TRANSACTIONS

AND

PROCEEDINGS

OF THE

NEW ZEALAND INSTITUTE

1907

VOL. XL

(TWENTY-SECOND OF NEW SERIES)

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

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NEW ZEALAND INSTITUTE.

ESTABLISHED UNDER AN ACT OF THE GENERAL ASSEMBLY OF NEW ZEALAND INTITULED "THE NEW ZEALAND INSTITUTE ACT, 1867"; RECONSTITUTED BY AN ACT OF THE GENERAL ASSEMBLY OF NEW ZEALAND UNDER "THE NEW ZEALAND INSTITUTE ACT, 1903."

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Secretary: Thomas King.

AFFILIATED SOCIETIES.	DATE OF AFFILIATION.
Wellington Philosophical Society ...	10th June, 1868.
Auckland Institute	10th June, 1868.
Philosophical Institute of Canterbury	22nd October, 1868.
Otago Institute	18th October, 1869.
Westland Institute	21st December, 1874.
Hawke's Bay Philosophical Institute	31st March, 1875.
Southland Institute	21st July, 1880.
Nelson Institute	20th December, 1883.
Manawatu Philosophical Society ...	16th January, 1904.

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1870.

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1872.

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1895.

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1896.

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1902.

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1903.

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1904.

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1906.

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1907.

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1903–4.

Hutton, Captain Frederick Wollaston, F.R.S.

1905–6.

Hector, Sir James, M.D., K.C.M.G., F.R.S.

1907–8.

Thomson, George Malcolm, F.L.S., F.C.S.

NEW ZEALAND INSTITUTE ACT.

THE following Act reconstituting the Institute was passed by Parliament :—

1903, No. 48.

AN ACT to reconstitute the New Zealand Institute.

[*18th November, 1903.*

WHEREAS it is desirable to reconstitute the New Zealand Institute with a view to connecting it more closely with the affiliated institutions :

Be it therefore enacted by the General Assembly of New Zealand in Parliament assembled, and by the authority of the same, as follows :—

1. The Short Title of this Act is "The New Zealand Institute Act, 1903."

2. "The New Zealand Institute Act, 1867," is hereby repealed.

3. (1.) The body hitherto known as the New Zealand Institute (hereinafter referred to as "the Institute") shall consist of the Auckland Institute, the Wellington Philosophical Society, the Philosophical Institute of Canterbury, the Otago Institute, the Hawke's Bay Philosophical Institute, the Nelson Institute, the Westland Institute, the Southland Institute, and such others as may hereafter be incorporated in accordance with regulations to be made by the Board of Governors as hereinafter mentioned.

(2.) Members of the above-named incorporated societies shall be *ipso facto* members of the Institute.

4. The control and management of the Institute shall be in the hands of a Board of Governors, constituted as follows :—

The Governor ;

The Colonial Secretary ;

Four members to be appointed by the Governor in Council during the month of December, one thousand nine hundred and three, and two members to be similarly appointed during the month of December in every succeeding year ;

Two members to be appointed by each of the incorporated societies at Auckland, Wellington, Christchurch, and Dunedin during the month of December in each alternate year ;

One member to be appointed by each of the other incorporated societies during the month of December in each alternate year.

5. (1.) Of the members appointed by the Governor in Council two shall retire annually on the appointment of their successors; the first two members to retire shall be decided by lot, and thereafter the two members longest in office without reappointment shall retire.

(2.) Subject to the provisions of the last preceding subsection, the appointed members of the Board shall hold office until the appointment of their successors.

6. The Board of Governors as above constituted shall be a body corporate, by the name of the "New Zealand Institute," and by that name they shall have perpetual succession and a common seal, and may sue and be sued, and shall have power and authority to take, purchase, and hold lands for the purposes hereinafter mentioned.

7. (1.) The Board of Governors shall have power to appoint a fit person, to be known as the "President," to superintend and carry out all necessary work in connection with the affairs of the Institute, and to provide him with such further assistance as may be required.

(2.) It shall also appoint the President or some other fit person to be editor of the Transactions of the Institute, and may appoint a committee to assist him in the work of editing the same.

(3.) It shall have power to make regulations under which societies may become incorporated to the Institute, and to declare that any incorporated society shall cease to be incorporated if such regulations are not complied with, and such regulations on being published in the *Gazette* shall have the force of law.

(4.) The Board may receive any grants, bequests, or gifts of books or specimens of any kind whatsoever for the use of the Institute, and dispose of them as it thinks fit.

(5.) The Board shall have control of the property hereinafter vested in it, and of any additions hereafter made thereto, and shall make regulations for the management of the same, for the encouragement of research by the members of the Institute, and in all matters, specified or unspecified, shall have power to act for and on behalf of the Institute.

8. Any casual vacancy on the Board of Governors, howsoever caused, shall be filled within three months by the society or authority that appointed the member whose place has become vacant, and if not filled within that time the vacancy shall be filled by the Board of Governors.

9. (1.) The first annual meeting of the Board of Governors hereinbefore constituted shall be held at Wellington on some

day in the month of January, one thousand nine hundred and four, to be fixed by the Governor, and annual meetings of the Board shall be regularly held thereafter during the month of January in each year, the date and place of such annual meeting to be fixed at the previous annual meeting.

(2.) The Board of Governors may meet during the year at such other times and places as it deems necessary.

(3.) At each annual meeting the President shall present to the meeting a report of the work of the Institute for the year preceding, and a balance-sheet, duly audited, of all sums received and paid on behalf of the Institute.

10. The Board of Governors may from time to time, as it sees fit, make arrangements for the holding of general meetings of members of the Institute, at times and places to be arranged, for the reading of scientific papers, the delivery of lectures, and for the general promotion of science in the colony by any means that may appear desirable.

11. The Colonial Treasurer shall, without further appropriation than this Act, pay to the Board of Governors the annual sum of five hundred pounds, to be applied in or towards payment of the general current expenses of the Institute.

12. (1.) On the appointment of the first Board of Governors under this Act the Board of Governors constituted under the Act hereby repealed shall cease to exist, and the property then vested in, or belonging to, or under the control of that Board shall be vested in His Majesty for the use and benefit of the public.

(2.) On the recommendation of the President of the Institute the Governor may at any time hereinafter, by Order in Council, declare that any part of such property specified in the Order shall be vested in the Board constituted under this Act.

13. All regulations, together with a copy of the Transactions of the Institute, shall be laid upon the table of both Houses of Parliament within twenty days after the meeting thereof.

REGULATIONS.

THE following are the new regulations of the New Zealand Institute under the Act of 1903:—

The word "Institute" used in the following regulations means the New Zealand Institute as constituted by "The New Zealand Institute Act, 1903."

Incorporation of Societies.

1. No society shall be incorporated with the Institute under the provisions of "The New Zealand Institute Act, 1903," unless such society shall consist of not less than twenty-five members, subscribing in the aggregate a sum of not less than £25 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 President 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 £25.

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 New Zealand Institute.

4. Any society incorporated as aforesaid which shall in any one year fail to expend the proportion of revenue specified in Regulation No. 3 aforesaid in manner provided shall from henceforth 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 then may 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—

(1.) 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";

(2.) And of transactions comprising papers read before the incorporated societies (subject, however, to selection as hereinafter mentioned), and of such other matter as the Board of Governors shall from time to time determine to publish, to be intituled "Transactions of the New Zealand Institute."

(*b*.) The Board of Governors shall determine what papers are to be published.

(*c.*) Papers not recommended for publication may be returned to their authors if so desired.

(*d.*) All papers sent in for publication must be legibly written, typewritten, or printed.

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

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

General Regulations.

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, 1903," 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 President and countersigned by the Secretary of any society, accompanied by the certificate required under Regulation 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 regulations of the Institute are complied with by the society.

9. In voting on any subject the President is to have a deliberate as well as a casting vote.

Management of the Property of the Institute.

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

Honorary Members.

11. The Board of Governors shall have power to elect honorary members (being persons not residing in the Colony of New Zealand), provided that the total number of honorary members shall not exceed thirty.

12. In case of a vacancy in the list of honorary members, each incorporated society, after intimation from the Secretary

of the Institute, may nominate for election as honorary member one person.

13. 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 President of the New Zealand Institute, and shall by him be submitted to the Governors at the next succeeding meeting.

14. The President may at any time call a meeting of the Board, and shall do so on the requisition in writing of four Governors.

15. Twenty-one days' notice of every meeting of the Board shall be given by posting the same to each Governor at an address furnished by him to the Secretary.

16. In case of a vacancy in the office of President, a meeting of the Board shall be called by the Secretary within twenty-one days to elect a new President.

17. The Governors for the time being resident or present in Wellington shall be a Standing Committee for the purpose of transacting urgent business and assisting the officers.

18. The Standing Committee may appoint persons to perform the duties of any other office which may become vacant. Any such appointment shall hold good until the next meeting of the Board, when the vacancy shall be filled.

19. The foregoing regulations may be altered or amended at any annual meeting, provided that notice be given in writing to the Secretary of the Institute not later than the 30th November.

TRANSACTIONS

TRANSACTIONS

OF THE

NEW ZEALAND INSTITUTE,

1907.

Art. I.—*Young Stages of* Dicksonia *and* Cyathea.

By G. B. Stephenson, M.Sc.

[*Read before the Manawatu Philosophical Society, 20th June,* 1907.]

Plates I–V.

Introduction.

Of late years it has been recognised that anatomical relations that are not directly dependent on the mode of life of the plant often indicate with some certainty community of descent. But Bower (Phil. Trans., 1900), in his work on the leptosporangiate ferns, practically omits anatomical structure from consideration. He points out affinities from the character of the sorus. But it was hoped, in the present work, that a study of the early stages of the different genera of tree-ferns would show that their community of descent was shown by similarity of structure: and especially that the method of attaining a tubular stele from a solid strand would show distinct constant characters. But it has been found that there is a striking similarity in the early stages of all the modern ferns investigated. Sporelings of *Lomaria, Hypolepis, Doodia, Asplenium, Polypodium punctatum, Pteris incisa,* all show a similar stelar structure to the tree-fern sporelings. It is only when the tubular stele begins to break up that marked distinctions appear. Probably in the great group of more modern ferns there is great variability even in the early stages of the sporophyte and the attainment of similar structure by plants only remotely related in the group.

In connection with this study, cultures of the prothallia of *Dicksonia squarrosa* and three *Cyatheas—dealbata, medullaris,* and *Cunninghamii*—were grown. The prothallia and the young sporophytes were imbedded in paraffin, cut with the microtome, and stained on the slide. The work was carried on in the laboratory of the Auckland University College, and the writer will always recognise a heavy debt of gratitude to Professor H. P. W. Thomas.

Sexual Generation.

The spores of the four tree-ferns studied all germinated very quickly—in two or three weeks (fig. 52). The slits of dehiscence were generally very narrow, and the spore-case remained attached. The normal heart-shaped prothallium was rapidly attained, and was similar in form and development to that of the *Polypodiaceæ.* But the tree-ferns' prothallium exhibits excessive variability. The apical cell may arise (especially in *Dicksonia*) in the cell next to the spore (fig. 57), or a long filament be formed; or even after the apical cell is formed it may grow out into a filament (fig. 62). In well-nourished prothallia, after about seven segments have been cut off, by a vertical pericline in the apical cell a three-sided initial is cut out, and a small-celled meristem now comes to occupy the depression at the apex. Normal prothallia produce a few antheridia and then archegonia on the "cushion." "Ameristic" prothallia, as usual in ferns, produce antheridia only.

The prothallia (of *Dicksonia* especially) produce adventitious "shoots" very readily if conditions are unfavourable. Filiform upright branches spring especially from the margins of male prothallia, and produce abundant antheridia. In a few cases one of these "shoots" formed an apical cell and formed a normal prothallium.

Antheridia.

All the forms examined were similar in the structure of the complex normal type of antheridium and in the variety of the reduction forms.

Normal Development.

(*a.*) Rudiment: lighter green, and more densely protoplasmic. (*b.*) Cap cell. (*c.*) Upper ring cell. (*d.*) Lower ring cell. (*e.*) Pedicil.

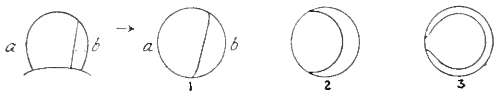
In *Dicksonia* an opercular cell was often cut out from the cap cell, and the ring cells were sometimes divided. In the reduced antheridia few walls are formed.

Absence of Pedicel.

The sperms take some time to mature, and during this time the wall is not easily permeable. The wall seems to be chemically altered for a time, so that the nearly mature sperms may not be injured if the prothallium is suddenly wetted.

The sperms are ejected rather flatly coiled, and as soon as the pellicle is softened in the water they spring out of it as if they were in a state of great tension. This movement is very jerky, especially at first. After half an hour they swim more regularly, and straighten out more as death approaches.

The "ring wall" in *Cyathea* is peculiar in that it is attached to the peripheral wall. Does this give us a suggestion as to how the ring wall originated from a form as in *Osmunda?*



Osmunda. *Cyathea.*

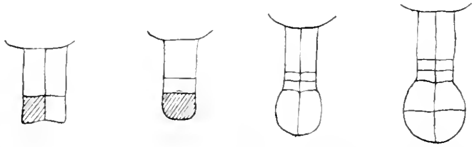
Campbell ("Mosses and Ferns") considers that the antheridia are intermediate between the *Polypodiaceæ* and the *Hymenophyllaceæ*.

ARCHEGONIA.

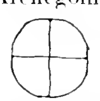
The archegonia, as Campbell states, are simply those of the *Polypodiaceæ*. It was found that the chief variations were in the basal cell and the ventral-canal cell. A single basal cell was nearly always present; there were rarely two (fig. 12), and rarely the cell seemed to be absent.

The ventral-canal cell was cut off from the apex of the central cell. Rarely it seemed to be due to the primary neck cell.

In young prothallia forming the first few archegonia the divisions of the segments at the apex do show some regularity. The basal segment may become the archegonium-rudiment (fig. 21*a*).



Archegonia may be formed at a distance behind the apex.



VIEW OF COVER ELL FROM ABOVE.

The first wall is parallel to the surface of the thallus—separating the "cover" cell, which immediately divides by a vertical wall parallel to the long axis of the thallus, and soon a wall at right angles to this follows.

The basal cell is now cut off at the base, and the central cell grows up between the cell-rows of the developing neck (fig. 13), and the primary neck cell is cut off (fig. 14), and later divides into two. When the neck is full-grown the ventral-canal cell is separated from the egg cell. When the egg is mature, and before fertilisation has taken place, the cells surrounding the egg are generally divided, so that a small-celled layer surrounds the egg (fig. 20).

Sometimes in *Cyathea* one or two cells break away on the opening of the neck.

The nucleus of the egg cell becomes very clear, and stains little just before fertilisation, and the nucleolus rapidly decreases in size.

Should an egg cell fail to be fertilised, the walls of the cells surrounding are rapidly cuticularised and turn brown. This process prevents bacteria and fungi from penetrating the soft walls round the egg (fig. 20). A similar cuticularisation takes place in prothallia attacked by fungi. A straight row of cell-walls becomes cuticularised, and the part invaded by the fungus is thus cut off.

SPOROPHYTE.

Embryo.

The embryo is closely similar to that of the *Polypodiaceæ.* Immediately after fertilisation the cells of the neck that are near the venter grow closely together and cut off communication with the outside. The oospore grows considerably before dividing, the nucleus remaining clear and nucleolus being evident. After the octants are formed, divisions become irregular, and the oval form is soon lost. A large apical cell is early recognisable in one of the cotyledonary octants, and this grows and divides more rapidly than the rest.

The stem quadrant shows little division for a time, and when the first leaf is fully developed appears as a green lateral protuberance on the leaf-base. The second leaf arises opposite the first, and the third almost opposite the second. The root is as in the *Polypodiaceæ.* The extent of foot-formation depends largely on the thickness of the prothallium. The octants that give rise to stem, leaf, and root are not in the same plane.

The first wall in the embryo is at right angles to the plane of the thallus, and the half nearest the apex of the thallus becomes stem and leaf; and this is the best disposition of the primary organs, whether the thallus is horizontal or vertical.

The Young Sporophyte.

The first leaf, guided perhaps by its positive heliotropism, soon appears between the prothallial lobes, and in *Dicksonia*, if the embryo is far from the apex, the leaf may break through the thallus.

The blade of the first leaf of *Dicksonia* consists nearly always of two equal lobes (fig. 77), but sometimes a simple spathulate form occurs similar to that of *Cyathea dealbata* (fig. 78). In *C. Cunninghamii* a more complex form is found. The attainment of the more complex form by *Dicksonia* and *C. dealbata* is dependent on the conditions of growth. For instance, under unfavourable conditions *C. dealbata* may form as many as five spathulate leaves.

The first leaf, except at the veins, consists of two layers of cells, with well-developed intercellular spaces (fig. 1).

"Rodlets" projecting into the air-spaces are not yet present in *Dicksonia*, but occur in the first leaf in *Cyathea*. These cuticular threads or rodlets are found in many different kinds of ferns, and probably point to some similar metabolic process.

The young leaves of *Dicksonia* are marked out from the others by the presence of hairs. These are sparsely scattered over the leaves along the line of the veins, and consist of eight or nine cells united into a slender filament, the terminal cell being somewhat larger and rounder. The cells of the filament become larger, with brown thick walls, as the plant grows, and finally we reach the long brown robust hairs of the mature plant, which protect the growing point and developing leaves, and later serve to retain moisture on the stem for the aerial roots.

In the young *Cyatheas* (plants of four or five leaves) short ramenta are present on the petiole, and especially at its base; but *C. dealbata* remains glabrous for some time. *C. medullaris* is more nearly similar to *Dicksonia*. Fig. 73 shows a long section of apex of *Dicksonia* (six leaves), and fig. 76 a similar stage of *Cyathea*, showing the developing ramenta (*r*).

PETIOLAR WINGS.

The first few leaves have a bulky green thin-walled cortex in the petiole. But as the leaves become more robust the assimilating tissue is found only in lateral wings, and later still in clusters of thin-walled cells forming discontinuous streaks on each side of the petiole. These groups are cut off and die; a lignification of the f.v. bundles begins. They are probably for aeration of the developing leaf.

Stomata.

Very numerous in first leaves, especially in *Dicksonia.* The mother cell is cut out from the acroscopic end of the elongating cells: auxiliary cells are absent. In the mature form (figs. 46, 47) an auxiliary cell is present, but there is much variation.

Slit of stoma parallel to line of greatest growth.

Petiole.

Dicksonia squarrosa.

In the first leaf there is a simple stele consisting of three or more tracheids grouped into a solid strand, and surrounded by two or three layers of parenchyma and an endodermis. The bundle is collateral, the few phloem elements being on one side, but the elements are more evenly distributed as we descend to the foot.

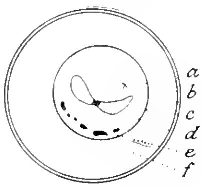
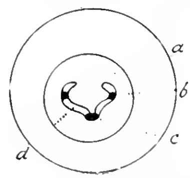


Diagram of Bundle at this Stage.

(*a.*) Phloem absent in the bay. (*b.*) Endodermis. (*c.*) Tracheids. (*d.*) Protoxylem group. (*e.*) Protophloem. (*f.*) Pericycle, with origin, with endodermis in a single original layer.

In later leaves the number of tracheids rapidly increases, and assumes the form of a shallow U, with definite spiral protoxylem in the centre (fig. 4).

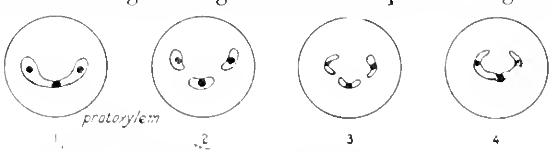


(*a.*) Phloem extends to here, and is not found inside the bay. (*b.*) Protoxylem group for insertion of pinnæ. (*c.*) Median protoxylem group. (*d.*) Xylem elements.

A few leaves later the protophloem is broken up into three separate masses (fig. 5), but the xylem forms a continuous arc.

Later again the groups of tracheids formed round the protoxylem groups are not contiguous, and now the arc is ready to break up into three separate bundles (fig. 5).

When the stem is about ½ in. and the largest leaf 2 in. the petiolar bundle breaks up into three separate portions, but these three fuse together again before the pinnæ are given off.



Base of Petiole. Just below First Pinna.

Differences between the petiole at this stage and when mature are unimportant, being only due to increase of size. In the mature form the breaking-up into separate bundles takes place very early. The separate bundles (fourteen or fifteen) take their origin almost directly from the protruding lips of the leaf-gap. But the bundles always show a single protoxylem group, and always fuse into a continuous arc before the first pinna is given off.

The protoxylem of the first few petioles is persistent, but later, when the petiole is marked by very rapid growth, the protoxylem cells are destroyed. Provision is made for this in a single layer of small dense cells that surround the protoxylem. These grow into the spaces that are left by the destruction of the spiral cells (fig. 8, *c.p.*: fig. 9, *d.l.*).

The phloem tissue, hardly distinguishable in the first few petioles, later contains very large sieve-tubes. These occur at first only on the convex side of the arc, but they finally form a ring. In the mature petiole the sieve-tubes are numerous, but each tube is in contact with at least one parenchyma cell (fig. 7).

Petioles of other ferns were examined—*Gleichenia flabellata* and *Cunninghamii*, *Aspidium aculeatum*, and *Hypolepis distans*—and though the sieve-tubes were numerous each bordered on a parenchyma cell.

Cyathea.

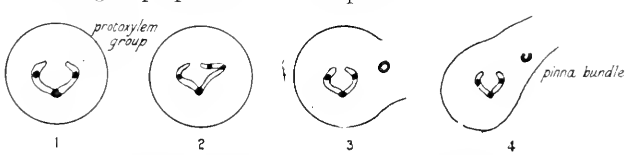
The first bundle is marked by collateral (fig. 2), and the cell-layer inside the endodermis is densely granular.

In very young leaves the petiolar arc breaks up into three, and then there is no fusion, as in *Dicksonia*, before the pinnæ are given off. Smaller differences from *Dicksonia* are in the large size of the last-formed metaxylem and the variation in position of the protoxylem group.

