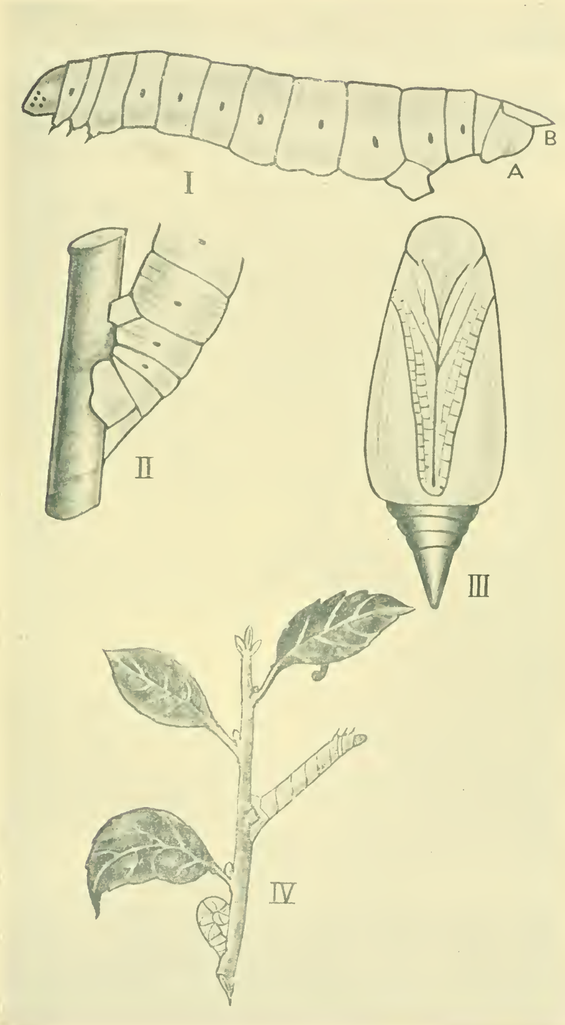

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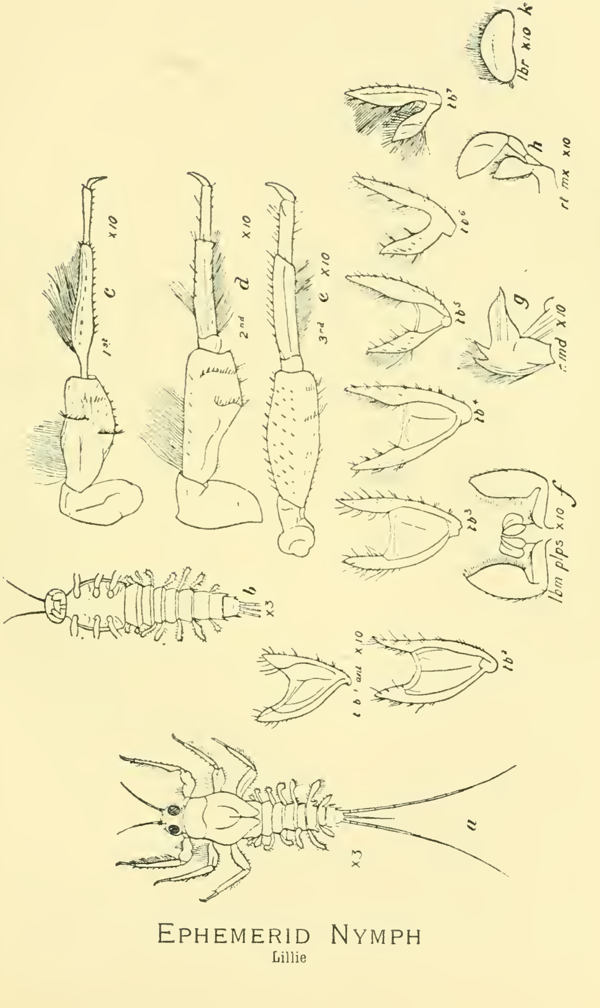