PINNA FROM PETIOLE.

Dicksonia.

In the first leaf of *Dicksonia* the venation is generally dichotomous. In later leaves the successive pinnæ arise by segments, being given off from the free ends of the bundle arc. But when the bundle has three groups of protoxylem elements only the two lateral groups provide for the pinnæ.

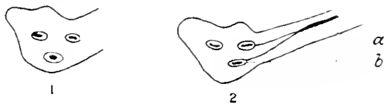


A SERIES OF SECTIONS SHOWING THE DERIVATION OF THE PINNÆ BUNDLE FROM THE PETIOLAR BUNDLE.

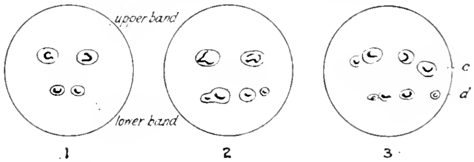
Later leaves show a similar process.

Cyathea.

In the first few leaves the process is similar to that in *Dicksonia*, but then differences arise because the arc is permanently broken into three.



First Stage. (Leaf, total length, 2 in.)
(*a.*) Pinna bundle. (*b.*) Lower median bundle takes part in the process.



Second Stage. (Leaf, total length, 10 in.)

Then the two small bundles (*c*) and (*d*) approach and fuse.

(*a.*) Upper band in pinna. (*b.*) Lower band in pinna.

A similar fusion is seen in *Pteris incisa*, *Polypodium punctatum*, and *Hypolepis distans*.

The third and final stage is similar to the second stage, but the bundles are more numerous.

(*a.*) Upper band. (*b.*) Lower band. (*c.*) Segments for pinna.

Gwynne Vaughan suggests that the curved form of petiole stele is primitive (*Loxsoma*); but this does not help us in deciding affinities. The curved form is simply the most convenient as regards strength and insertion of pinna-bundles.

Roots.

Similar in origin in the embryo and in later development, and branching to the *Polypodiaceæ*.

Often in *Dicksonia* in slender plants there is only one root per leaf for eight or nine leaves. The first few roots hardly branch at all. In *Dicksonia* in the slender diarch strand there are few protoxylem elements, but in *Cyathea* (fig. 32) they vary between two and five, the number partly depending on the branches given off.

When lignification of the cortex is taking place a few cells —especially well marked in *C. Cunninghamii*— opposite the oligogenetic rows remain thin-walled for some time, probably as long as they are likely to produce lateral rootlets. The endodermis stains deeply in acid fuchsin, but the oligogenetic rows do not stain.

The mature roots of *C. medullaris* are more robust and more variable than the others. Triarch and even tetrarch bundles are sometimes found (De Bary). This calls to mind the polyarch bundles in the *Hymenophyllaceæ*.

THE VASCULAR SYSTEM OF THE STEM.

The tracheids are scalariform in the foot of the embryo, but become spiral in first leaf and root.

Figs. 25–29 show the changes in the stele at this stage as we ascend from the root (fig. 25) to the protostele above the foot. The tracheids, at first extended in a line (fig. 26), become clustered as the foot is reached (fig. 27) and turn into a horizontal position. They turn into the vertical position again, and now the phloem is clustered to one side in the collateral bundle of the petiole.

The tracheids of the second leaf fit directly on to those of the first, and so a solid strand is found. But there is generally a change from the protostele to the tubular form of stele before the third leaf is given off. But the time is very variable, and in *Cyathea dealbata* especially the protostele may persist for five or six leaves. Sometimes the transition took place between the foot and the insertion of the first leaf (figs. 85–88). Here a few parenchymatous cells appear among the xylem elements (fig. 86), and rapidly increase in number (fig. 87), and then the segment is given off to the leaf. Figs. 79–81 show the third leaf given off in *C. dealbata* from a protostele. Here a parenchyma cell appears in preparation for the giving-off of the leaf, as in *Dicksonia*. But generally the transition in *Cyathea* is more irregular. Figs. 37–41 show the process in *C. Cunninghamii*. The sections are of the internode between the first and second leaves. The number of tracheids remains almost constant during the change.

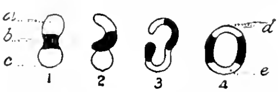


DIAGRAM OF XYLEM, SHOWING TRANSITION.

(*a.*) Part directly below third leaf. (*b.*) Cauline part. (*c.*) Part below second leaf. (*d.*) Third leaf given off here a little above. (*e.*) Second leaf now given off here.

Figs. 82–84 show the change in *C. Cunninghamii* at the base of an older plant (between first and second leaf). It will be noted that there is a considerable increase in the number of tracheids over a series in a younger plant (transition also between first and second leaf). In the younger plant there is almost constantly a single layer of tracheids on the ring; while in the same internode, if the plant has now seven or eight leaves, there are two or three layers of tracheids in a similar transition region. But without a great number of series it could not be stated that there is a late differentiation of tracheids outside the primary ring.

After the siphonostele is attained the stem increases rapidly in breadth. A well-defined endodermis is not present till the stem is about $\frac{1}{10}$ in. long.

Sieve-tubes are ill defined in the first petiole, and it is only after six or seven leaves have been formed that the tubes begin to assume the characteristic form. Distinct sieve-tubes do not appear inside the tubular stele for a considerable time.

Fig. 43 shows typical solenostelic structure, but at once the leaf-gaps begin to elongate, and persist throughout an internode.

[In the running stems which take their origin from buds formed early in the life of the plant a robust solenostele is found till the runner nears the surface of the ground and leaves are crowded again.]

Change takes place gradually till the mature form is reached: the leaf-gaps elongate, the number of orthostichies is increased, the outline of the stele becomes wavy, and the lips project to give off the leaf f.v. bundles.

The medullary bundles of the *Cyatheas* do not begin to be formed till the pith is fairly broad.

Near the apex, where the developing ring is still, meristematic groups of cells are separated by parenchyma from the ring, and these give the medullary bundles (fig. 42).

Mucilage.

No signs of a mucilage system in the early stages: mucilage-cells appear after the tubular stele is established; in the petiole especially they form regular rows.

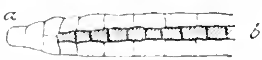


Diagram showing Origin of a Mucilage-cell Row. (Longitudinal section of leaf.)

(*a.*) Apex of leaf. (*b.*) Mucilage row.

In the petiole the rows follow the protoxylem groups rather closely, the rows being generally in the bays of the vascular arcs.

PROTOXYLEM.

The spiral elements of the petiole just join on to the stem, but the elements of the stem are scalariform.

In fig. 41 the two cells *px* are the protoxylem of the next leaf; these cells die out in the section lower down. Fig. 44 shows the stem protoxylem, but, as in *Loxsoma* (Gwynne Vaughan), these elements are scalariform.

STELAR STRUCTURE.

Up to the last few years consideration of the stele has been on the lines laid down by Van Tieghem, but lately more attention has been paid to the vascular structure of ferns, and a study of the ontogenetic development has modified the old standpoint. For instance, Jeffrey evidently considers the polystelic structure to be derived from the protostele through the siphonostele. For in an abstract (Proc. Roy. Soc.) of a paper (full paper not seen) which appeared in the Phil. Trans. Roy. Soc. there is the following: "Starting from the conception that the polystelic structure does not originate by the repeated bifurcation of the epicotyledonary central cylinder, but that the latter first becomes a concentric fibro-vascular tube, with gaps for the branches alone . . ." And in a note in the "Annals of Botany"—"*Lindsaya*, a new type of fern stele" (Tansley and Lulham): "Thus *Lindsaya* seems to furnish a phytogenetic link hitherto wanting between the protostele and solenostele, and this view is distinctly supported by the occurrence of the same stage in the ontogenetic series."

Thus the old views are being modified. The single strands no longer make us overlook the conducting system as a whole. The internal parenchyma is excluded from the stele (Jeffrey); the endodermis is no longer regarded as of great morphological importance; and a study of the ontogeny is held to be necessary for the right understanding of any form (*cf.* Farmer and Hill—*Angiopteris*: "It would appear to be probable that no right understanding of a difficult vascular structure is possible apart from a study of its ontogenetic development").

The presence, then, of the protostele in the early stages of modern types, and the persistence of the protostele in forms like *Gleichenia* and *Schizæa*, point to the protostele as the earliest form of stele. But there are two questions — (1.) Is this protostele made up of leaf-traces, or is it partly cauline? (2.) And how did the transition to the solenostele take place?

(1.) In forms with crowded leaves like *Cyathea* and *Dicksonia* it would be easy to agree that differentiation of the stele followed the differentiation of the petiole bundles; and in the earliest stages of the tree-fern the stem f.v. elements are essentially connected with leaves, though later there is some differentiation between the leaf-traces to provide a complete ring and to prepare for the insertion of leaves higher up the stem. But probably the mode of growth in *Gleichenia* and *Loxsoma* is the more primitive, and that in the ferns with crowded leaves is a later development, leading to the reduction of the cauline strand. In the primitive types we may assume that the first bundle system was differentiated to minister to the needs of a rapidly elongating spike or strobilus. Then, as the vegetative appendicular organs became larger, strands would be differentiated in them, and fit on to the central strand. Then later, as the leaves outnumbered the sporophylls and the leaves were crowded on the stem, the cauline strand was reduced, and on some ferns practically gives way to leaf-traces.

(2.) How did the transition to the solenostele take place? Of course, we can see that the ring is a better arrangement of the f.v. elements than the solid strand. If the stem is to be upright and bear a crown of leaves, only a few xylem elements will be needed, and these will strengthen the stem more and be better placed for leaf-insertion if they are in a ring; and the large undifferentiated pith may serve as a starch and water reservoir.

But how did the ring develop from the solid strand? Now, in *Gleichenia* we have a solid strand in the stem and a curved strand in the leaves; and when a part of the stem stele is cut off for the leaf, the segment remains attached to the main stele while it is assuming a curved form; and especially in *G. flabellata* the meristele remains attached at its edges to the stem stele for some time. Thus are formed "nodal islands."

Tansley and Lulham suggest that by the continuation of the nodal islands through the internode above and below a structure like *Lindsaya* would be reached—*Lindsaya* being, then, a phytogenetic link between the protostelic and solenostelic types.

But it seems probable that the transition has taken place quite independently in several groups, and the process need not be similar in all. In the *Schizæaceæ* the protostele is probably primitive, but siphonostely and even polystely has been reached in *Anemia* (Boodle). Similarly in the *Gleicheniaceæ* the protostele persists in many forms, but a solenostele has arisen in *G. pectinata* (Boodle).

In the *Marattiaceæ*, from the life-history of *Angiopteris* (Farmer and Hill, 1902), the change from protostele to siphonostele is due to parenchyma cells appearing in the centre of the xylem and the leaf removing a segment stretching to this pith. The change is somewhat similar in *Helminthostachys* (Lang, 1901, "Annals of Botany").

Perhaps it will not be out of place to refer to the running stem given off from the leaf-base in *Lomaria procera.* The stele is at first solid, and this may grow for some distance, and even branch dichotomously. But sooner or later a weak strand of parenchyma cells appears in the centre of the xylem, and rapidly increases in bulk. An island of sclerenchyma then appears in the centre of this parenchyma, and this a little later is surrounded by an endodermis; and now phloem elements are clearly visible inside the xylem ring. The runner now presents a robust solenostelic structure. Later, when leaves begin to be given off, the leaf-gaps elongate, and typical polystely results.

From a hurried study of *Aspidium aculeatum* plantlets, it seemed that robust plants with a strong protostele had parenchyma cells among the xylem, and small weak plants had a small solid strand. The transition is similar to *Dicksonia.*

Only a study of the early stages of a large number of ferns will show whether there is any constancy in the method in which the transition is made—constancy in groups of related ferns, or even in the same fern with the sporelings under varied conditions of nutrition. I incline to think that the method of change from solid strand to tubular stele is dependent somewhat on the rapidity of growth. If growth is rapid and the stem broadens quickly, some of the elements of the xylem strand will not need to function as wood elements, and so will remain undifferentiated. This will be the beginning of the pith. It was due in the early history of the stele to broadening of the stem, and consequent loss of function of some of the more deeply placed water-carriers, and these remained undifferentiated; then the stem widened further, and the segment of the xylem cut out for the leaf extended right to the pith; and then phloem elements would extend down into the pith, because the pith, now it is not cut off from the leaves by the xylem ring, can be advantageously used for storage of starch.

Polystely is only a well-marked variety of the tubular stele. Here the continuous ring is broken up by gaps other than those above the leaf-insertion. The change from the tube to the extreme polystely of some *Polypodiums*—*cf. P. serpens* and *P. novæ-zelandiæ*—is due to change of stem-habit. When the rhizome becomes thick because it is used for water and starch storage, and a creeping habit necessitates no mechanical strengthening, then only those wood elements of the primitive ring are differentiated which are needed for water-carriage. The ring could have been widened and attenuated, but this would not serve so well as the network that represents the tube.

Conclusion.

The study of the structure of the few tree-ferns examined, and their comparison with other forms, makes me feel that the form of the stele is too directly adaptive to prove relationship. Among the modern ferns the function of the stem decides the form of stele. If the stem is a creeping one, and not too bulky, then a tubular stele is found—*cf.* some species of *Pteris*, *Hypolepis*, *Polypodium punctatum*, runners of *Dicksonia* and of *Lomaria procera*.

If the creeping stem is extensively used for storage of starch and water, then extreme polystely will be found. If the stem is upright and the leaves crowded, a tubular stele, with leaf-gaps, will result, as in the tree-ferns, and in a less developed form in large forms of *Polypodium pennigerum* and *Aspidium aculeatum*.

The transition from the solid strand to the tubular form in any particular fern now is not important from an historical point of view. Perhaps the idea that in the ferns function insures differentiation, and unless there is functioning to be done no differentiation follows, suggests how the parenchyma appeared in bulky stems in the first place; and the same tendency results in extreme polystely in some ferns now.

But as far as the relationship between *Dicksonia* and *Cyathea* is concerned, though no single similarity will prove anything, yet the similarity of means employed in the young plants in overcoming the environment at a great many points does point to a similar inherited constitution.

EXPLANATION OF PLATES I–V.

Plate I.

Fig. 1. Transverse section, first leaf *Dicksonia squarrosa*. × 125.

Fig. 2. Transverse section, petiole first leaf *Cyathea dealbata*. × 250. *end.*, endodermis; *ph.*, phloem; *p.c.*, dense pericycle.

Fig. 3. Transverse section, stele of same plant (as in fig. 2); starch as yet absent. × 250.

Fig. 4. Transverse section, third petiole of *Dicksonia*; collateral stele. × 175.

Fig. 5. Transverse section, petiole *Dicksonia*. In next leaf meristele breaks into three. × 125.

Fig. 6. Transverse section, single bundle of mature petiole *Dicksonia*. × 80. *pph.*, protophloem; *s.t.p.*, sieve-tube parenchyma; *c.p.*, cavity parenchyma.

Fig. 7. Part of petiole bundle, showing relation between *s.t.* and parenchyma. × 175. *x.p.*, parenchyma cells, rich in starch, lining the xylem cells.

Fig. 8. Another part of same, showing cavity parenchyma. × 250.

Fig. 9. Transverse section, immature petiole. × 250. *px.*, protoxylem; *i.v.*, young tracheid; *d.l.*, dense layer of cells surrounding the protoxylem, and growing in to form the cavity parenchyma.
Fig. 10. Bundle of leaf of *Dicksonia*, near end of leaflet. × 250.
Fig. 11. Bundle of leaf of *Cyathea dealbata*, near end of leaflet. × 250.

PLATES II, III.

Figs. 12–18. Vertical (microtome) sections of prothallia of *Dicksonia squarrosa* parallel to longitudinal axis of thallus. The sections show the development of the archegonium. × 250.
Fig. 19. Sections parallel to surface, showing cells cut off in the parenchyma surrounding the egg cell. × 250.
Fig. 20. Similar section, showing cuticularisation of walls of venter. × 250.
Figs. 21–24. Surface views of young prothallia and their first archegonia. The shaded cells are the archegonium mother cells (*C. medullaris*). × 250.
Figs. 25–29. Transition from stele of root (fig. 25) to just below foot (fig. 27) to protostele of stem (fig. 29). × 250.
Fig. 30. Transverse section, first root *C. dealbata*. Characteristic thickened layer. × 250.
Fig. 31. Mature root *D. squarrosa*. *c.*, compressed tissue. × 120.
Fig. 32. Part mature root *C. Cunninghamii*, showing separated protoxylem. × 120.
Figs. 33–36. *C. dealbata*. Four successive transverse sections near apex, showing insertion of protoxylem elements of the petiole x_1, x_2, on to those of stem s_1–s_5. s_3 and s_5 are connected with next leaf. × 250.
Figs. 37–41. Transition protostele to siphonostele in *C. Cunninghamii*, between first and second leaves. × 250.
Fig. 42. Early stage, medullary bundle, *C. Cunninghamii*. × 250.
Fig. 43. Solenostele in a *Dicksonia*, $\frac{1}{10}$ in. long. × 60.
Fig. 44. Transverse section near apex of runner of *D. fibrosa*, showing the scalariform irregularly disposed first-formed xylem. × 80.
Fig. 45. Transverse section, stem, mature *Dicksonia*. Tracheids in rather regular rows, with parenchyma between. Well-defined layer of sieve-tubes. × 60.

PLATE IV.

Figs. 46, 47. Epidermis developing leaf, *C. dealbata* and *D. squarrosa*.
Fig. 48. Apex leaf, longitudinal section.
Fig. 49. Stoma, nearly mature, seen from below.
Figs. 50–59. Developed prothallia, *D. squarrosa*.
Figs. 60–68. *Cyathea Cunninghamii*. Figs. 60–63, abnormal forms, due to overcrowding; figs. 64–68, antheridia on filamentous prothallia.
Fig. 69. Vertical section, embryo, with basal and quadrant walls darkened. *c.*, apical cell, first leaf; *st.*, stem quadrant; *f.*, foot quadrant.
Fig. 70. Later embryo. Only root and first leaf have grown much.
Figs. 71, 72. Embryos dissected out and mounted whole.
Fig. 73. *Dicksonia*, six leaves; longitudinal section, showing apical cell.
Fig. 74. Transverse section, similar stage.
Fig. 75. Transverse section, mature apex of *C. dealbata*. Segments cut off in order (s_1, s_2, s_3).

Fig. 76. Longitudinal section, apex *C. Cunninghamii* (seven leaves). *r.*, ramenta.
Fig. 77. Young plant, *D. squarrosa*.
Fig. 78. Young plant, *C. dealbata*.

PLATE V.

Figs. 79–81. Protostele of *C. dealbata*, giving off petiole bundle (x_1, x_1). A parenchyma cell (*p.*) first appears in the xylem. × 330.
Figs. 82–84. *C. Cunninghamii*. Protostele to siphonostele. × 330. *l*, the first leaf, has been given off here. In fig. 84 note the distinction between the parenchyma of second-leaf bay and that of stem (below third leaf).
Figs. 85–88. *Dicksonia squarrosa*. Similar transition. Sections between the first leaf and the foot (the plant had four leaves) × 330 In fig. 86, *p.*, parenchyma cells appearing; in fig. 87, parenchyma increased—*px.*, protoxylem from the leaf; fig. 88, above insertion of leaf.

ART. II.—*Some Aspects of the Terrace-development in the Valleys of the Canterbury Rivers.*

By R. SPEIGHT, M.A., B.Sc.

[*Read before the Philosophical Institute of Canterbury, 1st May, 1907.*]

Plates VI–VIIA.

PART I.

Explanatory.

THE substance of this paper formed part of an ex-presidential address delivered before the Philosophical Institute of Canterbury. Considerable alterations and additions have been made to it, but the main conclusions stated originally have been retained, and further evidence put forward in support of them. The paper attempts to give, first of all, some account of the mode of formation of the terraces in the main river-valleys, and then considers the evidence of elevation and depression of the land during late geological times. Without attempting to summarise and criticize all that has been written on the subject, the author gives some account of this, especially in its bearing on terrace-formation, and finally he draws attention to the importance of frost erosion in the Canterbury mountains, and suggests that the supply of waste is a powerful factor affecting the erosive power of the rivers, and therefore, directly or indirectly, the conditions favourable to terrace-development.

Introductory.

The rivers of Canterbury which will be considered in this paper are those of the middle district—viz., the Waimakariri, Rakaia, Ashburton, and Rangitata. They closely resemble each other as regards the conditions under which the valleys were formed (with the partial exception of the Ashburton), so that statements made about one generally apply to all. They all rise in the main range of the Southern Alps (or close to it), and flow in a south-easterly direction till they reach the sea, the first half of their course being through the mountainous region of western Canterbury, and the second half across the plains which fringe this region on the south-east. The rocks of the first portion consist principally of folded slates, sandstones, greywackes, and allied sedimentaries chiefly of Lower Mesozoic age. Palæozoic rocks doubtless occur on the eastern and western margins of the mountain region, but the general absence of fossil evidence renders their true age difficult to determine.

The folding of these rocks occurred most probably in Upper Jurassic times, but traces of an earlier folding are also found. They are distinguished throughout the whole area by excessive jointing, which has rendered them particularly susceptible to the disintegrating action of frost, and has caused them to split readily into more or less rectangular and prismatic blocks. This effect is so marked that many of the mountains are, for several thousand feet in altitude, covered with a coating of *débris* so thoroughly that solid rock is scarcely visible. This is constantly moving down to lower levels under the influence of the transporting agents which operate in mountain tracts, but principally owing to the torrents formed by melting snows.

The rocks of which the plains have been formed consist chiefly of gravels, more or less perfectly rounded, and of sands, silts, and mud. The last predominates in the outer margin of the plains. There is in some cases an admixture of volcanic material and limestone, but these are of relatively minor importance.

The western mountain area formed at one time part of a great peneplain, and this has now been thoroughly dissected. The paths of the rivers are generally at right angles to the strike of the beds, so that the main streams may be called consequent, while the tributaries are generally parallel to the strike, and are therefore subsequent; but, owing to the age of the river-valleys and the influence of other disturbing agencies, marked departures from this rule frequently occur. A recent severe glaciation, after the valleys had reached a mature stage, exerted great influence on them, and its effects are still plainly evident. The rivers are all perfectly graded at the present time, but it is highly likely that they had reached an approximately similar condition in Oligocene times, as pointed out by Captain Hutton.

Although the mountain tract of the province has been thoroughly dissected, the plains are practically undissected, if we omit consideration of that dissection which is due immediately to the rivers themselves. They receive hardly any tributaries after they leave the mountains; the rain which falls on the plains soaks rapidly through the porous beds, and finds its way to the sea by percolation through the underlying shingle. The rivers do receive some tributaries—*e.g.*, the Kowhai runs into the Waimakariri, and four rivers coalesce to form the Ashburton—but they all rise in the foothills, and derive little of their water from the rainfall on the plains. It is therefore evident that there is a marked contrast between the physiographic conditions of the upper portion of the rivers and that of their lower courses, and hence the conditions which affect the terrace-development are highly dissimilar.

If we examine the valleys of the large rivers we find that their courses may be divided into four parts, relative to their terrace-development: (1.) The torrent path, where terraces are, as a rule, absent. (2.) A wider valley path, where the rivers are aggrading their beds, river terraces being absent, but glacial terraces or shelves common. (3.) A gorge path, where rivers burst through the outer range of Palæozoic rocks on a line running through Mount Hutt and Mount Torlesse: in this case the terraces have their highest development. (4.) A plain path—*i.e.*, the path from the foot of the mountains to the sea, where terraces are again strongly developed, but are, as a general rule, of a simple and continuous character.

The Torrent Path.

The rivers begin as fair-sized streams from the terminals of glaciers, and this part of their course shows the general characters of torrent and glacial erosion. The valleys are typically U-shaped, with flat floors and sides so steep as to be at times unscalable for miles. They show signs of having been recently swept clean, but are filling again with waste coming in from the sides. There are no terraces except those due directly to glacier action. Lateral moraines occasionally form terraces, but only in those places where they have been protected from the scouring action of the wild torrents which sweep this portion of their valleys. A frequent position for these terraces is round the end of a spur, and they slope down the valley at a steep angle, indicating a rapid fall in the level of the surface of the glacier, owing to its expanding as it accommodated itself to a part of the valley where the cross section was greater. The valley-walls also show signs of the truncation or partial truncation of the spurs. This is often attended by the formation of short glacier shelves due to the erosive action of the glacier. These shelves occur particularly where the glacier came over the shoulder of a spur and cut down its bed in a manner analogous to the action of a corroding stream. Good illustrations of this are to be seen towards the head of the Waimakariri, up the Bealey River, at Arthur's Pass, and in the neighbourhood of the West Coast Road between the Cass and the head of Sloven's Creek; but these last cases belong to another part of the river-valley.

The Valley Path.

The first part of the river-course grades into the second. Here the valley is flatter and wider, and still shows signs of glacier erosion; glacial terraces or shelves are common in much the same position as in the first part of the river-course, frequently in sets of three, as noted by Captain Hutton. In some cases it seems likely that terraces are formed by the erosive action of tributary glaciers. These are turned round by the resistance of the main glacier at the junction, and made to override the projecting spurs on the downstream side of the valley. The spurs are thus cut down to a marked degree, and show true terraces of primary erosion. These terraces are cut out of solid rock, and have a steep fall downstream—steeper than the grade of the valley, and of no great length parallel to its axis. This action is most probably going on now where the Ball Glacier joins the Tasman; and if we could see the side of the valley underneath, it would almost certainly show these glacier terraces. Good illustrations occur where a large stream, the name of which is unknown to me, joins the Waimakariri on its south bank about six miles above Bealey. This case is a most important one, as it shows conclusively that even the smaller tributary valleys were formed previous to the recent glaciation. The stream enters the main river by a channel cut out of the solid rock, and in the bottom of this glacial striæ are plainly visible, running across the bed of the stream and nearly parallel to the axis of the main valley. The channel must have been eroded previous to the glaciation, as it is very well marked, and depressed about 50 ft. below the level of the surrounding rocks, which are remarkably ice-worn as well, and form part of a truncated spur entering the main valley at right angles. It appears almost impossible that the channel of the stream can have been formed solely by glacier erosion, and the recency of the glaciation is emphasized by the perfection of the markings in a position where they are very likely to be effaced.

Apart from the glacier shelves there are no terraces, as in this portion of their course the rivers are aggrading their beds. The supply of waste is almost inexhaustible. It is poured in by every tributary stream and every shingle-slip, and the grade of the river is not sufficient for its transportation. Where the tributaries are large, the result is to flatten the grade of the main river above the junction and to push the main river over to the opposite side of the valley. This effect is especially marked in the case of the Bealey River. Surveys carried out by Mr. Edward Dobson, C.E., when searching for the best route to the West Coast, show undoubtedly that the grade of the Waimakariri has been considerably modified, in the manner suggested, by the action of this large tributary. The main river is not competent to remove the load poured into it.

This portion of the river-valley has been deepened by glacier erosion, though not to any great extent, as the *roches moutonnees* in the Rangitata, Rakaia, and Waimakariri valleys show; but the rivers have no power now to form terraces, except very low and temporary ones.

The valleys at the head of Lakes Pukaki and Tekapo, in the basin of the Waitaki, show the conditions which prevailed in all the valleys in Canterbury after the maximum glaciation was past. A lake occupied the Lower Rakaia Valley, ponded back by a bar stretching across the mouth of the gorge; a similar lake filled the Waimakariri Valley from the gorge as far as the junction with the Hawdon River, if not farther, and in all probability one existed in the Rangitata.

The formation of these lakes is due to one of two causes—(1) to the elevation of the land along an axis which coincides with the outer range forming the eastern boundary of the Southern Alps; or (2) to glacier erosion.

If this axis of elevation really exists, it would be approximately in a line with that running through the Kaikoura Mountains, where crustal movements are now going on. This axis has, without doubt, extended from the Kaikouras in a south-westerly direction, and perhaps the great Waipara fault has been associated with this earth-movement. The fault is of very recent date, and coincides with the gorge of the Waipara River, and has a downthrow to the north of over 1,000 ft. Unless this fault is due to lateral movement, it is necessary that a thickness of 1,000 ft. has been removed from rocks about the Weka Pass and Waipara River, for the escarpment of the Mount Brown beds presents a tolerably even line both north and south of the fault-line. The physical features are more easily explained by a lateral movement of the rocks, resulting in fracture along the gorge of the Waipara. The force producing this rupture must have come from the south-east, and it is therefore likely that it affected the rocks further south-west. If this axis extends into mid-Canterbury, it might account for the slight break in the grade of the rivers which occurs at their gorges. They have a flat grade above and a steeper grade below, as the following table taken from Haast's "Geology of Canterbury" will show:—

	Distance in Miles.	Fall of Rivers, per Mile.
Rangitata—		
From junction of Havelock and Clyde to beginning of plains	29	35
From beginning of plains to railway ..	$23\frac{1}{4}$	$39\frac{3}{4}$
From railway-crossing to sea	$8\frac{3}{4}$	29
Ashburton—		
From Clearwater Creek to beginning of plains near Two Brothers	$11\frac{1}{2}$	$37\frac{1}{2}$
From Two Brothers to railway ..	25	44
From railway to sea..	$10\frac{1}{2}$	$28\frac{3}{4}$
Rakaia—		
From junction of Wilberforce River to Gorge Island	19	$25\frac{1}{2}$
From Gorge Island to railway ..	$21\frac{1}{2}$	$23\frac{1}{2}$
From railway to sea	16	$23\frac{1}{4}$
Waimakariri—		
From junction of Bealey River to junction of the Esk River..	21	24
From junction of Esk River to junction of Kowhai River	17	33
From junction of Kowhai to White's old accommodation - house at height of 605 ft.	15	$26\frac{1}{4}$
From White's accommodation-house to tidal boundary	22	$27\frac{1}{2}$

The flat grade followed by a steeper grade is apparent in the Rangitata, Ashburton, and Waimakariri; but in the case of the Rakaia there is no marked break: its bed is almost uniformly graded for a long part of its course. This difference in grade may be due to crustal movements, but I think it is more probably due to glacier erosion; however, there is no impossibility that it may be due to both causes. The Canterbury valleys are of very ancient date, and were developed to a mature stage before the recent glacier extension. The glaciers hollowed out their middle portion, particularly where two valleys join, but left across the mouth a bar of solid rock, owing to the falling-off in erosive power near the terminal face. Behind this bar there is always a deep depression or basin in the solid rock—

as much as 500 ft. in the case of the Rakaia—and the hypothesis of the axis of elevation seems hardly competent to explain this remarkable occurrence in the valleys of all the principal rivers.

The deepened portion of the valley has been filled with glacial silt and angular *débris* from the hills; traces of old sub-lacustrine fans or deltas are to be seen in many places. These sedimentary beds are now being eroded by the rivers as they cut down through the bars of solid rock that form the main floor of the gorges by which the rivers issue on to the plains. The present shape of the river-valleys is due, therefore, to the modifying action of glaciers and other agencies on a previous matured stream system, the rough features of which were antecedent to the glacier extension. With this explanation it will be possible to consider the third division of the rivers' course as regards their terrace-development.

The Gorge Path.

In this paper I apply the term "gorge path" to that part of the river-course from its first meeting the lacustrine beds above the bar of rock till it has freed itself from all rock obstructions in the upper portion of the plains. It is only the middle section of this which shows the true character of a river gorge; but it is most convenient to consider the more extended length with regard to the terraces.

The three principal rivers of northern Canterbury burst through the outer range of mountains by gorges of a similar type. The Ashburton Gorge was formed under peculiar conditions, owing to the great changes in the directions of drainage caused by the extension of the glaciers. If we take the Rakaia as a typical case, we have a river flowing through a bed of glacial silt which partially filled the old Rakaia Lake, and then coming to a winding gorge cut out of the solid rock which forms the floor of a wide valley. This valley is nearly three miles in width, tolerably flat, but covered with heaps of morainic and fluvio-morainic matter. The river flows in meanders at a depth of nearly 500 ft. below the main floor. This winding trench was begun immediately after the ice began to retreat, no doubt while the lake was in existence above the solid bar of rock. Owing to increased power of corrasion, the river has deepened its meanders far below the upper floor of the gorge, and is now actively removing the projecting spurs between them. Several cases of nearly demolished spurs and of islets in the river-bed which are now quite cut off are to be seen in the Waimakariri as well as in the Rakaia.

Overlying the outer portion of the flat valley are the gravels of the Canterbury Plains. They rise in the Waimakariri fully 200 ft. above the wide floor of the upper gorge, and are found at places in the gorge itself. The plains are formed by the overlapping and coalescing of the fans of great Pleistocene and Post-Pleistocene rivers, and have covered up nearly all irregularities in the solid floor of the land; though at such places as Gorge Hill, Burnt Hill, View Hill, the older rocks are visible above the level of the plain. Owing to the rivers cutting down through the gravels the solid floor has been exposed in other cases. In this gorge portion the terrace-development is most perfect. In the Rakaia, sixteen terraces may be counted from the top of the heaps of morainic matter down to the level of the river—that is, in a height of 500 ft. The other river-valleys show similar phenomena, though perhaps the sequence is not so complete.

It seems highly likely that this portion of the river-valley was filled by gravels up to a certain level previous to the glacier maximum, as the moraines and fluvio-morainic deposits overlie the gravels at the mouth of the gorge. This filling-up might have happened several times during the Tertiary era, as our valleys were largely excavated before the Oligocene period, as emphasized by Captain Hutton, and it is possible for a glacier to override even loose gravels at its terminal face without displacing them. Some of the lower gravel-beds just below the Rakaia Gorge are so highly coloured by hydrated iron-oxide as to afford an easy means of distinguishing them from the upper gravel-beds. This points to a considerable lapse of time in order to allow for this oxidation, and suggests a much older date for the lower gravels. However, this evidence is by no means conclusive. The fact that the glacier deposits overlie the gravels of the plain is important, as showing that the extension of the glaciers was subsequent to the deposition of the gravels in this upper portion of the plains.

Terraces near the Gorge.

An examination shows that a great majority of the terraces in this part of the river's course are connected in some way with obstructions met with by the river as it cut its bed through the lacustrine silt just above the gorge proper, or through the gravels of the plains just below it. A number in the gorge itself are rock-cut terraces covered with a thin veneer of gravel.

As nearly all terraces are the remains of former flood plains—whether they are cut terraces or built terraces, or formed by a combination of both processes—any circumstances which tend to preserve these flood plains will favour terrace-development.

I select the Rakaia Gorge as typical of all the rivers, because it is the simplest in form, and now consider how the terraces arise here in the light of the fact that they are the remains of former flood plains.

In the Rakaia Gorge they are nearly all connected with obstructions :—

(1.) The highest ones are intimately related with the morainic heaps of the old glaciers, or those heaps of morainic material but roughly assorted by fluvio-glacial action. The rough angular and subangular blocks were rather difficult to remove by river action, and they protected portions of the original gravels, or they allowed flood plains to be built up under their protection either on the upstream side or on the downstream side of the obstruction. The topmost terraces are nearly all associated with these morainic heaps, and they form a series totally distinct from the lower ones.

(2.) The lower series of terraces have in most cases some connection with the underlying hard rocks, which in the Rakaia Gorge are principally volcanic. The flood-plain remnants are frequently on the downstream side of prominent bluffs of solid rock. These protect flood plains which have been built up on a foundation of solid rock or cut out of former river gravels. The bluff causes the stream to move across towards the opposite bank. Flood plains are therefore likely to form under its protection, as there is likely to be relatively slack water immediately below it in which suspended matter is dropped. A flood plain is thus rapidly formed, and when formed the bluff continues to protect it, prolong its life, and thus promote terrace-development. If these terraces have been formed on a floo of solid rock they will be doubly secure, owing to the influence of cause No. 3, mentioned subsequently. If, however, they are terraces cut out of old gravels, the bluff will still exert a protective influence. The former condition explains the occurrence of most of the terraces in the gorge proper ; immediately after the river has passed through the gorge, the latter is the most important. The sheltering action of bluffs is very apparent in the Ashburton and Waimakariri Valleys.

(3.) The third condition which promotes terrace-development near the gorge of the river is the occurrence of defending ledges of solid rock, which the river exposes as it lowers its bed through the gravels and lacustrine silts above the rock bar, or through the gravels of the plains immediately below it. The influence of defensive ledges was urged by Hugh Miller the Younger in a paper read before the Royal Society of Edinburgh in the year 1882. I have not been able to see this paper, but an account of Miller's theory was published in the "American Journal of

Science," vol. xii, 1902, by Professor W. M. Davis when describing the Terraces of Westfield River, Mass. The phenomena he there describes are reproduced in our rivers: good examples occur in the Rakaia, but excellent ones are to be seen in the Waimakariri at Little Gorge Hill, where the railway crosses.

It may be urged that there is no great difference between cause (2) and cause (3). It is quite true that a defending ledge may, under certain circumstances, become a protecting bluff; but the latter will be after the bluff has done duty as a defending ledge and the river has lowered its bed considerably. However, in very many cases the action is quite distinct, and some protecting bluffs have never been defending ledges.

(4.) The same result is obtained also by the defending action of a tributary stream which pours in a load of sediment. According to the general law of stream action, a tributary if fully supplied with waste will deposit it on joining the main river flowing on a gentler grade. In any case, the tributary pushes the main stream over. This action is much the same as a defensive ledge. The bank is defended from the destructive action of the main stream by the force of the tributary. If the main river can lower its bed, then we shall expect to have a series of terraces; but they are different in character from those due to the previous causes. They are usually lower and broader, and the sequence is more perfect; they are extremely common, and seen in almost every case when one stream joins another. They afford the most complete record of the oscillations of a river across its bed, and are more remarkable in this respect than those due to cause (3). Splendid examples of such terraces are to be seen at the junction of the Kowhai with the Waimakariri, and also at the junction of Woolshed Creek with the South Ashburton.

Closely connected with the action of tributary streams is that of talus cones. One of the causes of the partial destruction of the terraces is the formation of talus cones from the high shingle banks. These grow, owing to the erosion towards the head of the cone, till intermittent streams flow down them. Erosion then proceeds apace. In this way a portion of the terrace is rapidly destroyed; but the cone or fan on the floor of the river-valley protects the remaining portion of the terrace from the erosive action of the river, so that rapid destruction of one portion prolongs the life of the remainder. This action is to be seen in many places near the Rakaia Gorge.

Cases of all these four modes of terrace-development are to be seen in the gorge itself, or immediately after the river debouches on to the plains. In the Rakaia they may be seen as far down as the Curiosity Shop beds, about three miles below the Gorge Bridge, where harder sandstones and limestones underlie the shingle. Here there is a good example of the combined effects of the above-mentioned agencies. A protecting bluff determines the commencement of a terrace on its downstream side, and also protects the bank so as to cause one on its upstream side. The bluff also acts as a defensive ledge to the higher terraces, which were at first dependent on the larger and more resistent blocks of the terminal moraine of the Old Rakaia glacier. A little above the bluff are excellent examples of the protective action of talus cones, and on the opposite side of the river, a little higher up, of the action of a tributary stream developed from a talus cone.

All the above-mentioned causes are in operation in the Ashburton and Waimakariri Rivers, but it must be noted that all terrace remnants cannot be assigned to them. A number of smaller remnants are not related in any way to obstructions—that is, as far as can be detected at present. It is possible that some of the terraces above the gorge, where the river is cutting out the silt and gravels filling the old lake, may be the remains of old lacustrine beaches.

The Plain Path.

The fourth division of the river-course is that across the plains, when the river no longer meets solid obstructions in its bed. The terraces here are simple and continuous in character; the sequence is not so complete, as the remains of flood plains are, as a rule, fewer and higher. The river-bank sometimes drops from the level of the plain to that of the water, a distance of as much as 400 ft. in a single face. These terraces are caused by the river moving across its bed lowering its channel as it does so, making and again destroying its flood plains. One reason why the terraces are so high is that the lower ones, being composed of loose and incoherent materials, are readily removed, and the river is able to swing, in some cases, the whole width of its former highest channel. The high terraces are formed by the river planing off a strip every time it swings across its bed, and swinging to the full width possible a large proportion of the times. There is thus a tendency to produce high and simple terraces. These are higher, however, in the upper part of the plains, and get lower as the river approaches the sea; in fact, it is certain that the Waimakariri is rapidly raising its bed in its lower portion—so much so that it threatens danger to Christchurch, and demands the erection of costly protective works as a defence in flood-time. On one occasion, in the year 1868, the river burst through, flooded the neighbouring country, took a course by an old river-bed, and ran in a considerable body of water right through the city. The danger of this recurring is all the more serious as the river is now showing a decided tendency to wear away its southern bank. The Rangitata and Rakaia are also aggrading their lower portions in all probability. Mr. Edward Dobson informs me—and examination of the railway-levels confirms his statement—that the river is running at a higher level at the Rakaia railway-bridge than its old bed immediately north of it. The old bed is about three miles and a half wide, and bounded on the north by a high terrace, which the railway descends near the Bankside Station. At the foot of this terrace the bed is 317 ft. above sea-level; but at about two miles and a half from it, going south, the level of the bed rises to 339 ft., and falls in the next mile to 337 ft., which is the level of the water at the bridge. This last height is subject to slight variation, depending on the position and size of the anastomosing streams. These facts seem to show that in former times the river ran 20 ft. below its present level, and that in all probability it is now filling up the broad, flat trench which it once eroded out of the tolerably level plains. It is thus showing the characters of a stream on a fan, though in this case the fan is confined by the old river terraces.

The section across the Rakaia river-bed at the railway is most instructive. The railway surveys show that, in most cases, the low terraces within the main terrace are not absolutely flat, but have a slight inclination away from the river, being higher at the edge than they are some distance back. They thus exhibit a form which resembles in some degree the scarp slope and dip slope of sedimentary rocks. The scarp corresponds to the terrace, and the dip slope to the gently backward-falling surface of the terrace. This resemblance is merely one of form, and not of structure, and it is exactly what might have been expected in a case where terraces are partly due to erosion, and partly to building up a flood plain, the latter process being the more important. It is unfortunate that this interesting section cannot be reproduced.

PART II.

From the foregoing description of the mode of occurrence of the terraces, it is evident that there must be some cause or causes of exceptional character which have contributed to their formation. In order that a river may form terraces on the scale that occurs here, it must have considerable power of corrasion, both vertical and lateral, and in order to form high terraces the former must be relatively more important. I will therefore consider the circumstances that affect the power of corrasion, and discuss briefly their bearing on the case in question.

The three main circumstances which affect the corrasive power of a river are—(1) its gradient, (2) its volume, and (3) its load.

The Gradient.

The following table, taken from Haast's "Geology of Canterbury," gives the grade of the rivers on that part of their course between their gorges and the sea. Alongside this, for purposes of comparison, I have also put the grade of the plains where the rivers cross them:—

	Slope of Rivers in Feet per Mile.	Slope of Plains in Feet per Mile.
Waimakariri	28	36
Rakaia..	23½	39½
Ashburton	40	42½
Rangitata	37	45

These figures give the average slope, but in both the grade of the rivers and also in that of the plains there is a perceptible flattening on approaching the sea.

The following features are shown by this table:—

(1.) The rivers all have a steep slope as they cross the plains—in fact, they are still mountain torrents. They should therefore be eroding their beds very rapidly, as their banks are composed of incoherent material, were the erosive power given by their high grade not partly counteracted by other influences. Owing also to this lack of consolidation, lateral corrasion is relatively great. In the upper portion of the plain track, vertical corrasion is more important, so that the terraces are higher; but in the lower part, lateral corrasion becomes more important, and the terraces are much broader and lower.

(2.) The slope of the bed is dependent on the size of the river. The smallest river has the most rapid fall per mile, and the largest river—the Rakaia—the least fall.

(3.) In every case the slope of the plain is greater than the slope of the river, but there is no connection between the slope of the plains and the size of the present river crossing them.

Changes in the Height of the Land.