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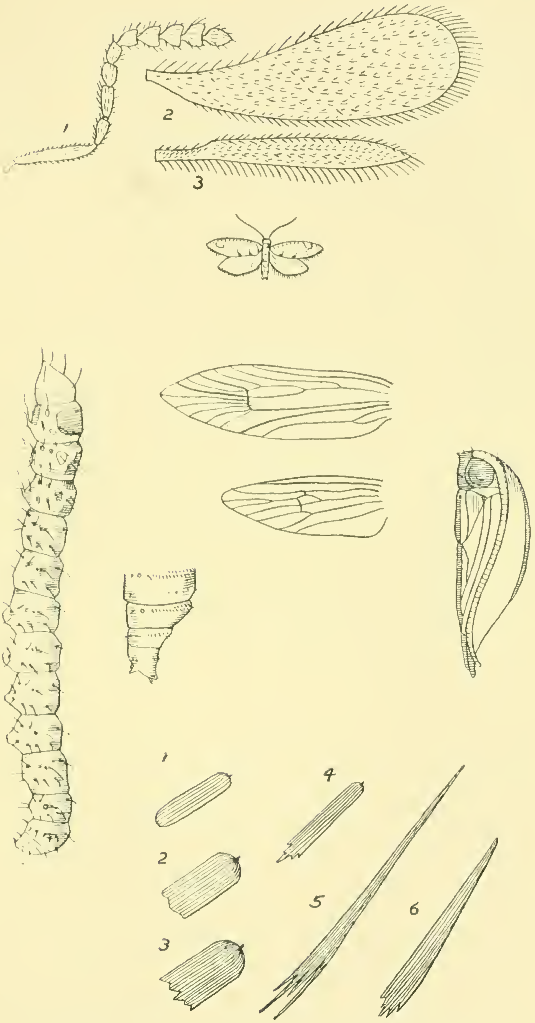

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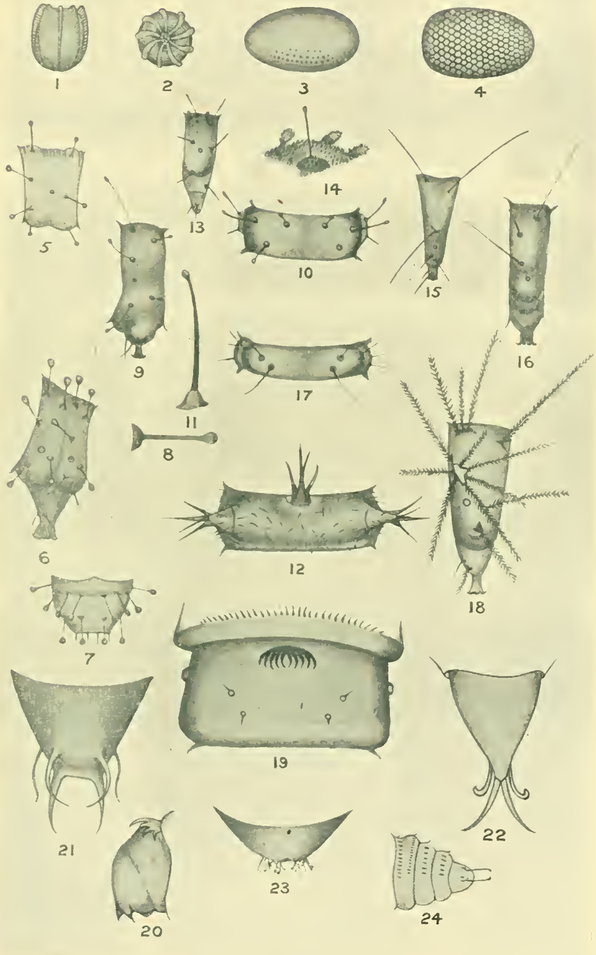