As the grade of the rivers will depend either directly or indirectly on the height of the land above sea-level and its distance from the sea, it is necessary here to consider the evidence for elevation and depression.

(1.) *Evidence for a Recent Elevation.*

The existence of peat-beds, as well as buried logs—that is, an old land surface—is proved by artesian-well borings in the Christchurch area. Peat has been found at the following depths: at Ward's brewery, 400 ft.; at Sydenham, 500 ft.; and at Islington, 700 ft., below the surface of the ground. As the first two places are less than 20 ft. and the last only 112 ft. above sea-level, the evidence is convincing that the land stood at least 600 ft. higher than at present when the outskirts of the plains were formed. This proves a substantial elevation in recent geological times; and as artesian borings are put down further a greater elevation may be proved, as only in the immediate neighbourhood of the Port Hills has solid rock been reached by such borings.

Additional positive evidence of an increased height of the land is to be found in the bays which surround Banks Peninsula. They are all, or nearly all, drowned valleys, and were formed when the land was higher. In most cases they are valleys which have been formed wholly by water action. In the cases of Akaroa and Lyttelton Harbours, the original craters of volcanoes have, perhaps, been enlarged by explosions, but certainly have been further amplified by water erosion and extended into the valley form. The exposed floors of these valleys grade into the submerged portion. The usual depth of the bay near its outlet to the ocean is from 6 to 8 fathoms—that is, from 40 ft. to 50 ft.—and this gives the minimum elevation necessary to allow the valleys to be formed. But all the bays have been filled to a marked extent by mud washed from the hillsides, so that no accurate estimate can be made of the depth of the rock floor beneath. Borings in search of artesian water-supply put down in the valley behind Sumner failed to reach either water or solid rock at a depth of 200 ft.

The date of this elevation is difficult to determine in the absence of any fossil evidence or any other accurate time indication; but, taken in conjunction with the evidence from artesian wells, it is, I think, of fairly recent date. Another proof that the land has recently been higher is afforded by the shape and position of the valleys of the streams near Timaru. In most cases they are submerged where they enter the sea.

The evidence from the valleys as well as that from the wells proves conclusively that the land was recently much higher, certainly as much as 600 ft. This elevation would produce a great extension of the land eastward, as the sea-bottom is sensibly flat till the hundred-fathom line is reached at a distance of about forty miles from the present coast-line. Then the depth increases very rapidly to over 1,000 fathoms within the next few miles. This submarine bank or shelf no doubt marks the utmost eastward extension of the land since Pliocene times. The fan of the Rakaia and Ashburton at one time stretched further east than the present coast-line, as pointed out by Sir Julius von Haast. This would probably have been so extended during a period when the land was at a higher level. On depression setting in, the outer segment of the fan was swept away owing to its being exposed to the full force of the heavy seas and the strong northerly drift on the coast: and this would, no doubt, contain that portion where the streams were actively aggrading their beds. In the case of the Waimakariri, however, this portion has only been submerged, not actively eroded, owing to the protection afforded by the volcanic mass of Banks Peninsula and its submarine easterly and north-easterly extension. Soundings marked on charts show this extension, and also show that the depth increases very gradually from the mouth of the Waimakariri for some distance out into Pegasus Bay. The coast-line here is not marked by any cliff such as occurs on that part of the Ninety-mile Beach near the mouth of the Ashburton River and on the coast near Oamaru. In this place erosion of the coast-line by the action of the waves is extremely rapid, and threatens serious loss in the near future unless adequate protection is given.

An elevation of even 600 ft. would have considerable effect on the climate of the country. In the first place, it would largely increase the extent of country above the snow-line, and hence cause a great extension of the glaciers. The present terminal face of the Tasman Glacier is 2,460 ft. above sea-level; an increased height of the land of, say, 600 ft. would bring it down nearly to the upper end of Lake Pukaki, which is 1,550 ft. above sea-level—that is, supposing the glacier would reach the same distance above sea-level in time of high land as of low land. This supposition may not be strictly accurate, as it is quite possible that the glacier would come down further owing to the increased accumulations of snow; but even if not, the effect of the elevation would still be very marked.

The effect of high land is easily seen on comparing the size of the glaciers at the head of the Waimakariri and Rakaia with those near Mount Cook. Even allowing for the increased average height of the peaks in the last-named locality, the glaciers are of enormously greater importance and come down to a much lower level. The height of the terminal face of the Tasman Glacier is 2,460 ft., while that of the Lyell Glacier at the head of the Rakaia is 3,568 ft., and that of the Waimakariri 4,162 ft. above sea-level.

It is possible, therefore, that, owing to increased snowfall due to elevation and to larger collecting-grounds, the proved elevation of 600 ft. would cause a marked glacier extension; it might even cause a glacier epoch. Captain Hutton has previously explained the advance of the glaciers as due to increased height of the land, and pointed out, from biological evidence, that there could have been no marked refrigeration of the climate.

Another effect of elevation of the land would be to cause desert or steppe conditions to prevail on the plains at the foot of the mountains. Owing to their increased height, the mountains would intercept more of the moisture brought by prevailing westerly winds from the Tasman Sea, which, owing to its depth, probably existed under the same conditions then as now. The mountains would then intercept more moisture, and cause it to fall as snow on the higher levels. Their eastern slopes near Mount Hutt and Mount Torlesse receive their chief rainfall from the west; but, when the higher central ranges cut off this moisture, the eastern slopes would receive much less of this westerly rain. Further, owing to the coast-line being so far to the east of its present position, there would be on the plains a smaller rainfall from the prevailing winds which at present supply the coastal lands. Even at the present time the plains of Canterbury experience a modified steppe climate. The average rainfall for Hokitika is about 119 in. per year, while at Lincoln, near the eastern border of the Canterbury Plains, it is only 25 in., and in one year it fell as low as 14 in. The average annual rainfall for Christchurch is only 23 in. These steppe conditions would be intensified during a period of elevation, and the climate would resemble that of Patagonia or Thibet as it is at present.

The present steppe conditions are marked by the great number of xerophilous plants which are found in Canterbury and Otago, and there are indications from their life history that the desert conditions were at one time more severe.

In his admirable paper on the "Plant Geography of the Waimakariri," Dr. Cockayne draws special attention to the present climatic conditions of the country, and emphasizes the existence of steppe conditions. When speaking of the eastern climatic plant-region he says, "The œcological condition of this region is essentially xerophilous. This is not to be wondered at when the small rainfall and constant drying winds in conjunction with the usually stony soil is considered." In this same paper, in giving expression to an opinion of Diels, the great œcological and systematic botanist, he further says, "Diels was much struck with the extreme xerophilous character of many plants, which he considered out of all proportion to any severity of climate they have now to endure. At the present time the driest regions of New Zealand are less arid and possess a more equable climate than Middle Europe, so he considered *Carmichaelia*, *Hymenanthera*, *Corokia*, and some others to be descendants of a forest flora which had been forced to retreat northwards during a rising of the land, which led to the formation of a dry easterly steppe region, where survivors of the forest had become modified and assumed the structure and physiognomy of desert plants." If this opinion of Diels is correct, I think the conditions are easily explained by an increased height of the mountains modifying the climate. However, Dr. Cockayne shows in his paper that the present conditions are severe enough to account for the plant modifications.*

(2.) *Evidences of Depression.*

The evidence for the lowering of the land below its present level is as follows :—

(1.) Marine terraces occur at Kaikoura, Port Robinson, Amuri Bluff, Motonau, Conway River, and at Banks Peninsula. They are found as high as 600 ft. above present sea-level at Amuri Bluff. The first five of these have been recorded previously by Haast, Hutton, Hector, and McKay, but the last case has not been previously noted as far as I am aware. The evidence for this is as follows: Round the coast of Banks Peninsula the headlands have in many cases flat extremities. The lava-flows which form them dip outwards at low angles, but the edges of the streams are truncated and cut level on the upper surface. The greatest height at which I have noted this marine terrace is at Lyttelton Heads, where the elevation is over 450 ft.; the same phenomenon can be seen at Whitewash Head, near Sumner, and at the Long Lookout Point. It is well marked, besides, in other places. The height of this terrace diminishes, as a rule, on those parts of the coast-line which would be exposed during submergence to strong currents and heavy seas. It is low on the southern side of the peninsula. I have not come across in any place traces of marine organisms, but it is not likely they would occur plentifully, or be preserved when they did occur, in such a position. One of the principal conditions which promote rapid erosion on rocky coasts seems to be the presence of strong currents, which can sweep away the material dislodged by wave and other action. Headlands which stretch out far into the sea, particularly if the water be deep on either side, will therefore commonly show a marked wave-cut

* Dr. Cockayne has told me privately that he has latterly modified his opinion somewhat, and now thinks that present conditions are hardly severe enough to account for the xerophilous plant forms.—R. S.

terrace, while an even coast-line will show none. Thus we have the remarkable shore platforms at Kaikoura Peninsula, but hardly any sign of them on the steep hills to the north and south. The conditions would be extremely favourable for the cutting of distinct shore platforms on the spurs of Banks Peninsula during a period of depression.

(2.) The existence of the silt deposit or loess was held by Captain Hutton to be a proof of subsidence. If it is a marine deposit, it undoubtedly proves that the land was much lower—quite 1,000 ft.—as may be inferred from the distribution of the deposit, and its present occurrence so far above sea-level would be a proof of subsequent elevation. However, there are strong reasons for believing it is a wind deposit, and I know from conversations with Captain Hutton that he was not quite satisfied with some of his evidence. One difficulty which strikes me with regard to Captain Hutton's contention is the following: The so-called silt must have been formed of glacial rock-flour during a period of severe glaciation—*i.e.*, during a period of marked elevation of the land. All observers are agreed, I believe, in this. Now, Captain Hutton's theory demands that it should have been distributed into its present position by marine action during a time of depression of the land. It is absolutely impossible that the two processes could have gone on simultaneously in the Canterbury area. If the silt were swept down by great rivers issuing from the glaciers and distributed by the sea at their mouths, the area of deposition would be forty or fifty miles to the eastward of the present coast-line. Further, if the sea advanced to cover the Canterbury Plains, the glaciers would then have disappeared, or have lingered on only the very highest parts of the Southern Alps. The sea must therefore have distributed the silt during a time of depression posterior to the time of elevation when glaciation was at its maximum. It would have been expected that the silt would be thickest in the hollows and on lower ground. Such is not the case, however; it shows a marked tendency to be thickest on the spurs and to thin out on low ground. In this way it closely resembles the distribution of the loess in the Valley of the Mississippi, to explain which the aid of the sea has never been called in.

Professor A. Heim, of the University of Zürich, an observer of wide experience, and an authority of the greatest weight on glacial and allied problems, differed with Captain Hutton on this point. After a visit to New Zealand he published in Zürich, in the year 1905, a paper which has many valuable observations on geological problems in this country. The following is a translation of his remarks in this work on our so-called loess:

"When the great glaciers which were thrust forward to the outlets of the alpine valleys receded, and the ground moraines which were left behind were dried up by the north-west wind (*Föhn*), then the fine dust was blown far over the surface right up to the sea. The deposit of dust accumulated in the form of the fertile loess. Then, as we see in many parts of Germany, the loess covered the land-surface, sometimes from half a metre to a metre in thickness, and sometimes from 10 to 15 metres. Where it breaks away on the upper edge of the river-bed region it forms perpendicular walls, and here long-buried moa-bones frequently appear. But even now the loess formation is going on. We have ourselves seen how thick are the clouds of dust whirled up from the broad, shingly river-beds by the north-west wind and spread over the cultivated land. The rain, when it falls afterwards, unites the dust with the agricultural land. A part of the fertility of the eastern plains depends on the loess covering."

After a general consideration of the evidence, and from my own observations, I have come to the conclusion that the loess has not been beneath the sea. It is very thick on the hills between Tai Tapu and Birdling's Flat, but is completely swept away from those places which have been exposed to lake or sea erosion. It could not exist in its peculiar position on the tops of spurs, &c., if they had been washed by the sea since it was laid down. Further, if it had been a marine deposit it should have covered the whole landscape irrespective of its form, and it is unlikely that it has been removed by denuding agents from so many places and left comparatively untouched on the spurs and the sides of valleys. I am therefore inclined to think it was a wind deposit during the steppe conditions of a higher land and drier climate, with severe windstorms sweeping from great river-beds greater clouds of dust than are seen now in the Rakaia and Waimakariri, although these are by no means of insignificant proportions at the present time.

The deposit of loess covers up the old shore platforms on the south-west side of Banks Peninsula, therefore the depression during which they were formed was pre-loess, and therefore before the great glacier extension. If this is really so, it serves to emphasize the recency of this extension. The general order of events would therefore be a period of low land, when the marine terraces were formed, then an elevation in glacier times, followed by a depression till now, with probably minor periods of slight elevation. There is a slight elevation going on now, as may be seen from the wave-worn caves at Sumner now several feet above high-water mark, and the bands of sand-dunes between Christchurch and the sea. This, no doubt, accounts for the low, broad terraces to be seen in the lower reaches of the Avon and Heathcote Rivers.

The elevation of the land is always considered a most important point in causing terrace-development, but this is chiefly in those cases where rivers have been near their base-level. Subsequent elevation causes them to form terraces owing to the restoration to them of their power of corrosion. This is the case of the Avon and Heathcote terraces just mentioned.

Now, the Canterbury rivers have a remarkably steep grade, and a depression of the land would hardly be felt in their upper and middle portions. I think it very probable that if the land were lowered till the shore-line corresponded with the main line of railway, the erosive power of the streams near the gorges would be only very slightly altered. Further, if terracing were due to elevation it should be progressive upstream from the coast, whereas the contrary is the case: the terraces are highest in their upper portions.

I do not think that change in the height of the land has materially affected the erosive power of these rivers. Near the sea-coast it has undoubtedly exerted some influence, and the raising of the bed of the Waimakariri near Belfast is most probably due to continued depression of the land.

The Volume and Load.

Other causes must therefore be sought to explain the river terraces. If we consider change in volume, we are forced to conclude that our rivers have shrunk in volume from what they were in the glacier epoch. If our mountains were higher, they would intercept more snow, and the average volume of the rivers would be greater. The largest rivers of Canterbury, such as the Waitaki and Rakaia, drain the highest portions of the Alps; further, the Rangitata, with a comparatively small drainage-basin, is nearly as large a river as the Waimakariri with a large drainage-basin, because the small area supplying the Rangitata is an area of high mountains, where the glaciers are larger. Our rivers are therefore smaller than they were, and they would not be likely, therefore, to be able to terrace their beds were this not accompanied by a marked diminution in the load.

It is important to notice here the different grade of the plains—that is, of the old glacier rivers as compared with the grade of the present rivers. They are all, without exception, running on a gentler gradient now than formerly. If we except the hypothesis of elevation along an axis through the outer range of mountains, we are forced to conclude that the last important cause—viz., the load of the river—is the predominating factor in determining whether the rivers could terrace the plains or not. The volume in all probability is now less, the grade of the rivers is less, and yet terraces are formed on a tremendous scale.

Part III.

The existence of enormous supplies of waste in the valley of a river profoundly influences its action. The energy of a stream is limited, and its excess is chiefly spent on transportation and corrasion. It will therefore be evident that terrace-forming must be connected in some way with the load a stream carries. If the load is excessive, there will be no energy left for lowering its bed, and hence for forming permanent terraces. Many of the laws governing streams may be studied by examining the miniature fans and deltas formed at the roadside or in other places after heavy rain. The following order of events is apparently true for a miniature fan as for our large rivers:—

During flood-time the stream is fully loaded with waste from the surrounding country, but drops it on the gently sloping ground, thus raising its bed. Terraces are absent. When the height of the flood is past, the supply of waste falls off—only smaller particles are carried; and there is an excess of energy left over for corrasion, and the fan is terraced, on a small scale it is true, but the processes and the sequence of events are just the same as on a large scale. If this is so, the degradation of its bed by a river which is fully loaded in flood-time will occur principally as the flood is falling, and will continue till the river is running clear again and carrying no sediment. I have repeatedly noticed this order of events on shingle fans, and I have received confirmation of these facts from engineers whose business it is to supervise the fords across the streams on the Christchurch–Hokitika Road. It must be remembered that our rivers when in flood are undoubtedly highly charged with waste, and therefore differ greatly from the condition of ordinary streams when in flood. These may be discoloured by fine particles, and may even move stones along; but the supply of waste on the Canterbury mountains is exceptional in amount, therefore our rivers in flood-time are comparable to the excessively charged streams of a small fan, and the sequence of events is apparently the same, although the conditions are somewhat different.

I think it can be proved that when the volume of a stream diminishes, the transporting power falls off in a slightly greater ratio than the energy. The result of this will be that, when a stream is fully loaded, on a diminution in volume there will be an excess of energy left over for corrasion, and the stream will therefore channel its bed. The explanation of this phenomenon may be due to the fact that with a falling volume the larger particles are dropped first, and if there is not an approximately equal quantity of smaller material for the river to move in place of the material dropped there will be an excess of energy left over for corrasion. Under ordinary circumstances there is an insufficient supply, and so the river-channel is lowered.

The supply of waste has such an important bearing on the corrasive power of a river that a consideration of the circumstances which control the supply in the Canterbury mountains will be relevant here. One of their most striking features is the vast supply of *débris* supplied by their slopes exposed to frost erosion. This effect is so marked that whole mountain-sides are covered with angular *débris*, which is continually moving downwards, but especially so in the case of shingle-slips. These are often from 2,000 ft. to 3,000 ft. in height, and may be as much as a mile wide. The reasons for this excessive supply of waste are as follows: (1.) The jointed character of the rocks in the drainage-basins of the rivers. (2.) Owing to intense folding of the rocks, they frequently dip at very steep angles, and therefore the weakest beds are exposed to the atmosphere without being protected by more resistent beds. (3.) The age of the folding dates back to Mesozoic times, and therefore weathering agents have been able to exert their influence to a marked extent. (4.) The range, both annual and diurnal, of the temperature is very great. (5.) The absence of close plant-covering over large areas. All these causes promote extensive disintegration, and any explanation of the life history of our rivers must take them into account.

One of the principal factors determining the production of waste is the extent of mountain-slope not protected by a close covering of vegetation. The area of most vigorous denudation is between the snow-line and the upper limit of this covering. The snow protects the underlying rocks to a certain extent; but, nevertheless, even here the denudation is rapid, but especially on those steep faces where snow cannot lie. When the snow is turned to ice the effect is somewhat similar. Erosion will not proceed as rapidly under the ice as on the slopes at a higher and lower level free from ice, but exposed to the action of frost. The effect of elevation of the land will be to make the area above the snow-line greater and to expose a much greater area to the influence of frost. The part affected in the Southern Alps is principally that between the 3,500 ft. and the 7,000 ft. contour lines. If the land were raised, the country affected would be approximately that between the same levels, but the area included would be very much greater; although this would be diminished by the accumulation of ice in hollows where it could not melt. Large areas below the snow-line would be covered with glaciers; but, in spite of this, the area exposed to frost action would be more extensive, and therefore the supply of waste would be in excess. A very large amount of erosion due to glaciers, as estimated by the proportion of sediment in the rivers flowing from their terminal faces, is due primarily to the action of frost on the hillsides above the glaciers.

The supply of waste in this case would be increased during elevation, owing to the previous loosening action of the plants on the rocks rendering them subject to other weathering agencies; again, if this were also attended with a general desiccation of the climate on the mountains fronting the east, the supply of waste would be further increased owing to the disappearance of the protective plant-covering.

From a general survey of the country in the upper basins of our rivers I am of opinion that the period of maximum weathering has passed. The old and mature shingle-slips are far larger than those now existing. Vegetation in many cases has got the better of the moving shingle, and in some cases the old fans are completely covered with forest. Our shingle-slips at the present time are diminishing in extent, and they will continue to do so unless the plant-covering is destroyed either by nature herself or by man.

The excess of waste during a period of elevation accounts for the present form of the Canterbury Plains. They have been formed by the overlapping fans of great glacier streams, as can be conclusively proved by carefully contouring their surface. The contour lines show them to have been formed in exactly the same way as an ordinary shingle fan, except that their grade is more gentle. They were built up to their present height when the rivers were overloaded with sediment, during a time of high land, severe glaciation, and acute frost action. On the land being depressed, the supply of waste would fall off, and the rivers would begin to terrace their old deposits in a manner analogous to that in which a stream terraces its fan during a falling flood. This action was certain to occur unless the volume of the river fell off in a relatively greater proportion. I believe that such would not occur in Canterbury, owing to the excessive amount of waste which would be poured into the rivers falling off in a greater ratio than the decrease in snow or rain.

It will be noted in every case that the grade of the rivers is less than that of the plains; the rivers are therefore able to do their work on a gentler slope than formerly. This can only be due to—(1.) Elevation of the interior of the country since the plains were formed. (2.) Rivers having a greater volume, and therefore power to move their load on a gentler grade: this is extremely unlikely. (3.) A diminution in the supply of waste:

this last appears to me the most satisfactory explanation. No doubt the erosion of its bed which the river is enabled to perform owing to the diminution of the supply of waste would tend to be neutralised by the depression of the land proved on page 32. If the land had been low, and the former supply of waste comparatively small, this depression would have been sufficient to produce aggradation instead of corrasion. But the land is still high, the rivers are still powerful torrents, and the supply of waste fast diminishing. These factors are sufficiently great to nullify the effect of depression in the higher portion of the river-course; but the rivers have now reached such a stage in their development that in their lower course aggrading is now going on: hence depression has made its influence apparent. This is what might reasonably have been expected; and, if depression continues, this effect will become more and more marked, so that the terraces will tend to disappear. However, should the slight elevation which has taken place recently continue, aggrading in the lower portion of the river-course will cease and terracing will be resumed.

I have been confirmed in my conclusion that the supply of waste is a controlling factor in the terrace-development of our rivers by observation of the history of shingle fans. In their youthful stage they are built up by an aggrading stream; in their vigorous middle period they are partly channelling their fans and partly building them up on their outskirts; when they reach their mature stage they become channelled and terraced by the stream that runs through them. This terracing closely resembles that on the plain course of our rivers. It is more marked near the apex of the fan, and falls off towards the fringe This may be due to the fact that the river is more confined near the apex of the fan, and therefore more capable of vertical corrasion. But it is also due to the fact that in former times of excessive supply of waste that waste was chiefly deposited just below the gorge. It may perhaps be due to increase in volume of the river as it enlarges its drainage-area. However, increase in volume will not explain the fact that after every freshet a stream apparently terraces its fan on a diminishing volume.

In his accounts of the formation of the Canterbury Plains, Captain Hutton maintained that they had been levelled by the sea and subsequently raised, so that the rivers were able to terrace them. If this were the case, terracing should progress up-stream, should show a maximum development near the sea, and not, as in this case, near the gorges. If, however, the loess is not marine but of æolian origin, as seems very probable, and since it is incapable of resisting marine erosion, there cannot have been any recent elevation of more than a few feet. The general recent direction of land movement has been downward, and this is indicated also by the aggradation going on in the Lower Waimakariri and Rakaia.

The evidence afforded by Otago, where river-terracing is also shown on a gigantic scale, points distinctly to a sinking land. Unless there has been at the same time an increase in the rainfall—and as long as conditions have been the same over the Tasman Sea there seems to be no reason why this should have increased on the mountains—we are at once driven to consider the supply of waste to be a predominating factor in terrace-formation in the valleys of the Canterbury rivers. If we consider those parts of the world where terraces are greatly developed—*e.g.*, British Columbia, the Rocky Mountains region, the Himalayas, and Patagonia—we must be struck by the fact that they have all passed through a severe glaciation, when waste filled the valleys, and now terracing is actively going on. Elevation of the land has had an important effect in some cases, but not in all. It seems that too little consideration has been given to the control exerted by excessive waste-supply.

Note.

I have omitted mention in the above of the effect which sagging of the coast-line might have had on the formation of terraces. Owing to the loading of the coast-line with enormous quantities of waste from the land, it is highly likely that differential lowering of the crust has taken place, and is probably going on now; perhaps the general lowering since the glacier maximum may be intensified in the coastal regions by this process. It is highly likely that a large syncline has been forming under the Canterbury Plains and to seaward of them, dating from some time posterior to the Upper Cretaceous period, and that the coal-measures and overlying limestones and other beds have experienced the results of this movement. Very interesting evidence on this point has been afforded by the cruise of the steam-trawler "Nora Niven." Mr. Edgar Waite, Curator of the Canterbury Museum, informs me that at certain positions along the coast large pieces of brown coal were brought up in the trawl. They were frequently from 2 ft. to 3 ft. in length, and weighed at times over 1 cwt. They were obtained from the following stations: No. 39, twenty-six miles east of Timaru; depth, 28–31 fathoms. No. 42, thirty-one miles north-east of Timaru: depth, 21–24 fathoms. No. 54, twenty-seven miles north-east of Godley Head; depth, 21–27 fathoms. No. 57, four miles east-south-east of Waiau River; depth, 26–43 fathoms. Their occurrence at such a uniform depth, their absence elsewhere, and their large size renders it highly improbable that they were carried to these places either by ocean-currents or by rivers. In fact, pieces of coal of such size would be quickly reduced to fragments in any of the rivers which cut through the coal-measures. It seems, therefore, highly probable that such masses have come from outcrops of coal in positions which come to the level of the sea-bottom in the localities where they are found.

Similar occurrences of coal outcropping on the sea-bottom are recorded from the North Sea. If this is really so, then the brown-coal measures of Malvern, Mount Somers, and of other places along the foot of mountains probably extend eastward under the plains in the form of a great syncline, and reappear at a depth of about 150 ft. below sea-level about thirty miles to the eastward of the present coast-line on the scarp of the continental shelf. It is therefore likely that sagging of the crust has gone on in Post-Cretaceous times, but with periods of depression and elevation, as proved by the marine terraces on Banks Peninsula. If this has gone on recently, it would no doubt affect the form of the terraces; but I am inclined to think that its effect is not apparent, unless the depression of the land which went on since the glacier maximum is partly due to this cause. The effect of this depression is, without doubt, apparent in the lower courses of the present rivers, as explained previously.

In conclusion, I have to express my sincere thanks to the following gentlemen for their kindly criticism and generous advice and assistance on many points: Dr. L. Cockayne, Dr. F. W. Hilgendorf, Messrs. E. G. Hogg, E. K. Mulgan, R. M. Laing, T. H. Jackson, Edgar R. Waite, and Edward Dobson, C.E.

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Haast, Sir J. von: "On the Geology of the Canterbury Plains." Trans. N.Z. Inst., vol. vi.

Thomson, J. T.: "On the Glacial Action and Terrace-formation of South New Zealand." Trans. N.Z. Inst., vol. vi. (This paper draws special attention to the resemblance between the mode of forming a river-fan and that of the plains.)

Crawford, J. C.: "On the Old Lake System of New Zealand, with Some Observations on the Formation of the Canterbury Plains." Trans. N.Z. Inst., vol. viii.

Hardcastle, J.: "Origin of the Loess-deposit of the Timaru Plateau." Trans. N.Z. Inst., vol. xxii.

Cox, S. H.: "Report of the Geological Survey, Mount Somers and Malvern Hills District, 1883." (This gives a good description of the geological structure of the rocks in the districts named, and in particular those near the Rakaia Gorge.)

Hutton, Captain F. W.: "On the Cause of the Former Great Extension of the Glaciers in New Zealand." Trans. N.Z. Inst., vol. viii.

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Hutton, Captain F. W.: "On the Formation of the Canterbury Plains." Trans. N.Z. Inst., vol. xxxvii (1904).

Hutton, Captain F. W.: "Report on the North-east Portion of the South Island." Geological Survey Report, 1872–3.

Hutton, Captain F. W.: "The Origin of the Fauna and Flora of New Zealand." "Annals of Natural History," vol. xv (1885).

In these articles Captain Hutton puts forward his views as regards the reason for the extension of the glaciers, the evidence for the marine origin of the loess, and for the formation of the Canterbury Plains. As they come from such a distinguished author, they are worthy of the greatest consideration.

Cockayne, Dr. L.: "The Plant Geography of the Waimakariri." Trans. N.Z. Inst., vol. xxxii.

This paper gives an excellent account of the present climatic conditions of the basin of the Waimakariri, as well as of its œcological botany. Special attention has been paid to the xerophilous plants, and to the reasons for their frequent occurrence in this area.

Hilgendorf, Dr. F. W.: "The Influence of the Terrestrial Rotation on the Canterbury Rivers." Trans. N.Z. Inst., vol. xxxix (1906).

This paper is a valuable contribution to the literature dealing with the river-terraces. In it the author attempts to prove that the earth's rotation has affected the form of the terraces. While admitting that this is a *vera causa*, yet the geological difficulties in the way of conclusively demonstrating its effect are so great that I cannot regard the conclusion as satisfactorily established. The labour and

care which the author has displayed in collecting his data are worthy of admiration, and this paper will always remain a standard one with reference to the form of the cross section of the river-beds from terrace to terrace, whatever the cause of this form may be.

Dr. Albert Heim, Professor: "Neujahrsblatt von der Naturforschenden Gesellschaft auf das Jahr, 1905, Neuseeland." Zürich, 1905.

EXPLANATION OF PLATES VI–VIIA.

PLATE VI.

1. Looking south-west through the Rakaia Gorge. The terrace in the foreground has been eroded largely from solid rock, outcrops of which can be seen on its level surface in three places.
2. Upper Waimakariri. Partially truncated spur, taken from the top of another on opposite side of river-bed, which is here about three-quarters of a mile wide.
3. Looking down Rakaia River from the Gorge Bridge, showing river-bed and high terraces.

PLATE VII.

1. River Hawden, at junction with the Waimakariri, showing aggrading shingle-streams filling up the bottom of an old lake-bed.
2. Upper Waimakariri River, showing *roches moutonnées* and glacial terrace, near top of picture.

PLATE VIIA.

Map of part of Canterbury District.

ART. III.—*The Development of some New Zealand Conifer Leaves with regard to Transfusion Tissue and to Adaptation to Environment.*

By Miss E. M. GRIFFIN, M.A.

Communicated by Professor A. P. W. Thomas.

[*Read before the Auckland Institute, 14th November, 1906.*]

Plates VIII–X.

THE present investigations have been confined principally to species of two genera, *Podocarpus* and *Dacrydium*, both belonging to Eickler's and later to Engler's group *Podocarpeæ*, which by many botanists are regarded as being more or less primitive Conifers.

As far as I have been able to ascertain, the species taken as the objects of this research have not yet been investigated with regard to the development of their leaves. In only one place have I seen the structure of any of them described. Mr. Worsdell, in his valuable paper on "Transfusion Tissue,"* has just indicated the structure of one New Zealand Conifer, *Podocarpus totara*, presumably of the mature leaf; but, as will be seen later, a slightly different structure has been seen in fresh material. More will also be said in connection with this paper when the origin of transfusion tissue in the *Podocarpeæ* is discussed.

Another paper dealing with a similar subject is one entitled "Centripetal Wood in Leaves of Conifers," by Ch. Bernard.† Unfortunately I have not a copy of this paper, but from a short summary of it which appears in the Journ. Micros. Soc. Lond., Dec., 1904, it seems that he has confined his attention entirely to the bundle, and in particular to transfusion tissue. From his results he arrives at the same conclusion as does Mr. Worsdell with regard to the origin of transfusion tissue in Conifers.

Papers dealing with the structure of other Conifer leaves seem to be very numerous, but only a very small number of them deal with leaves from the standpoint of development in a particular species. The most important work in this direction is one by Aug. Daguillon, "Recherches morphologiques sur les feuilles des Conifères," written, "*pour obtenir le grade de docteur ès sciences naturelles*," in 1890. Daguillon has taken for his research the leaves of some species belonging to the genera *Abies*, *Picea*, *Cedrus*, and *Larix*, and has confined himself to strictly morphological (in the limited sense of the word) considerations of their development. In dealing with the *Podocarpeæ*, while keeping in view the morphological aspect, I have endeavoured in each species to go a step further and to explain the development by physiological considerations. This paper of Daguillon's will be dealt with later, at the end of this thesis, where a short comparison of the morphological results obtained in these two rather widely different groups of Conifers will be given. It has been thought best not to institute comparisons with outside groups in the main part of this paper, as these would obscure the connection between the more closely allied species. The following is the summary given by Daguillon at the end of his work (a translation has been given for clearness) :—

In the *Abietineæ*—(1.) The existence of primordial leaves—*i.e.*, of leaves intermediate between cotyledon and mature leaves—is constant. (2.) The passage from the primordial form can take place without numerous transitions, as in *Pinus*, or by

* Trans. Linn. Soc. Lond., 1897.

† Beiheft. Z. Bot. Centralbl., xvii. (1904).

insensible transitions, as in *Abies*. (3.) This passage is sometimes characterized by a modification of phyllotaxis. (4.) Sometimes marked by a change in the epidermal surface. (5.) Nearly always accompanied by the development below the epiderm of one or more sclerenchymatous layers, which afford the leaf protection and support. (6.) The pericyclic sclerenchyme, which encloses more or less completely the median vein, acquires a considerable development. Further, among the two sorts of elements of which it is composed (cells with bordered pits and fibres with smooth membranes), the latter are often absent from the primordial leaves, appearing with the passage from the primordial to the definite form. (7.) In certain genera (*Abies* and *Pinus*) the fibro-vascular system of the median vein, proceeding from a single bundle of the stem, bifurcates in the interior of the adult, while it remains simple in the primordial leaf. (8.) In all cases the number of conducting elements of the xylem and of the phloem augments when the primordial passes into the mature leaf. (9.) When foliar parenchyma is heterogeneous and bifacial the differentiation of the palisade parenchyma is generally accentuated in the adult leaves.

Before proceeding to the main part of the work, it might be as well to add a word or two about the material used, and its preparation for sections. In all cases the leaves have been obtained directly from nature in different localities round about Auckland. As far as possible, only plants growing under exactly the same environment have been used for the different developmental stages.

The sections from which most of the drawings have been made were cut by hand. It was found impossible to get very good results from material imbedded in paraffin and cut by the microtome. The great thickness of the epidermis and hypoderm no doubt largely accounts for this—in the first place making penetration hard during imbedding processes, and in the second place causing an obstruction to the razor, especially in transverse sections. By stripping off the epidermis and hypoderm good results were obtained by the microtome in longitudinal sections (radial and tangential) of the vascular bundle in the cotyledons of two species of *Podocarpus*.

The method of double-staining with hæmalum and saffranin has been found the most convenient and differential. Sections treated thus have been supplemented by others which have been mounted straight in a mixture of glycerine, alcohol, and saffranin. These sections are much less likely to have become distorted, while the saffranin marks off well such tissues as are lignified.

The drawings have all been done with the aid of a camera lucida.

CLASSIFICATION OF SPECIES TAKEN. (ENGLER.)

Group	.. TAXACEÆ.
Subgroup	.. PODOCARPEÆ.
Genera	.. *Podocarpus* and *Dacrydium*.

Species—

1. *Podocarpus totara* (totara).
2. ,, *ferruginea* (miro).
3. ,, *spicata* (matai).
4. ,, *dacrydioides* (kahikatea).
5. *Dacrydium cupressinum* (rimu).
6. ,, *Kirkii*.

Podocarpus totara.

The leaves of this species have been chosen as an introduction to this genus on account of their simple but well-marked transitions, which all point to the greater adaptation of the maturer plant to surroundings which call for a xerophytic habit. With the exception of young plants with cotyledons, all the leaves of the different stages were gathered within not so many yards of one another.

Young Plants with Cotyledons.

The cotyledons of this species are interesting, for they remain much longer on the plant than they do in other species of this genus. They may be found on plants several inches high, which have an appreciably thick and woody stem. There is a marked development seen in the cotyledons on the older plants from those on the younger. There is a general increase in thickness of cuticle and epidermis for protection, and increase of vascular tissue for conduction. This development is best shown by a study of transverse sections of the two.

Young Cotyledon, $\frac{3}{4}$ in. long.—The epidermal cells are protected by a fairly thick cuticle, and have well-thickened outer and side walls.

The stomata occur on both surfaces, but more on the lower than on the upper. They are only a very little sunk, and hence very little overarched by neighbouring epidermal cells. There is an air-space beneath each.

The sclerenchymatous hypoderm is not developed except just at the margins, where more protection is required.

The chlorophyll parenchyma shows rather a high degree of differentiation. At each margin of the leaf we find ordinary parenchyma, the diameter of which is the same in all directions. Below the epidermis, on the upper side of the leaf, we find cells more or less elongated at right angles to the surface, while on the lower side there is a tendency to elongation parallel to the surface. The cells in between these two layers are elongated in the direction of the margins, which is very desirable, considering the distance there is between the bundles and from these to the margins. Here and there between these elongated cells we find ordinary parenchyma cells, which are often seen in transverse section to form lines stretching across at right angles to the elongated cells. These cross-rows probably serve for quicker communication between the upper and lower surfaces. None of the elongated cells show any signs of lignification, which cannot be expected at this stage of development.

Vascular bundles: There is no sharply marked off endodermis round each bundle; the pericycle is one or two cells thick. The protophloem forms a well-marked crescent-shaped zone of crushed elements, while the active phloem elements are arranged in three or four radial rows. The sieve-tubes at this developmental stage are long and narrow elements which still have nuclei and horizontal transverse walls. Above the phloem are the xylem tracheids. These are spiral or pitted elements, or elements with both spiral markings and bordered pits, which latter commonly occur on the oblique end walls. On the ventral side of these elements we find the protoxylem with more or less irregular and crushed spiral thickenings. At the sides of the xylem are one or two rather larger elements, the transfusion tracheids; while occasionally an element is found on the ventral side of the wood, which therefore corresponds to centripetal xylem. Sacs containing a substance with tannin reaction also occur at the sides and on the ventral side of the bundle in the pericycle. I may mention in passing that these sacs have very much the appearance of large tracheids under certain treatments, but there can be no doubt of their nature when they are treated with ferric chloride.

It is rather interesting to note the gradual decrease of tracheids in the bundle towards the apex. In a section very near the apex we find the number reduced to six or seven, whereas near the middle and base we find as many as twenty. The number of transfusion tracheids at the sides has increased, for we find groups of twos and threes against the one or two in the middle section. These elements have spiral and pitted markings, which are seen in transverse section on the slightly oblique transverse walls.

Older Cotyledon.—Transverse section: This presents typically the same appearance as the preceding section. It is characterized, however, by a much thicker cuticle and by thicker epidermal walls. The thickened hypoderm also appears along the sides here and there as one or two isolated cells. The palisade form of the parenchyma cells on the upper surface is rather more regular, while the middle cells are narrower and longer on the whole than those of the preceding section.

In the vascular bundle we find a more clearly defined endodermis and a general increase of the conducting elements. In the greater number of the bundles we find a tendency for the bundle to split into two. We find larger transfusion elements at the sides than in the younger cotyledon.

It is rather interesting to note the complete absence of resin-canals in the cotyledons, especially when in accordance with a prolonged period of growth these leaves have assumed a differentiated character as great or even greater than the succeeding leaves.

Young Leaf on the same Plant as the Cotyledons, $\frac{1}{2}$ in. long.

The leaf in transverse section presents a long and narrow appearance like the cotyledon, but it differs in having a midrib up which runs the single vascular bundle of the leaf.

The cuticle is thicker again than that of the cotyledon, especially at the margins, and there are also thicker walls around the epidermal cells.

The stomata here occur only in four longitudinal rows on each side of the vascular bundle, on the lower surface only, and are much more sunk—obvious protections against excessive transpiration.

The hypoderm occurs as one or two rows at the margins, and extends a considerable way from there in a continuous band round the sides. There is another continuous band above the vascular bundle, while between the margin and the bundle it occurs in irregular groups of two or three.

The chlorophyll parenchyma presents much the same characters as the cotyledon.

In the vascular bundle the most striking difference from the cotyledon is the presence of a resin-canal. This is placed in connection with the phloem, and presents the same characters as in other Conifers, secretory cells surrounded by a ring of strengthening cells. The endodermis is better marked, and in the pericycle we find abundant transfusion tracheids showing transitions out from the protoxylem (*px*), through the centrifugal tracheids at the sides, to the transfusion tracheids in contact with the endodermal cells. The elongated cells of the chlorophyll parenchyma are just outside of the separating endoderm cells, and hence in direct communication with these tracheids. The phloem has the same character as before, but the crushed protophloem elements do not form so conspicuous a part of the bundle.

Older Leaves.

The leaves on plants of two to four years' growth show a gradual development of cuticle and hypoderm. In the chlorophyll parenchyma are found slightly lignified elements in connection with the bundle transfusion tracheids, which have greatly increased in number. In a plant about 2 ft. high, very well developed accessory transfusion tissue was found. Mr. Worsdell himself found only very slight lignification in this species, but here, at this stage, there are undoubted lignified walls in certain of these cells. The walls are much thickened, and have pits which do not show any signs of bordered thickening. These lignified elements are in direct communication with elements which show no signs of lignification, but which also have pits on their walls. Mr. Worsdell inclines to think that cells of this structure are not equivalent in function to cells in a similar position in *Cycas*. He thinks, on account of the presence of simple pits, the thickness of their walls, and scattered arrangements, that these elements are more of the nature of stone cells, and are not used for conduction, but merely serve the mechanical function of strengthening the leaf. These cells do undoubtedly serve for this purpose, but I think their position in direct communication with the normal transfusion tracheids shows that they also serve for the equally important function of carrying out water towards the margin.

Mature Leaves.

The leaves of the shrub and mature stages are very similar in structure, but differ in arrangement on the stem. The leaves of the shrub stage stand out more or less at right angles to the stem, but in the mature stage they are arranged in a closer spiral, and form a much smaller angle with the stem. This is obviously a xerophytic adaptation. The structure of these leaves does not differ greatly from the young leaf already fully described. The stomata are more numerous, and are confined still to the lower surface, and well away from the vascular bundle, which is protected by a continuous line of hypoderm. Undoubted accessory transfusion tissue was found, but the cell-walls did not appear so strongly lignified as in the younger stages. In the vascular bundle the number of transfusion tracheids at the sides has greatly increased. A few tannin-sacs occur on the ventral side.

Summary, P. totara.

Summarising the principal points in connection with the anatomical development, we find,—

In the cotyledon, a sclerenchymatous hypoderm at the margins, and at a later stage one or two isolated elements along the sides; stomata on both surfaces; highly differentiated parenchyma cells, and two vascular bundles, with tannin-sacs, but no resin-canal; very few transfusion tracheids, and a great number of crushed protophloem elements. Near the apex of the cotyledon we find less wood in bundle and more transfusion tracheids at sides, while in the older cotyledon we see a tendency for the bundles to divide up again.

In leaves of the same plant, hypoderm elements along sides; stomata deeply sunk only on under-surface; one vascular bundle, with a resin-canal; and a greater number of transfusion tracheids and less crushed protophloem.

In later stages, fully developed sclerenchymatous hypoderm; greatly modified accessory transfusion tissue, with pits and lignified walls.

In shrub and mature stages, the same characters in the transfusion tissue; greater development of chlorophyll parenchyma, both of palisade and irregular-shaped cells. In the shrub, leaves standing out at right angles; in the mature tree, more parallel to stem.

In all stages we see a gradual increase in the number of transfusion tracheids from the early stages to the later.

The development, then, of *P. totara* is chiefly marked by the acquisition of protective characters and by the production of increased facilities for conduction, especially of water, both in the bundle itself and towards the margins. The mature form does not differ greatly from the leaf of the first year, and shows many points of resemblance even with the cotyledon.

Origin of Transfusion Tissue.

Now, from the cotyledon up to the mature leaf there appears in every stage undoubted transfusion tracheids. These I have verified not only by double stained transverse sections, but also by longitudinal sections, both radial and tangential.

Mr. Worsdell, in his paper on "Transfusion Tissue," says, concerning *Podocarpus totara*,—"In the much shorter and narrower leaf of this species it is interesting to note the complete absence of this tissue [*i.e.*, transfusion] in the leaf. Here the central mesophyll cells are elongated in the direction of the margin of the leaf, but are thin-walled and unpitted. I was able to determine, however, the presence of a very slight lignification of their walls." These remarks are directly opposed to what the present writer has found in the leaves of this species. I do not know what material Mr. Worsdell had at his disposal, or what methods he used in obtaining his results, but with material gathered straight from nature I have certainly found undoubted transfusion tracheids and undoubted lignification in the accessory transfusion tissue.