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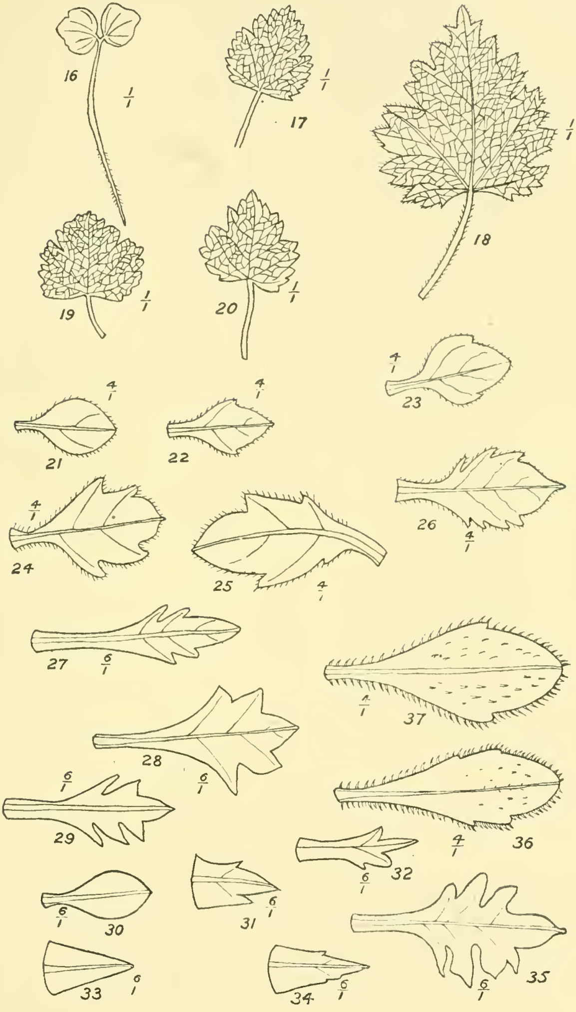

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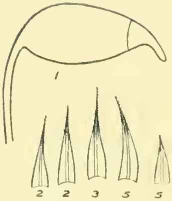

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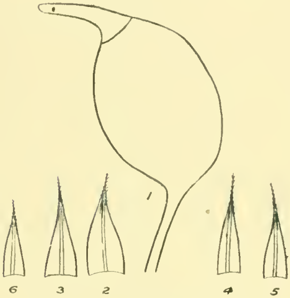

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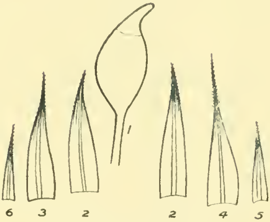

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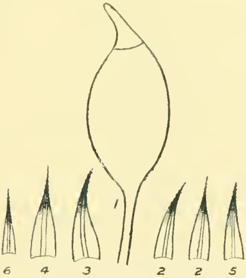

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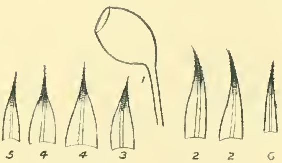
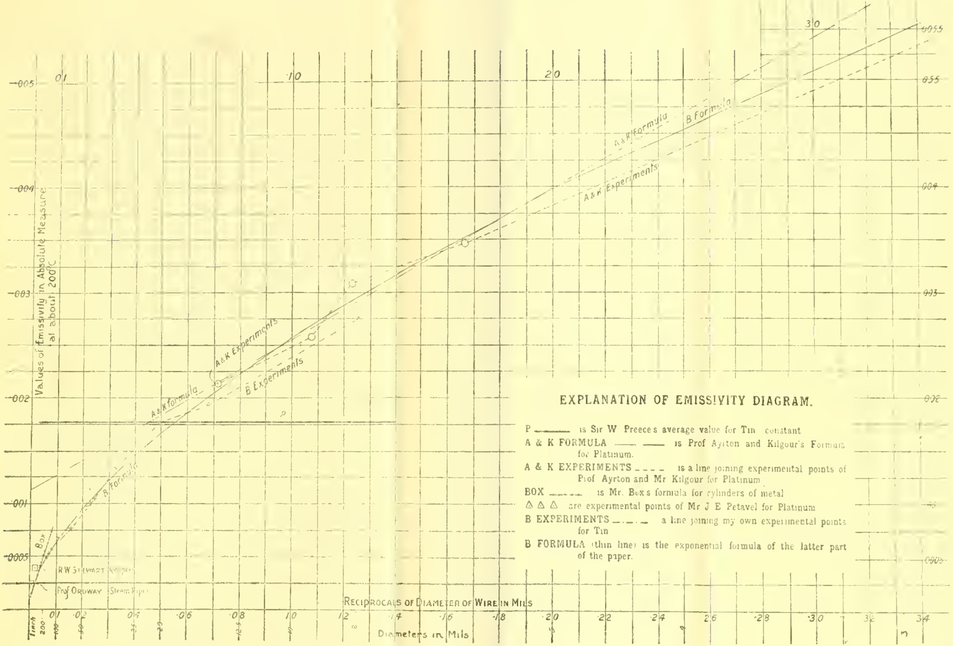