I should like to add here an opinion concerning the probable origin of transfusion tissue in the species I have investigated. Mr. Worsdell's paper does not leave much doubt as regards the origin of transfusion tissue in those two primitive groups of gymnosperms, the *Cycadales* and the *Gingkoales*. In both these groups we see at some period a great development of centripetal xylem. In *Cycas* it is this wood which does most of the conducting work of the plant in the leaf and petiole, the centrifugal xylem playing quite an inconspicuous part. It is therefore natural here that if any modification takes place in any tracheids for the conduction of water out to the sides, it will be in those of the centripetal xylem. This will be so not only because of their much greater number, but also because the centrifugal wood is probably of very much later development here, formed after the leaf has been functional for a considerable period. In the cotyledons of *Gingko* the centrifugal wood is again the better developed, and the previous remarks will also apply here. In Mr. Worsdell's figure of the leaf, however, it does not seem very clear as to which elements are centrifugal and which centripetal; the centripetal elements marked are much smaller than those of the centrifugal, and also smaller than an element marked "*px*," which seems to form a direct transition to the transfusion tracheids at the sides of the centrifugal xylem. It does not, therefore, seem clear in this case why these tracheids should be regarded as formed from the centripetal xylem (*vide* Trans. Linn. Soc. Lond., Dec., 1897, pl. 23).

When we come to what we consider the more advanced group of gymnosperms—*i.e.*, the *Coniferæ*—the centripetal wood has fallen out of use, its place having been taken by the centrifugal. It seems, therefore, more natural in this case that this wood, which even in the cotyledons has usurped the function of the centripetal in the matter of conduction, should also be the one to become modified for transfusion tracheids.

When starting on the study of the *Podocarpeæ* leaves I fully expected to gain further evidence in support of Mr. Worsdell's theory, and it was only after the development had been traced in several species that I was forced to see that the evidence in the *Podocarpeæ* pointed much more strongly in favour of the origin of transfusion tracheids, the greater number at least from centrifugal rather than from centripetal xylem. Mr. Worsdell has said nothing as regards the origin of this tissue in the *Podocarpeæ*, having confined himself merely to denoting its position in the mature leaf of two species of *Podocarpus;* while in the third species (*totara*), as has already been pointed out, he was unable to find any at all. I therefore feel more at liberty to express an opinion with regard to this group. It seems rather a premature proceeding to confine the origin of transfusion tissue in all gymnosperms to centripetal wood when the evidence is conclusive only in the lowest groups.

Now, in the *Podocarpeæ*—of which, for the development of transfusion tissue, *P. totara* may for the present be taken as a type, the development being similar in the following species—in no section either of the cotyledon or of the mature leaf was there any great development of centripetal xylem, the elements, if any, being very occasional even in the cotyledons, where we should most expect to find them. From the cotyledons upwards the transfusion tracheids were always at the side of the centrifugal wood, and in many cases, as will be seen from the drawings of the bundle, there were direct transitions to them from the *px* through the centrifugal tracheids which extended out towards the sides. In every species there was a marked increase in the number of transfusion tracheids from the earliest to the later stages, where there is no evidence of any centripetal xylem ever having been formed. These transitions, which in many cases make it hard to distinguish which is to be regarded as centrifugal wood and which as transfusion tracheids, together with this gradual increase in number from the earliest to the later stages, seems to give almost conclusive evidence in these species of their origin not from the centripetal but from the centrifugal xylem. Near the apex of the young cotyledon we actually see the wood of the bundle passing out to the sides, and serving as transfusion tracheids. When one or two elements of centripetal wood have been formed, in many cases they have been preserved and used on the ventral surface as transfusion tracheids, but I see no reason because of this why we should regard all transfusion tracheids as having been formed on this side of the *px*, and then as passing out and attaching themselves in direct communication with the centrifugal tracheids at the sides.

The character of these elements does not in any way alter this opinion: there are transitions here out through tracheids at the sides from the *px*. In the case of *P. totara* it will be seen from the longitudinal section of the shrub-leaf how greatly modified are these elements on the outer edge, appearing almost like parenchyma cells, and very hard, in many cases, to distinguish from these. I have found undoubted cases where the walls are only very slightly lignified, the reaction of the wall being more that of cellulose, but which have undoubted bordered pits on their walls. This seems to point to the fact that some at least of the outer transfusion elements are formed from modified parenchyma.

The presence of bordered pits in the transfusion tracheids seems constant in this species, where they occur in the maturer stages on the oblique transverse walls, being plainly seen in transverse sections. The character of these tracheids varies, as does the character of the wood. In the cotyledon they hardly differ at all from the wood of the bundle, except in length; in both cases there is present a great amount of spiral thickening on the walls.

It may be noted here that the above remarks in no way detract from Mr. Worsdell's important discovery concerning the presence of centripetal wood in Conifers. The investigation of these species has added further evidence of this, though this wood is not so markedly developed here as in species described by Mr. Worsdell. What the writer has endeavoured to show is that Mr. Worsdell has carried his discovery too far when he ascribes the origin of transfusion tissue in all gymnosperms to centripetal wood, and to that alone.

The next two species are of a very similar nature to the one I have just fully described, but, as a rule, are much simpler. In parts, for briefness and clearness, I shall give the description more in the form of notes.

Podocarpus ferruginea (Miro).

In most respects this leaf is much simpler than *P. totara*, for we do not find such marked modification for protective purposes, nor such highly differentiated parenchyma in the earlier stages.

The first two leaves of the seedling, as in totara also, are placed opposite one another, alternating with the two cotyledons, and standing out at right angles from the stem. The succeeding leaves arise also in alternate pairs, but lie almost in the same plane as the stem; hence we get apparently a single row on each side of the stem; but even in older plants we can trace four rows of leaf-bases down the stem.

Cotyledons.

The cotyledons of miro die much sooner than those of totara; they remain only till the young plant has six or seven leaves to assimilate for it. The cotyledons of which I cut sections were growing under a large miro in moist and shady conditions.

In transverse section they are a great contrast to those of totara.

In the epidermis we find only slight development of cuticle, and only slightly thickened walls in the epidermis—thicker on the under surface, which in germination is the more exposed.

The stomata occur chiefly on the upper surface, only an occasional one on the lower: this is also for protection.

Of hypoderm in the usual form of sclerenchyma there is no trace, but certain large cells in the layer below the epidermis have become modified to form tannin-sacs, more on the dorsal or under surface than on the upper, where are most stomata. These sacs also occur in great numbers around the xylem.

The chlorophyll parenchyma is very homogeneous, consisting only of larger and smaller parenchyma cells.

The vascular bundles are much larger than those of the totara cotyledons. This seems as if increased provision had been made to carry a greater supply of water to make up for the poorer protection against transpiration. Below the vascular bundle we find two, occasionally one or three, resin-canals. The presence of tannin-sacs was noted before.

The xylem forms a well-marked group of centrifugal elements, and there are one or two isolated tracheids at the sides of the bundle and on the ventral side of the wood.

The phloem is also well developed, and, as in totara, there is a crescent of crushed protophloem. These crushed elements are separated by three or four rows of parenchyma cells from the resin-canal.

Hence we see that in most respects the cotyledon is simpler than that of *P. totara*, but it will be noted that there is an increase of vascular tissue in the bundle.

Young Leaves.

These were on the same plant as the cotyledon, and are from $\frac{1}{10}$ in. to $\frac{1}{2}$ in. in length. They are very simple in structure. In transverse section we note briefly:—

Epidermal walls thicker than those of cotyledon, and cuticle better developed.

Stomata on both surfaces, but more on lower than upper. Here the upper is the more exposed, not the lower, as in cotyledon.

Chlorophyll parenchyma differentiated. Upper palisade and lower looser, some elongated towards margins.

In the vascular bundle the chief difference from cotyledon is the presence of a single resin-canal instead of two or three. Tannin-sacs and transfusion tracheids occur.

Plants approximately Two Years Old.

These are from 6 in. to 7 in. high, and the leaves from $\frac{1}{2}$ in. to $\frac{5}{6}$ in. in length. We note briefly:—

The cuticle and epidermis more thickened than in previous stage.

Stomata only on lower surface.

Chlorophyll parenchyma, same arrangement as preceding section, but more developed.

Vascular bundle same as stage 1, only more elements.

Succeeding Stages.

In the succeeding stages we find a greater development of cuticle, and there are a few cells corresponding to a hypoderm. The number of transfusion tracheids is much increased, and the vascular and chlorophyll cells much better developed.

Though the maturer stages are better protected than the younger, and have stomata only on the lower surface, yet we note that in every stage of leaf there is an absence of a sclerenchymatous hypoderm, and that the middle parenchyma cells are only very slightly elongated towards the margin, and there is no lignification. In view of the difference of leaf-structure, it is very interesting to compare miro with totara with respect to habitat. As we should expect from the character of the leaves, the totara is found in much more exposed conditions than the simpler miro. The observations of the authoress on their habitat have been confined to places north of Rotorua; but nowhere was the miro found in an exposed environment, while the totara was frequently found where only the hardiest of plants were surviving.

Podocarpus spicata (Matai).

This species is rare in this part, but is more common in the South Island. I was unable to get any of the earliest stages or of the mature, so I have not traced the course of development. I found, however, plants about 2 ft. in height and young trees. I will just indicate the structure of their leaves, since they are to some extent intermediate between totara and miro. These young trees are very hard to distinguish from miro, having the same arrangement of leaves, and are also somewhat similar in shape, but are blunter at the apex and whitish in appearance underneath.

Young Plants about 2 ft. high.

This particular plant was growing in an exposed position, and both its leaves and stem were coloured rather a bright-bronze pink, the youngest leaves and stems pink, the older ones more bronze-coloured. This is due to the presence of a pigment in the cell-sap of the epidermal cells—perhaps anthocyanin—and it is there for protective purposes. The leaves of this plant were very short, and had blunt apices, which make the leaf more oblong in shape.

The anatomy is similar to that of miro: no hypoderm, stomata only on lower surface, and the same vascular bundle. The advance is in the character of the chlorophyll parenchyma, for here we find, in the middle, cells which on either side of the bundle are well elongated towards the margins. They have pits on their end walls, but the lignification is very slight.

In the shrub stage the leaves were much longer, and green in colour. Their structure is very similar to that of the preceding leaf.

This species, then, is interesting, for to some extent it is an intermediate form between the two preceding.

Podocarpus dacrydioides (Kahikatea).

We now come to a species whose foliage is very different from that of the three forms already described. Kirk gives the general appearance and height of kahikatea in his "Flora," and in his description notes that the young plants are always of a deep-bronze colour. This is not always the case; young plants growing in the shade of the bush are, as a rule, of a bright-green colour. Those that grow in open, exposed places, however, tend to assume a dull-bronze colour. This is due to a colouring substance in the epidermal cells, and is very probably of a similar nature to that found in matai; but I have not investigated its nature in either of the species. Its object in young plants is no doubt to protect them from excessive light. Hence in these young plants we find developed a remarkably high power of adaptability to environment, by which young plants grown in the open can protect themselves from the effect of a too-intense light.

Which Form of Foliage is the more primitive?

From the earliest stages there are two distinct forms of foliage, both forms of which are greatly reduced. One form is flattened, and in appearance is very like a very much reduced totara-leaf; these are arranged in rows along two sides of the lateral branches. The other form is shorter, awl-shaped, and adpressed in spiral arrangement to the stem. Both kinds of leaves vary a good deal in size and exact shape throughout development. In some cases we find gradual transitions from one form into the other, but very often abrupt changes take place.

In the three preceding species the leaves were all of the same kind, and the development in each was a more or less obvious adaptation to environment, the younger stages being the simplest, and the development gradual. In the case, however, of a plant with distinct dimorphic foliage the development is not so simple, and we are confronted with the question, Which form is the more primitive? Is the flattened form, which Kirk says is the juvenile form, or the awl-shaped, which is the mature form, the more primitive? This is a question which needs careful observation before it can be answered. It has generally been thought that the flattened form is the more primitive, and that the awl-shaped is the modified form. This is not the case; the flattened form is really the modified leaf, and the awl-shaped the more primitive. By a very careful observation of the external form alone this conclusion would be arrived at, and it is strengthened so as to leave no doubt at all by the study of the anatomical structure.

Let us first just look at the relative positions of the two kinds of leaves on a plant. By a comparison of a number of plants we arrive at this conclusion—*i.e.*, the flattened form is never found on main stems, but only on the lateral branches. The rounder form occurs on both the main stem and on the lateral branches at different periods of development. Again, the flattened forms are not, as has been supposed, the first-formed leaves on a germinating plant. If a seedling be carefully examined during germination it will be seen that the awl-shaped leaves are those which appear first on the main stem. One or two of these leaves are also formed at the base of the branches of the first whorl, but higher up we find only the flattened form. This form is the only one found on the lateral branches in older plants, with the exception of the prophylls, which soon die off. When the plant has reached a certain stage, however, the awl-shaped leaves too begin to appear on the lateral branches, and the other form becomes rather smaller and not so flattened. In the mature stage the awl-shaped leaf is the general rule on both stem and branch, being finally triumphant.

Now, the lateral branches are alone in a suitable position for assimilation, and since they alone have flattened leaves, we surely must conclude that these branches bear the modified form so as to increase the surface for assimilation. This theory is strengthened by the fact that all lateral branches tend to stand out at right angles to the stem, and hence expose the whole surface of the leaves to the sun. For confirmation of the theory we shall have to compare the anatomical structure of the two forms on the same plant.

Leaves of Seedling Six Months Old.

Flattened Form.

The leaf is on first sight apparently a much reduced specimen, similar in shape, in transverse section, to the preceding species; but the strange position of the vascular bundle strikes one at once. This is nearer one margin than the other, and the resin-canal is opposite the nearer margin. I will now give the structure of this form, and, later, a comparison with the awl-shaped leaf will leave no doubt as to what changes have taken place.

The epidermis at this early stage is very much thickened, as is also the cuticle.

The stomata are confined to four regions, which are the corners of a rectangle, with the bundle for the centre.

The hypoderm is well developed, but does not form a continuous band.

The chlorophyll parenchyma at the margins and along the sides consists of large ordinary parenchyma cells. In the middle of the leaf, radiating out from the bundle to the sides and margins, are long, narrow, and in some cases curved, elements. These would evidently serve for conduction of water, but it is doubtful, however, whether they owe their modification primarily for this purpose. The smallness of the leaf makes this modification unnecessary, and it is more probable that they originated in quite a different manner, as will be seen by a comparison with the next section.

The vascular bundle, as seen in the diagram, is slightly nearer one end than the other. It contains a resin-canal opposite the nearer margin, which is strengthened by a row of sclerenchyma. The *px* is turned towards the further margin, and between the *px* and the resin-canal are the very scanty elements of phloem and wood. There are two or three elements of transfusion tracheids starting from the *px* and running out to the sides, and an occasional element is also found outside the *px* corresponding to centripetal xylem.

Awl-shaped Leaf.

The cuticle and epidermis are better developed in the awl-shaped leaf. This may be expected, for the two kinds of leaves are exposed to the same conditions, and the smaller form has so little tissue that it would wither very easily unless it had great protection against excessive transpiration. This view is not altered by the fact that transpiration is lessened by decrease of surface.

The stomata here, as in the preceding leaf, occur in four regions, but two regions are here about opposite the vascular bundle, the other two being on the sides representing the upper surface of the leaf.

The hypoderma is well developed at the two most prominent margins, but is broken by the stomata along the rest of the surface.

The arrangement of the chlorophyll parenchyma differs in one important respect from that of the preceding leaf: there are no elongated elements on the morphologically lower surface of the leaf, only one layer of small parenchyma being between the resin-canal and the hypoderm. The elongated elements on the upper surface are not nearly so long as those of the flattened leaf, and are fewer in number, as we find only one row.

The vascular bundle is like the preceding one, only very much reduced, there being only three or four elements of phloem and wood. The *px* is turned towards one of the more prominent margins, as in the preceding section, and it is more obvious here that the two sides nearest the resin-canal represent the lower surface, whilst the two nearest the *px* represent the upper.

Origin of Flattened Form.

Now, it has already been pointed out that from the order of succession and the arrangement on the stems the awl-shaped leaves should be considered the more primitive. The first leaves are formed while the cotyledons are still inside the endosperm, and hence are shut up between them. These young leaves have therefore a very constant environment in the successive generations. The leaves, however, after the cotyledons have expanded are subjected to much more varying conditions, and hence some slight variations in form might prove advantageous under a given condition, and thus, in course of time, become "selected." In this case it would seem probable that the young plant at a certain period of its history found that, after the store of food had been used, the greatly reduced awl-shaped leaves presented an inadequate surface for assimilation. Hence by natural selection it may have gradually acquired the more flattened form, which now appears at a very early stage in the cycle of development. This theory is borne out by a comparison of the transverse sections of the two forms, where we find out also the detailed evidence of the change. It was seen that in the awl-shaped leaves the elongated elements were absent on the morphologically lower surface of the leaf, and only one row was present on the upper. In the flattened form, however, we find elongated elements on both sides of the bundle, and these are also longer and more numerous on the upper surface of the bundle. The leaf has not actually flattened, in the sense of detracting from the thickness to add to the width, but has extended itself out on two sides by the elongation of its parenchyma. By this extension a flattened form of leaf has arisen, for the width of the new leaf is much greater in proportion to its thickness. We may therefore speak of the extension as a flattening process—*i.e.*, the leaf has become flattened in the median plane.

The flattening, further, has taken place in such a direction that a dorsi-ventral arrangement of the leaves, in two rows, one on each side of the stem, is necessary so that advantage may be taken of the increased surface. The young lateral branchlets, with the flattened leaves ranged down each side, present somewhat the form of a pinnate leaf. The stem is very slender, and the leaves towards the apex become smaller, the apex itself being occupied by imperfect small leaves. As a general rule these young lateral branches are of limited growth.

If the flattening had been towards what corresponds to the margin of a flat leaf, the appearance in transverse section would have been just that of a reduced totara-leaf. The bundle would then have occupied a central position, slightly nearer the lower surface than the upper. The protoxylem would have been turned towards an upper flat surface, the resin-canals towards a lower, while at each side of the bundle, towards the margins, would have extended similar elongated elements to those of totara. The actual flattening has, however, taken place in the opposite direction, so that each apparent upper and lower surface of the leaf consists half of the morphologically lower surface and half of the morphologically upper surface. In other words, the median line of the dorsal and ventral surfaces has become in each case a margin. This makes the protoxylem face one of the margins, but at the same time it is opposite the upper surface, while the resin-canal has a position similar with regard to the lower surface.

It may be noted again that the position of the whole bundle, including the resin-canal, remains nearer one margin than the other—that is, nearer the lower than the upper surface.

The dorsi-ventral arrangement may have taken place simultaneously with the flattening. If this did not happen so, and the flattened leaves still remained in spiral arrangement on the branch, the effect would be rather to decrease than to increase the surface for assimilation. The leaves would then present their margins to the sun, as is the case in many species of *Eucalyptus*.

The plant seems to have gone to an unnecessary amount of trouble to insure the flattened form and dorsi-ventral arrangement, but it is impossible to know all the factors at work in producing this result. Perhaps it is to the advantage of the plant in assimilation and transmission of food to have a part of both wood and phloem in direct communication with each flat surface. The arrangement of the leaves in the bud may be one factor in producing the flattened form. I have not yet followed out all the details of the development in the young seedlings.

Having now found out how the flattening has taken place, and which form is the more primitive, it will perhaps be interesting to note briefly the further modification of each form in the succeeding changes of development.

Plant entering on Second Year.

The anatomy of the two forms of leaves is very similar to that of the younger stage, but shows an advance in the hypoderm, which in both forms is better developed at the sides than in the preceding stage, and in the vascular bundle, which in both forms has a greater number of conducting elements. The number in the rounder form is, as a rule, less than in the flattened form. The transfusion tissue is well developed in both, consisting of large tracheids showing transitions out from the *px* to the endoderm, on the other side of which are elongated parenchyma cells, which at this stage show no signs of lignification. There is an occasional lignified element above the *px* which may represent centripetal xylem, kept at this period as a transfusion tracheid on account of the unusual relation of the *px* to the elongated parenchyma. The resin-canal in both is very large in proportion to the size of the bundle, as will be seen from the figures.

Plants Three or Four Years Old.

Here we see the maximum development of the flattened form. Not only are the leaves on the lateral branches more flattened and narrower in transverse section, but the leaves on the main stems, while they keep their awl shape, are here also inclined to be flattened, as can be seen in transverse section. This increased surface for assimilation will be of great service to the young plant at this period, because it has now reached the stage when it must struggle hard for its existence if it is to make a place for itself among the other forms of vegetation. In both these leaves and those on older plants we find an increase of transfusion tissue, especially at the sides of the bundle. We also find that the middle elements of the parenchyma become undoubtedly lignified, which shows that these elements, which perhaps in the first place had their origin for a different purpose, have now become specialised further for the conduction of water.

Mature Foliage.

Here we find on both stem and lateral branches none but very much reduced awl-shaped leaves about $\frac{1}{12}$ in. in length. This is the general rule for the mature plants, which grow as is usual in large forests. When they grow in forests, branches with leaves are found only at the top, for these alone can reach the sunlight, for assimilation and natural selection tend to the extinction of useless organs. In more open positions, however, trees may grow to a fair height, still keeping branches near the ground, and it is on these trees that a more flattened form of foliage sometimes occurs. This form does not, however, differ in any important respect from the preceding leaves, so I will describe only the usual type of mature foliage.

As a general rule the leaf is triangular in section, the base representing the upper surface. This form is more like the early stages of the awl-shaped leaves. It is interesting to note the bulging-out of the upper surface in certain of the mature leaves, showing that even here the leaves are liable to more or less modification.

The arrangement of the chlorophyll parenchyma is rather different from that of the preceding leaves. The row of cells round the leaf next to the hypoderm has here become modified, and forms closely packed palisade parenchyma. In the preceding forms the parenchyma round the edge was composed of loose and irregular parenchyma cells. On the lower surface occur only irregularly shaped parenchyma cells; on the upper surface their place is taken by elongated cells, which are rather irregular. This arrangement is very analogous to that of the youngest awl-shaped leaves, where, however, there was only one row of irregular-shaped parenchyma between the bundle and the lower surface.

In the vascular bundle we do not find any increase in the number of elements of true xylem; there is rather a decrease. The transfusion elements are, however, much better developed, forming great groups at the sides of the bundle, and extending round also on the ventral side. It seems as if nearly the whole of the xylem had here become modified into this tissue.

Remarks on Origin of Transfusion Tissue in Kahikatea.

It will be as well here to add a few separate remarks on the origin of transfusion tissue, as, owing to the differences in form, this tissue is arranged somewhat differently. The position in this leaf in no way contradicts what was said concerning the origin earlier. In this species, as in the preceding ones, there is hardly any development of centripetal xylem in the younger stages. If there had been any the tracheids would most likely have been preserved as transfusion tracheids in the flattened form of leaf, for increasing facilities of conduction out towards the spurious margins. When transfusion tracheids do occur in the younger stages, they occur more often at the true sides of the bundle, forming transitions outwards, as in the previous species. I have, however, found an occasional tracheid on the ventral side of the wood in young plants about two years old (*vide* plate); while in older plants we see transfusion tracheids starting to be formed on all sides of the bundle, seemingly arising directly from the *px*. This is a later development, arising out of the increase in parenchyma tissue, for there is not nearly so marked a development seen in the awl-shaped leaf of the same stage. In the mature leaf we see this development carried further, and transfusion tracheids occur on all sides of the bundle, and arising in some cases from the *px* on the ventral surface. This leaf would form a strong support for Mr. Worsdell's theory, unless the intermediate forms had been studied. We may regard here the transfusion tracheids on the ventral surface as a later development of centripetal xylem, arising on account of the needs of the leaf, but not as modified primitive centripetal xylem.

We will now pass to two species of a different genera—*Dacrydium cupressinum* and *D. Kirkii*—and show where they differ from the species of the preceding genus. We will take *D. cupressinum* first, as it shows in its foliage many points of resemblance with the last species.

Dacrydium cupressinum (Rimu).

Of this species I was fortunate in finding all forms growing under the same conditions, from young germinating plants to mature foliage. The mature leaves of this species are very hard to distinguish from those of the kahikatea, especially when separate from the mother tree. Both are awl-shaped, and arranged spirally, closely adpressed to the branches. The leaves of the rimu are, however, slightly longer, and not quite so closely adpressed to the stem as those of kahikatea. Both trees, when growing amongst other trees in the forest, lose their lower branches. The height of the tree thus makes it very hard to distinguish the difference in foliage when viewed from the ground; but these trees can readily be distinguished by other points. One of the most important of these is that, while the lateral branches of the kahikatea are erect, those of the rimu are pendulous. Hence the rimu is greatly used for ornamental purposes, while the kahikatea is but rarely so used. If grown in the open, as in cultivation, the rimu may grow to a great height while still keeping pendulous branches low down on the main stem. An analogy to this was seen in the kahikatea. In the young stages, however, there is a great difference in the appearance of the young plants of these two species: this is due to the absence of dimorphic foliage in the rimu. Here we find only narrow awl-shaped leaves arranged spirally round the stem. We find little or no flattening of the leaves, though there is a slight tendency in the earliest stages to flatten each side of the bundle, though not, as in kahikatea, towards the upper and lower surfaces. These awl-shaped leaves are, however, much longer than those of the awl-shaped kahikatea, varying in length in the younger stages from $\frac{1}{2}$ in. to $\frac{1}{10}$ in. in the mature.

It would be a very interesting study to compare the rate of growth of young plants of these two species of the same age, and growing near each other under exactly the same conditions, and thus find out which form of leaf—the shorter, flatter form of the kahikatea, or the longer, narrower one of the rimu—is more advantageous for plant-growth.

Further differences will be noted in the more minute structure of the leaves in the various stages.

Cotyledons compared with those of other Species.

The cotyledons bear a great resemblance to those of miro and kahi-katea, both in general shape and structure.

The epidermal cells have thickened walls and cuticle, especially on the lower surface. This seems to be a general rule among the cotyledons of the *Podocarpeæ*, and probably of other Conifers also, though I have not seen it remarked on. This is no doubt due to the mode of germination. The young cotyledons stay inside the seed for some time to absorb the food, and hence the upper surfaces are pressed together and are thus protected, while the lower surfaces are exposed as soon as the hypocotyl appears above the surface with the bases of the cotyledons.

The stomata also appear much more regularly on the upper surface in the *Podocarpeæ*. In this particular species they occur only on the upper surface, a position similar to that found in the kahikatea cotyledon in its youngest stages, and in miro they are more numerous on the upper surface. The fact that the stomata are produced on the upper surface and then are exposed when the cotyledons open out may, in some measure, account for the fact that the cotyledons last for so short a time. In the cotyledons of totara, which last for a considerable time, we find great thickening of the epidermis on both sides, and stomata, though they occur on both surfaces, are very much greater in number on the lower. This provision for the future is in accordance with the highly specialised character in other directions.

Hypoderm, as in miro and kahikatea, is absent.

The chlorophyll parenchyma is homogeneous, like that of miro; and, like miro, tannin-sacs occur beneath the lower epidermis and round the bundle.

In the vascular bundle there is only rarely found a resin-canal. These canals are not found universally in the cotyledons of the *Podocarpeæ*. We find none even in the more advanced stages of totara, none in the early stage at least of kahikatea, while we find two or three in miro. In this particular leaf we find small-celled parenchyma in the place where the canal should appear. The number of elements in the wood is very small, and the protophloem does not form as well-marked a crescent as in most of the preceding species. I was unable to find any trace of isolated transfusion tracheids, but, as will be seen in the figure, the wood tends to arrange itself out on either side of the *px*, and the outermost tracheids are the largest.

Leaves of Young Plants with Cotyledons.

We see in this leaf a tendency to elongate out at the sides of the bundle.

The epidermis has well-developed outer walls on both surfaces, and there is no sclerenchymatous hypoderm.

The stomata are still only on the upper surface, and remain so throughout the development. Hence we see that in this leaf these organs never occur on the lower surface; their position in the cotyledon is advantageous in the later stages. The position of the stomata on the first leaves of the different species varies. In totara, in the first stage, stomata occur only on the lower surface; whilst in miro we find at this stage a few still retained on the upper surface, though in the succeeding stages they occur only on the lower. This brings out again the early provision totara makes for the protection of its first leaves.

In the chlorophyll parenchyma we find the row of cells next to the epidermis modified into palisade parenchyma, but the rest is homogeneous.

The vascular bundle is very much reduced; there are only three or four elements of phloem and wood, and no trace of transfusion tracheids. There is a small resin-canal beneath the bundle.

The Succeeding Leaves on Older Plants.

These gradually increase in diameter, and are triangular in transverse section, except on the more mature trees, where they are oval in young conical trees and four-sided on the older forest forms. The increase in diameter is usually correlated with a decrease in length, a provision for protective purposes. The mature foliage is very like that of the mature kahikatea, but can readily be distinguished by the smallness of the resin-canal. The number of palisade cells in the chlorophyll parenchyma increases as the tree gets older, till in the mature leaf we find this tissue arranged in rows of three, radiating out from the vascular bundle, or running in rows from the lower to the upper surface. The vascular bundle does not vary much except in size. In the mature leaf there are lignified elements present in the pericycle, but I have not ascertained their nature in this species. They do not show any markings on their walls in transverse section, but these may perhaps be seen in sections cut longitudinally.

Dacrydium Kirkii.

This species is very rare, and is confined to the north, where only a very few trees occur. The material which has been used was got by Professor Thomas, of this college, from a district north of Auckland. I have none of the very early stages, all investigation being confined to a single young plant, about 7 in. or 8 in. high, and to the foliage of the mature tree; but in this case the mature tree alone forms a very interesting study. On the young plant there occurred only one kind of leaf—one like that of miro or totara, and in transverse section almost identical in shape and size to that of a totara-leaf. On the mature tree we also find this kind of foliage, but longer and broader. In addition to this large leaf, we find almost every stage of reduction, to very small scale-like leaves, separate from the stem only at their apices. On a single branch one form may be seen gradually merging into the other, or we may find quite abrupt changes. On this particular tree the larger form predominated on the lower branches; further up there was a mixture of the two; while on the top branches only scale leaves were found.

This example of dimorphic foliage in a *Dacrydium* forms a great contrast to the example of *P. dacrydioides*. In the latter we saw that dimorphic foliage only occurred on the younger plants, whilst in the former it is found only on the mature. That of kahikatea is an example of adaptation in the intermediate stages, the primitive form reinstating itself finally on the mature tree. In *Dacrydium Kirkii*, however, the opposite is the case, for here we have an example of adaptation late in life, the adapted foliage being on the mature tree. The large, broad lamina is well adapted in the early stages for vigorous growth, but is evidently unsuitable in the mature state.

We saw that in totara and miro the mature leaf was always more reduced than those of the intermediate stages. *Dacrydium Kirkii* has carried this reduction to the extreme. This extraordinary amount of reduction, occurring in one and the same mature tree, and accounting for the intermingling on one tree of two totally distinct kinds of foliage, is perhaps not paralleled by any other tree in existence.

Anatomical Structure.

The structure of leaves on the young plant corresponds very closely to that of a miro-leaf on a plant of the same size, though the shape in transverse section is more like a totara-leaf.

The large form of the mature leaf is also very similar, but has increased enormously in size in comparison with the former leaf.

We still find a total absence of hypoderm, and find stomata still in the middle region of the upper surface, as well as in great numbers on the lower.

We find a remarkably small amount of differentiation in the chlorophyll parenchyma, considering the great expanse of leaf. In this also the leaf agrees closely with miro. The middle elements are only very slightly elongated, and show no signs of lignification ; on the upper surface we find one or two rows of wide palisade parenchyma, while the rest is composed of loosely arranged irregular-shaped parenchyma.

The vascular bundle is of great size, the phloem being better developed than the wood. Transfusion tracheids are well developed at the sides of the bundles.

We see by this transverse section that, of all leaves of those we have studied, this leaf is the least adapted for the prevention of excessive transpiration. It has the largest expanse of leaf, no sclerenchymatous hypoderm, and in addition it bears stomata on the exposed upper surface. Taking these facts into consideration, we should not be surprised that the tree has endeavoured to make up for these deficiencies by a reduction of its leaves in length and breadth.

I have cut sections of various stages of reduction to see if the reduction in length and breadth is correlated with any anatomical changes. None of any importance occur till the leaf has been very greatly reduced, and closely united to the stem. The reduction in length is as great or greater in proportion to the reduction in width.

Reduced-scale Leaf: Free Tip.

We note a great difference in size from the last stage. We see that the margins are greatly strengthened and are curved round the stem to serve for the protection of the neighbouring leaves. In the middle of the upper surface we see a bulge out of tissue. This is a continuation up of the region of the leaf where it joins the stem.

In the chlorophyll parenchyma we also find changes. Here we find the palisade parenchyma on the lower surface and the looser on the upper, instead of *vice versa* as in the preceding stages. This naturally follows, for the under surface is now the more exposed. In the bundle we find a reduction of elements corresponding to the reduction in size, but there are still large groups of transfusion tracheids at the sides of the bundle.

Transverse Section: Base where Leaf has joined Stem.

Stomata: We find no stomata now on the upper surface, for the region in which they occurred has become joined to the stem. The stomata are then, on the final stage, only on the lower surface, and are here on the exposed surface; but they are greatly sunk, and are protected by the very close adpression of the leaf to the stem, and by the overlapping of neighbouring leaves.

It is hardly necessary to give a summary of this leaf, the description being scarcely more, but it may be as well to mention again that—(1.) In *Dacrydium Kirkii* we have an example of dimorphic foliage in a different genus to that of kahikatea. This dimorphic foliage, however, occurs only on the old plants, while in kahikatea it occurs only in the younger stages. The dimorphic foliage in *D. Kirkii* was a result of reduction from the more primitive form; that of kahikatea was the result of an enlargement of this form. (2.) In this leaf we have an example of stomata preserved on both surfaces of a broad leaf to the mature stage. Stomata at this stage were absent from the broad leaves of totara, miro, and matai. The presence of these stomata, and the absence of a sclerenchymatous hypoderm, makes it possible to explain why a reduction has taken place in this species.

Comparison of Different Forms of Leaves.

The species I have chosen represent very fairly the different types of foliage found in the New Zealand *Podocarpeæ*; but, as my thesis is already very extensive, I shall not be able to give at present a comparison of these species with the other forms. I should like to add, however, that the most common form of leaf in the New Zealand *Podocarpeæ* is that represented by totara, miro, matai, and the earlier stages of *Dacrydium Kirkii*. Of these species the totara-leaf represents the most advanced form of this type, miro and *Dacrydium Kirkii* the simplest, whilst matai is intermediate between the two. A comparison of the structure in the "broad lamina" leaves of the *Podocarpeæ*, in conjunction with their habitats, might lead to some very interesting phytogenetic considerations. The totara is obviously the best adapted for living in exposed positions, and it is found where miro and matai could not survive. This type of foliage, which, in many respects, corresponds to *Taxus* *baccata*, is supposed to represent the most primitive type of Conifer leaf. The prevalence of this type in New Zealand Conifers is very suggestive when we consider the complete isolation of New Zealand from other countries, an isolation which can only have taken place at a very early geological period.

Very different from the first type of foliage are the reduced forms also found in the New Zealand *Podocarpeæ*. The reduction in *Dacrydium Kirkii* is a later development in its life-history, but in rimu and kahikatea we find from the beginning of development very much reduced forms. This reduction incites, both in kahikatea and in rimu, an attempt, though very different in each, to increase the surface for assimilation in the young plants. It is very probable that this reduced form may have been derived through scale leaves like those of the mature *Dacrydium Kirkii*, but it is not within the scope of this thesis to go into phytogenetic details regarding the origin of the different types of Conifer fol'age.

It is hardly necessary here to draw any further conclusions as regards the anatomical development in these species, as I have given summaries and comparisons as I have proceeded. My investigations have not been extensive enough to draw many general conclusions for the whole group, but I should like to show before concluding how far the development in these species agrees with that of the *Abietineæ*. For this purpose I will give a very short summary and comparison on parallel lines to that of M. Daguillon, which is quoted in the introduction of this thesis.

1. In the *Podocarpeæ*, as in the *Abietineæ*, the existence of leaves intermediate between the cotyledon and mature leaves is constant.

2. The passage from the primordial form in all species investigated shows insensible transitions. We find nothing to compare with *Pinus*, for though in the two plants with dimorphic foliage—*Podocarpus dacrydioides* and *Dacrydium Kirkii*—we find often abrupt changes, insensible transitional forms also occur.

3. In the *Podocarpeæ*, as in the *Abietineæ*, the passage is sometimes marked by a modification of phyllotaxis—*e.g.*, totara.

4. Sometimes by a change in the epidermal surface. This change is perhaps more marked in species of the *Podocarpeæ* than in the *Abietineæ*. One or two parallel changes occur in species of the two groups, especially as regards the position of stomata.

5. In both groups there is a development below the epiderm of a sclerenchymatous hypoderm, though we find remarkable

exceptions in the cases of miro, matai, and *Dacrydium Kirkii*. It might be noted here again the frequent occurrence in the *Podocarpeæ* of tannin-sacs in the layer next to the epidermis. Daguillon does not mention anything of the kind as occurring in the *Abietineæ*.

6. It is interesting to note the almost complete absence of "pericyclic sclerenchyma" in the *Podocarpeæ;* one or two isolated fibres alone occur. The only strengthening development here is the row of sclerenchyma cells round the resin-canal. This must, however, form a very strong support for the leaf, owing to the arrangement of these cells in a circle. Daguillon also notes the presence of transfusion tissue in the pericycle, but its distribution is very different in the two groups. In the *Abietineæ* it generally extends right around the bundle, often appearing to be connected with the phloem; in the *Podocarpeæ* this tissue generally occurs in groups at the sides of the bundle. From the position of the transfusion tracheids, as shown in Daguillon's figures, it seems more likely that they originated from the centrifugal than from the centripetal xylem. Daguillon himself says nothing about their origin, evidently regarding them as modified pericyclic cells. Tannin-sacs occur in the pericycle of many *Podocarpeæ*.

7. A bifurcation of the bundle like that occurring in the later stages of the *Abietineæ* does not occur in the *Podocarpeæ*. The bundles of the mature leaves are, however, broken up by medullary rays. It is in the case of a cotyledon—*i.e.*, that of totara—that we find the most parallel development.

8. In both groups the "number of conducting elements of the xylem and of the phloem augments when the primordial passes into the mature leaf."

9. In both groups also "when the parenchyma is heterogeneous and bifacial the differentiation of the palisade parenchyma is generally accentuated in the adult leaves."

We see from this summary and comparison that in the *Abietineæ* there are many anatomical developments similar to those we have noted in some of the *Podocarpeæ*. This similarity in development must not be confounded with the entirely different matter—similarity of structure. The leaves of the two groups are generally very different both in external form and in the arrangement of their component anatomical elements. But in both groups, to put the matter generally, disregarding all specific differences, the development tends to the differentiation of tissues for protection and strength, and also, both in the bundle and in the parenchyma, to modifications for increasing the power of conduction.

To sum up in a few words: the development of the successive stages of Conifer leaves is, to a very great extent, merely the acquisition in the mature leaves of better appliances for the manufacture of food, and for its protection during the processes of assimilation.

EXPLANATION OF PLATES VIII–X.

LETTERING USED IN FIGURES.

cut.	Cuticle.	*peric.*	Pericycle.
epid.	Epidermis.	*t.t.*	Transfusion tissue.
hyp.	Hypoderm.	*p.ph.*	Protophloem.
l.sur.par.	Lower surface parenchyma.	*ph.*	Phloem.
upp.sur.par.	Upper surface parenchyma.	*x.*	Xylem.
e.par.	Elongated parenchyma.	*px.*	Protoxylem.
acc.t.t.	Accessory transfusion tissue.	*cpx.*	Centripetal xylem.
t.s.	Tannin-sac.	*scler.*	Sclerenchyma.
end.	Endodermis.	*r.c.*	Resin-canal.

The following are transverse sections, unless otherwise stated:—

PLATE VIII.

Fig. 1. Vascular bundle, youngest stage; totara cotyledon. × 192.
Fig. 2. Vascular bundle, apex, young cotyledon; totara. × 192.
Fig. 3. Vascular bundle, older cotyledon. × 192.
Fig. 4. End of young cotyledon. × 192.
Fig. 5. Vascular bundle, youngest leaf. × 192.
Fig. 6. Tangential section, young cotyledon; totara. × 192.
Fig. 7. Outlines, transverse section—(*a*) cotyledon; (*b*) young leaf. × 12.
Fig. 8. Vascular bundle, older totara-leaf. × 192.
Fig. 9. Radial longitudinal section through outer elements transfusion tissue; shrub; totara. × 100.
Fig. 10. Transverse section, showing transitions in size of transfusion tracheids from *px* to endodermis; shrub; totara. × 100.
Fig. 11. Middle elements; older leaf, totara. × 100.
Fig. 12. End of mature leaf, totara. × 100.
Fig. 13. Outlines, transverse section—(*a*) mature totara; (*b*) mature miro; (*c*) youngest leaf; (*d*) cotyledon (miro). × 12.

PLATE IX.

Fig. 14. Bundle of cotyledon; miro. × 164.
Fig. 15. End of cotyledon; miro. × 100.
Fig. 16. Tangential section, bundle, cotyledon; miro. × 164.
Fig. 17. Bundle, older leaf, miro, stage 1. × 164.
Fig. 18. Bundle, stage 2; miro. × 164.
Fig. 19. Radial longitudinal section transfusion tissue; mature miro. × 164.
Fig. 20. Awl-shaped leaf, stage 1; kahikatea. × 100.
Fig. 21. Flattened leaf, stage 1; kahikatea. × 100.
Fig. 22. Bundle, awl-shaped leaf, second year; kahikatea. × 192.
Fig. 23. Bundle, flattened leaf, second year; kahikatea. × 192.
Fig. 24. Outlines, transverse sections—(*a*) cotyledon; (*b*) stage 1, awl-shaped; (*c*) stage 1, flattened form; (*d*) leaf, awl-shaped, on plant three years old; (*e*) flattened form on three-year-old plant; (*f, g, h*) different mature forms; kahikatea. × 22.

PLATE X.

Fig. 25. Flattened form, plant three years old, lower surface elements; kahikatea. × 192.
Fig. 26. Flattened form, plant three years old, upper surface elements; kahikatea. × 192.
Fig. 27. Bundle, mature kahikatea. × 192.
Fig. 28. Rimu; bundle, cotyledon. × 192.
Fig. 29. Transverse outlines—(*a*) cotyledon; (*b*) stage 1; (*c*) stage 2; (*d*) stage 3; (*e*) shrub; rimu. × 22.
Fig. 30. Stage 1; rimu; bundle. × 192.
Fig. 31. Stage 2; rimu. × 192.
Fig. 32. Stage 3; rimu. × 192.
Fig. 33. Mature leaf; rimu. × 192.
Fig. 34. Transverse outlines, *Dacrydium Kirkii*—(*a*, *b*, *c*) sections from apex to base of mature scale leaf; (*d*) large form of leaf; (*e*) large form, natural size; (*f*) scale form, natural size. × 12.

ART. IV.—*Some Observations on the Schists of Central Otago.*

By A. M. FINLAYSON, M.Sc.

Communicated by Dr. P. Marshall.

[*Read before the Otago Institute, 8th October, 1907.*]

Plates XI and XII.