CONOSTOMUM MINUTUM SP. NOVA.

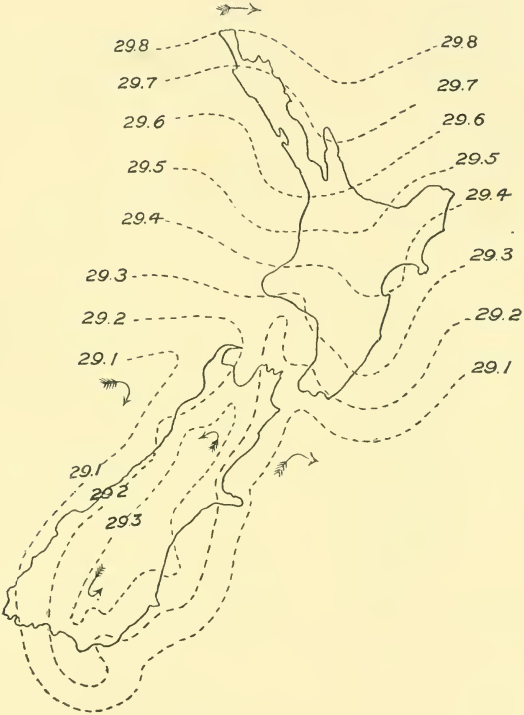
N.Z. MOSSES.

R. Brown

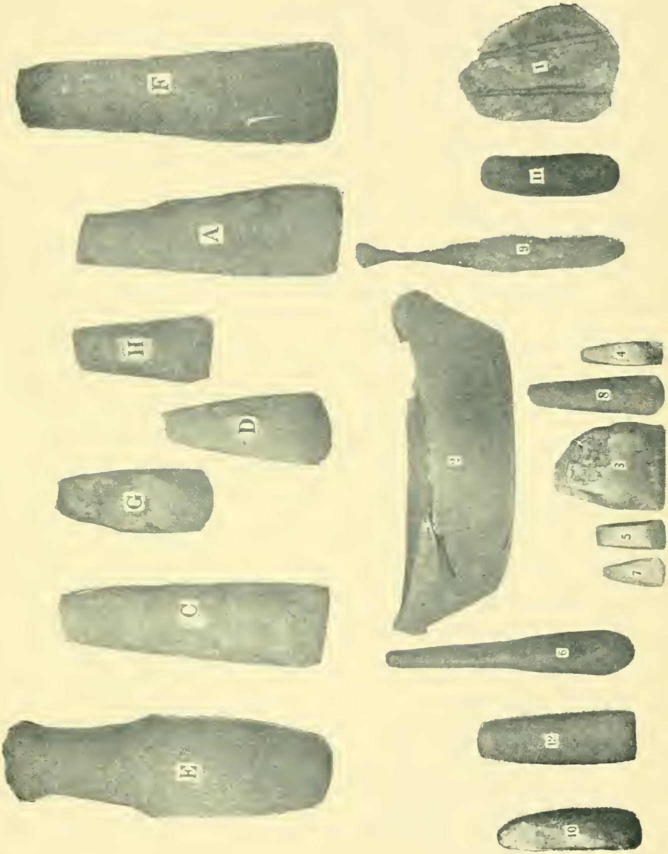


EMISSIVITY DIAGRAM

E. G. Brown.

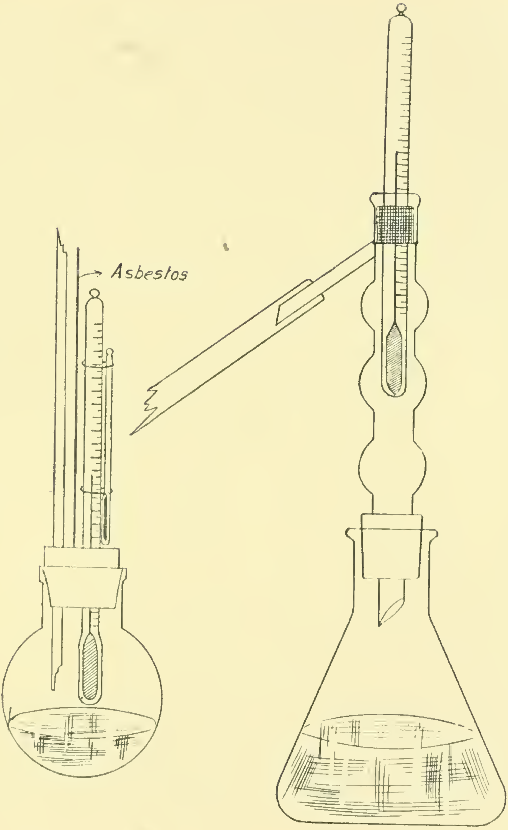


ISOBARS
Schaw



MAORI RELICS

W. Smith

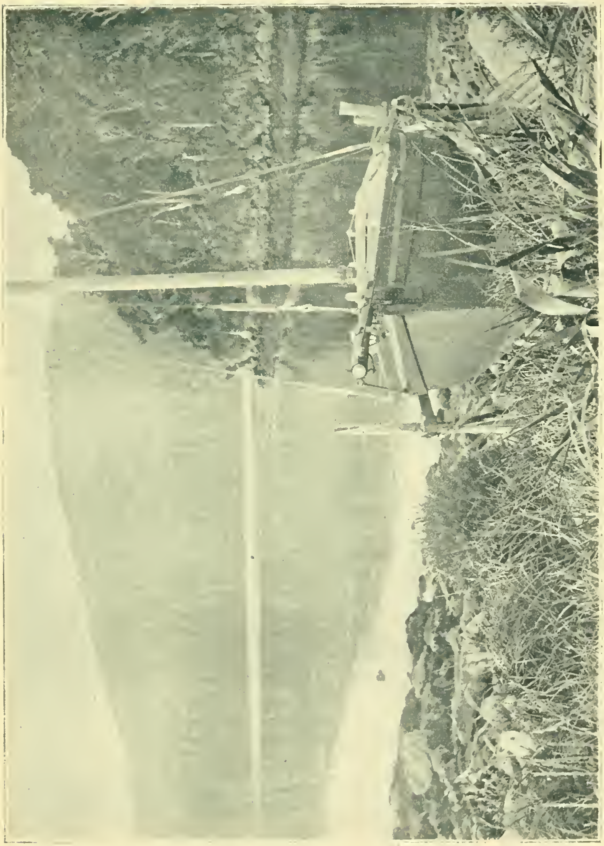


INVESTIGATION OF KAURI GUM
Prideaux

DOCTOR'S COVE, S.W. CORNER OF RESOLUTION ISLAND.

WAIHOPAI HARBOUR, S.W. CORNER OF RESOLUTION ISLAND.

NORTH SIDE OF PIGEON ISLAND. RESOLUTION IN THE DISTANCE.



BOAT HARBOUR, PIGEON ISLAND.

IN CASCADE HARBOUR.

Stumps of Trees supposed to have been cut down by Captain Cook, in March, 1773, on Astronomer's Point, Pickersgill Cove, Dusky Sound, for the purpose of securing a firm base for his observing instruments, when determining the longitude of N.Z. In December, 1863, when one of these stumps was secured for the Dunedin Museum by Dr. Hector, they were overgrown by a growth of large forest trees—J. Hector.

33
1900

TRANSACTIONS

AND

PROCEEDINGS

OF THE

NEW ZEALAND INSTITUTE

1900

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