1. DENUDATION FORMS.

MANY of the Central Otago ranges are capped by vast assemblages of rock hummocks or buttes. These are well displayed on the Dunstan, Old Man, Carrick, and Rough Ridge Ranges, also at Barewood and Macrae's. As we approach the coast these hummocks become more numerous and smaller, till they finally disappear. They are best seen near mature river development, while sufficient erosion removes them altogether. They are thus not enduring features of the landscape, but are brought into existence, and again destroyed, by erosive activity.

These peculiar forms have been remarked by several observers, notably the late Captain Hutton* and Mr. T. A. Rickard†; but the only one who discusses their nature is Rickard, who studied them at Barewood. As he observes, they are generally composed of more siliceous and resistant portions of the rock. Basins and cavities are frequently developed near their base,

* F. W. Hutton, "Geology of Otago" (Dunedin, 1875), p. 91.
† T. A. Rickard, "Goldfields of Otago," Trans. Am. Inst. Min. Eng., vol. xxi, p. 411.

and these are seen to face generally to the north—*i.e.*, to the midday sun. The formation of these cavities is, therefore, probably due to changes of temperature, and to freezing, and consequent disintegration.

No writer, however, has sufficiently emphasized the importance of joints in the production of these hummocks, for to this factor their formation is chiefly due. This is evident from a

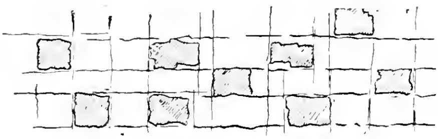

FIG. 1.

study of them in any one locality, where they are seen to be roughly square in plan, with their corresponding sides parallel.

Castle Rock, on the Dunstan Range, in the form of two large turrets, shows very conspicuously the effect of the jointing (fig. 2).

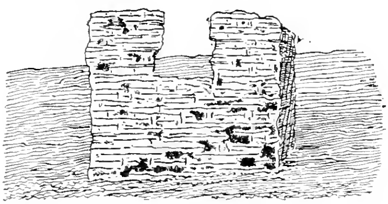

FIG. 2.

The buttes are seen to best advantage in districts of horizontal strata, and this is why they are so conspicuous along the summits of many of the ranges, where the bedding-planes of the schist are generally horizontal. Where the dip increases they become irregular; and with a nearly vertical dip, as on the fault-line at the south end of the Pisa Range, they appear as nearly upright minarets or "bayonet peaks" (fig. 3).

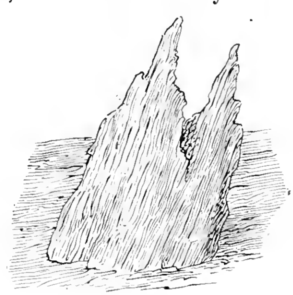

FIG. 3.

It thus appears that the amount of dip is the chief cause of their varying form, the jointing of the rocks the cause of their existence.

The combined effects of spheroidal weathering and of splitting along joint-planes have been the cause of the numerous resemblances in the rock-hummocks to human forms, such as the Monk on the Carrick Range, and the Celebrities on the Skipper's Road.

2. Fracture Cleavage.

This phenomenon, hitherto undescribed, is well displayed in the lower schists at Alexandra and on the Dunstan Range. Here we find a series of cross-fractures filled with quartz, and inclined to the foliation or flow-cleavage planes at an angle of 45° (Plates XI and XII). The veins thus formed are widely spaced and discontinuous.

This is a typical example of fracture cleavage developed by shearing in the zone of rock-fracture. Its mode of origin has been pointed out by C. R. van Hise, who says, "In the zone of rock-fracture, where the differential stress surpasses the ultimate strength of the rock, there may be produced a fissility in two sets of intersecting planes equally inclined to the greatest pressure."* In Otago one set is generally emphasized to the exclusion of the other. The name "fracture cleavage" is due to C. K. Leith, who has discussed its nature at length in his monograph on "Rock-cleavage."†

In some of the upper members of the schists, shearing-planes occur frequently along the foliation-planes, and there result slip-bands marked by a line of crushed and broken rock. These are well seen in some of the railway-cuttings in the Taieri Gorge.

It thus appears that the effect of shearing-stress differs according to the depth of the rocks affected, since fracture cleavage in the lower schists gives place to slip-bands along the foliation-planes in the upper schists.

3. The Chlorite-schists.

Distinctive types of chlorite-schist occur generally near the base of the mica-schists, notably the coarse chlorite-schist on the Dunstan and Pisa Ranges, and the granular chlorite-schist in younger beds at Cowcliff Hill, near Gibbston. These have all the characteristics of metamorphosed igneous rocks, an origin which was suggested by Hutton for some bands of chlorite-schist near Queenstown.‡

Field Relations.

The two types referred to are interbedded with the mica-schists, in bands varying from 50 ft. to 300 ft. thick. They are frequently underlain by thin distinctive bands of micaceous quartz-schist, which may represent altered contact rock.

* C. R. van Hise, "Principles of North American Pre-Cambrian Geology," U.S. Geol. Survey, 16th Annual Report, part i, p. 643.

† C. K. Leith, "Rock-cleavage," Bulletin No. 239, U.S. Geol. Survey (1905), p. 119.

‡ F. W. Hutton, "The Foliated Rocks of Otago," Trans. N.Z. Inst., vol. xxiv (1891), p. 360.

Composition.

The following analyses show the composition of these rocks :—

	1.	2.	3.	4.	5.
SiO_2 ..	42·97	39·90	49·18	41·28	46·28
Al_2O_3 ..	16·06	8·22	15·09	18·48	12·96
Fe_2O_3 ..	7·92	13·12	12·90	9·44	4·67
FeO ..	6·05	7·26	..	8·20	6·06
MnO ..	0·45	0·39	..	..	..
TiO_2 ..	2·75	2·06	..	..	..
CaO ..	11·45	14·09	10·59	7·04	10·12
MgO ..	3·24	2·26	5·22	7·48	8·71
K_2O ..	0·90	2·57	1·51	2·21	3·75 (K₂O + Na₂O)
Na_2O ..	2·64	3·41	3·64	3·52	
CO_2 ..	3·45	4·01	..	..	..
SO_3 ..	0·16	Nil	..	..	..
H_2O ..	1·33	2·00	1·87	2·74	3·34
	99·37	99·29	100·00	100·39	95·89

1. Chlorite-schist, Dunstan Ra.; Anal., J. S. Maclaurin (Bull. No. 1, N.Z. Geol. Surv., 1906, p. 42).

2. Chlorite-schist, Gibbston; Anal., A. M. Finlayson.

3. Chlorite-schist, Klippe, Sweden; quoted by Roth, Gesteinsanalejsen, 1884, p. 8).

4. Epidote-schist from diabase, South Mountain, Pa.; C. H. Henderson, Trans. Amer. Inst. Min. Eng., xii, p. 82.

5. Diabase, Point Bonita, Calif.; F. L. Ransome, Bull. Geol. Dept. Univ. Calif., i, 106.

The features of the two Otago types are the low silica percentage, and the high proportions of lime, magnesia, and notably titanium. These figures indicate a basic igneous rock. Analyses 3 and 4, of chlorite-schist and epidote-schist respectively, show analogous features. No. 5, of a typical diabase, is inserted for comparison, and shows close correspondence in respect of the main constituents.

Petrography.

Under the microscope, type No. 1 (Plate XII, 2) shows a mass of chlorite fibres and scales imbedded in elongated granules of quartz, the structure being perfectly schistose. Rutile is abundant in elongated crystals; plagioclase and magnetite are accessories, though the last is frequently very coarse and strikingly developed in large and thickly clustered octahedra. Calcite and epidote are very abundant, and the rock is sometimes so highly epidotised as to constitute an epidote-schist. Some specimens carry pyrite in large flattened cubes. The alteration of the rock is too intense to determine whether this constituent is original, but it was at least introduced prior to the dynamic metamorphism of the schist, the large size of the individuals being the result of recystallization during metamorphism.

Type No. 2 (Plate XII, 3*a*) is less schistose, and preserves more of its original structure. It is composed of a mass of labradorite and quartz crystals thickly grouped, the interspaces being occupied by fibres of chlorite, a good deal of calcite and epidote, with rutile plentiful and magnetite accessory. The feldspars are roughly rectangular, and simple or once twinned. The absence of polysynthetic twinning indicates secondary recrystallization. Both feldspars and quartz are crowded with crystals of epidote having a marked centric arrangement. The rock is practically a feldspar-schist.

The specific gravity of these rocks varies from 2·9 to 3·2.

Conclusions.

Judging from the above lines of evidence, there is no doubt that the schists described are altered flows or sheets of basic igneous rocks, contemporaneous with the associated mica-schists of sedimentary origin.

4. Igneous Intrusions.

The So-called Porphyrites of the Carrick Range.

Both Hutton and Ulrich refer, in their "Geology and Goldfields of Otago," to dykes of porphyrite, or hornstone-porphyry, on the Carrick Range, in the vicinity of the Carrick reefs.* Careful examination failed to locate these dykes, and I can only conclude that both these authorities have been misled into calling dykes some outcrops of dark iron-stained gossan near old Carricktown. These have frequently a brecciated structure, and the resulting appearance resembles a porphyritic rock with phenocrysts of quartz. The outcrops are, however, simply the barren caps of lodes.

Two magnesian dykes occur in Central Otago which were unknown to Hutton, and which have not been hitherto described.

Gibbston Dyke.

This occurs across the Kawarau River from Gibbston, about half a mile up the left branch of the Springburn, a tributary of the Gentle Annie. The schist in the neighbourhood of the intrusion has been highly crushed and disturbed. The dyke

* Hutton and Ulrich, "Geology of Otago" (Dunedin, 1875), pp. 31 and 157.

is composed of altered olivine rock, and sections show the characteristic mesh structure of serpentine derived from olivine. Where least altered, it is a black serpentine rock, showing occasional good cleavage-surfaces of hypersthene. The serpentine in more-altered portions graduates into talc, and the rock is traversed by veins of calcite and chrysotile asbestos.

The surrounding rock is a fine-grained mica-schist with a band of fine chlorite-schist. For a distance of 6 ft. from the contact the mica-schist has been altered into a highly quartzose schist, with a striking development of biotite blades arranged across the foliation-planes. The chlorite-schist shows, as a result of the intrusion, numerous actinolite needles. This development of the magnesia minerals, biotite and actinolite, is a characteristic contact-effect of magnesian intrusions.

Moke Creek Dyke.

This occurs on the right bank of Bushy Creek, 300 yards above its junction with Moke Creek, between Kilpatrick and Moke Lakes. It lies on approximately the same line of strike as the Moke Creek copper lode, and is, like the other, a serpentinised olivine rock. The outcrop is very obscure, and highly weathered into a talcose serpentine, with remnants of massive dark-green serpentine.

This dyke is particularly interesting, in that an analysis of the serpentine showed it to contain 0·075 per cent. of copper. Copper-ores are frequently associated with magnesian rocks, and this proximity of a copper-bearing dyke to a copper lode strongly suggests that the ore in the lode has been formed from a previous concentration of the ore in an ultrabasic magma beneath.

5. ON THE PRESENCE OF SEGREGATED GOLD IN THE SCHIST.

The majority of writers—notably Hector,* Ulrich,† McKay,‡ and Rickard§—in order to account for the vast amount of alluvial gold in Otago, claim that the schists carry gold segregated in the quartz laminæ. In the first place, the contention is unnecessary, as is evident from a careful study of the lodes in Otago. In the second place, only two examples have

* Sir J. Hector, "Outline of New Zealand Geology" (Wellington, 1886), p. 83.

† Hutton and Ulrich, "Geology of Otago" (Dunedin, 1875), p. 157.

‡ A. McKay, "Gold-deposits of New Zealand" (Wellington, 1903), p. 68.

§ T. A. Rickard, "Goldfields of Otago," Trans. Am. Inst. Min. Eng., vol. xxi, p. 442.

been recorded, and both of these rest on unsatisfactory evidence.

McKay records the occurrence of gold in laminated quartz at Green's Reef, Ophir.* Both Ulrich† and Park‡ have conclusively shown that there is here a zone of crushed rock on the line of a fault, through which mineralising solutions have risen. The crush-zone is penetrated by cross-veins and "flats" of quartz carrying pyrite and gold, and leaving no doubt as to the secondary origin of the metal. This instance must therefore be rejected.

H. A. Gordon states that gold has been found in the schist near the Bullendale lode, Skipper's.§ He did not describe or figure the specimen, nor did he, apparently, take any precautions to observe from where it was taken, which was very necessary in the case of a wide mullocky lode like that at Bullendale, where a broad belt of country has been intersected by several parallel fissures, and the intervening rock impregnated with auriferous pyrite.

I examined a reported instance near Butcher's Gully, Alexandra,|| which proved to be on the line of a crush-zone, highly mineralised, the rock being penetrated by "flat" veinlets of quartz resembling laminated quartz.

My conclusion is that the occurrence of gold in the schist laminæ is not borne out by observation.

The presence of gold in the schist would therefore require to be tested by careful analysis, and, in view of Wagoner's recent researches on the presence of gold in various rocks,¶ it is quite probable that the mica-schists of Otago may carry minute quantities of gold. It is, however, inconceivable that the quantity present could ever induce one to claim such as the main source of the alluvial gold of Otago.

The first investigator who opposed the view that the alluvial gold of the drifts was derived from segregated gold in the schists was Professor James Park, in his report on the Alexandra Subdivision,** and to him I am greatly indebted for the many facilities and opportunities he gave me during my work with him on the Cromwell Subdivision.

* A. McKay, "Gold-deposits of New Zealand" (Wellington, 1903), p. 68.

† "Handbook of New Zealand Mines" (Wellington, 1887), p. 75.

‡ J. Park, Bulletin No. 2, N.Z. Geol. Surv., 1906, p. 29.

§ "New Zealand Mining Handbook" (Wellington, 1906), p. 33.

|| Hutton and Ulrich, "Geology of Otago" (Dunedin, 1875), p. 157.

¶ Luther Wagoner, "Detection and Estimation of Small Quantities of Gold and Silver," Trans. Am. Inst. Min. Eng., vol. xxxi, p. 798.

** Bulletin No. 2, N.Z. Geol. Surv., 1906.

EXPLANATION OF PLATES XI AND XII.

PLATE XI.

1. Fracture cleavage in rock-face, lower schists, Alexandra. (Photo by Professor Park.)

PLATE XII.

1. Fracture cleavage in boulder, Bannockburn Bridge. (Photograph.)
2. Section of chlorite-schist, Dunstan Range. Magnetite (black) marks the foliation-planes. Chlorite (cloudy) and quartz (clear) are present. × 32 diameters.

3*a*. Section of granular chlorite-schist, Gibbston. Shows large recrystallized feldspars and quartz. × 32 diameters.

3*b*. Same negative as 3*a*; printed deep, to show centric arrangement of epidote and twinning of feldspar.

ART. V.—*Geology of Centre and North of North Island.*

By P. MARSHALL, M.A., D.Sc.

[*Read before the Otago Institute, 10th September*, 1907.]

Plate XIII.

A GREAT deal of interest is attached to the northern part of the North Island from a geological point of view. This interest is partly a result of the direction of the trend of the land, which, somewhat to the west of north, offers a striking contrast to that of the rest of the Dominion, which is directed north-east and south-west. It is of some importance to know whether this direction of the northern portion indicates a new structural direction, or whether the land is composed of broken fragments of mountain-ranges parallel to the great structural feature of the North Island—the Tararua-Ruahine-Kaimanawa-Raukumara chain.

Additional interest attaches to the extreme north, because here Mr. McKay has mentioned the occurrence of intrusive masses and "sills" of crystalline rocks of plutonic character, which he has classified with the syenites. Except for the occurrence of tonalites and other dioritic rocks from the Cape Colville Peninsula, and of granites as boulders in conglomerates at Alexandra and at Gisborne, plutonic rocks are unknown in the North Island. From a popular point of view, the greatest interest attaches to this part of New Zealand because volcanic action has been more pronounced here than elsewhere, and is still maintained spasmodically. No comprehensive attempt has been made to deal with these volcanic areas since Hochstetter's time, though much information has been gained by several investigators in various parts of the district.

In a short paper of this kind it will be impossible to attempt anything more than a general discussion of these three matters.

A reference to any map which shows the contours of the western Pacific at once makes it clear that the northern peninsula is not continued far as a submarine ridge below the waters of the Pacific. Still, there are submarine ridges parallel to it. A small ridge of this nature lies relatively close to the land, but does not extend far to the north. Over a portion of it the water is less than 500 fathoms in depth. A second ridge, of much greater importance, lies five hundred miles to the west. This, like the other, has a fairly large portion which is less than 500 fathoms below the surface of the water. The ridge continues as far north as New Caledonia without in any place dipping below the 1,000-fathom level.

There is, however, another submarine ridge of some importance north of New Zealand. Commencing about three hundred miles north of the Bay of Plenty, this ridge, less than 1,000 fathoms below the sea-level, extends continuously nearly as far north as Samoa. In ordinary maps it is not indicated as continuous, but as divided into two portions between the Kermadecs and the Tonga Islands. There does not appear to be any reason to divide the ridge into two parts in this manner. It is true that those soundings that have been made between these groups of islands indicate rather deeper water, but none of the soundings are in the direct line of the ridge, and all parts of it are extremely narrow. The evidence that is available seems to point to the continuous nature of the ridge rather than to its separation into two parts. The ridge appears to be a continuation of the trend-line of the main structural features of New Zealand. Wherever the ridge rises to the surface it displays volcanic rocks, as at the Kermadecs and at Tongatabu, though it must be remembered that Professor Thomas has obtained specimens of syenite from the former group. To the east of this ridge there is a deep rift in the bed of the Pacific. In places it is 5,000 fathoms in depth, and there appears to be definite evidence that it is 4,000 fathoms and more in depth throughout a distance as great as the length of the ridge that borders it so closely on the west. The evidence in favour of the continuity of the rift is similar to that given above—viz., in those places where discontinuity is generally represented in maps no soundings have been made in the direct line of the rift.

So far as submarine contours go, it appears from the foregoing statements that there is no definite evidence as to the nature of the northern peninsula. Trend-lines there undoubtedly are, and some of these are parallel to but not continuous with the peninsula. On the other hand, there is strong evidence of pronounced structural lines in the bed of the Pacific in the same direction as the mountain-ranges, and, if an intermediate depth of 1,600 fathoms be disregarded, actually continuous with the dominant structural features of the North Island.

If we turn to the rocks of this portion of the land we find three main types—(1) volcanic rocks of many kinds; (2) Cainozoic sediments, probably of Miocene age; and (3) intensely folded and often contorted sandstones and shales, which have been classed as Carboniferous, though there is no definite evidence that they are older than the Mesozoic. With these are associated in many northern localities the plutonic rocks previously noted.

Of these three rock-groups, the first two are not folded, and therefore afford no evidence as to the structural features at present being considered. The slates and sandstones have, however, been subjected to earth-pressure of an intense nature, and it is from them that information is to be expected. Though the whole of the area has been geologically examined, it is a remarkable fact that there is in the reports that describe the country practically no statement as to the direction of the strike and dip of these older sediments. I was able to make a few observations last summer in the Bay of Islands, and here the beds are much contorted, and are often so changed that the stratigraphic planes are completely obscured. However, from the observations that could be made, there appeared to be a north or north-north-east strike, and the same direction appeared to be represented in the hills between Mangonui and the Oruru Valley, and in the shales that are occasionally displayed in the range extending from Reef Point to Raetea. This statement is very general, but it remains the only indication of the structural lines of the country. So far as it goes, it indicates that the trend of the land is not a result of structural characters, but, as it were, accidental, because here it happened that fragments of mountains with a northerly strike in many ranges were left in such large numbers as to constitute an apparent north-westerly trend. This view is in accord with that expressed by Suess.

At present a portion of the district is being examined in detail by the reorganized Geological Survey, so definite information will shortly be forthcoming.

The second matter of special interest is the occurrence of plutonic rocks at various places, which has been noted by McKay, who referred them to syenites or diorites. At Mangonui Township McKay states that these rocks are interbedded with sandstones and shales. Of this no evidence could be seen. Certainly the character of the rocks varied somewhat: the colour is darker, and they are more compact in some places than in others. When examined under the microscope it was seen that the differences were due to unimportant variations in a diorite rock. The rock is not coarse-grained, and the feldspar is nearly all triclinic, andesine and oligoclase being chiefly present. All the ferro-magnesian mineral is hornblende, but it is much decomposed into serpentinous and chloritic substances. There is some magnetite. In the absence of analyses, the rock appears to approach the syenites somewhat closely. At Ahipara other specimens were obtained that appear to represent the mass that extends from that locality to Reef Point, though the actual specimens were obtained from Ahipara only. The rock, again, is not particularly coarse-grained, and in hand-specimens is less grey than the diorite mentioned above. The separate minerals are clearly seen in hand-specimens, and, in addition to feldspar and a dark ferro-magnesian mineral, olivine was evidently present.

When seen in thin sections the rock is at once identified as an olivine norite. The feldspar is a basic variety of labradorite. Augite is plentiful, and but slightly schillerised. The hypersthene is not abundant, and is generally associated with olivine, which is rather frequent. This appears to be the only olivine norite recorded from New Zealand, though it is probable that similar rocks exist in the Darran Mountains, near Milford Sound. Other specimens of plutonic rocks were obtained from the Raetea Saddle. They were almost entirely norites, but were wanting in olivine.

In those sections that were seen the relations between the plutonic rocks and the Mesozoic shales were not clearly displayed. No actual contact was observed, but from the irregular succession of the rocks on the road to the Raetea Saddle it was evident either that the Mesozoic sediments rested on a highly eroded surface of plutonic rock, or that the plutonic material was intruded into the sediments, and is therefore of Post-Mesozoic age. This is the view taken by McKay, and, although it is impossible to mention any section that negatives it. there are a few facts which suggest that more vigorous investigation is yet required. It is obvious that the intrusion of such large masses of plutonic rock would be likely to induce much contact action, yet when search was made in the sediments no evidence of contact action could be found, even when the outcrop of norite was close at hand. The slight schillerisation of the pyroxene also indicates that the plutonic matter has been subject to much dynamic action since its formation. Since there is no evidence of earth-movements in this district since the period of folding of the Mesozoic sediments, it would appear that the norite received its character of schillerisation at a period not later than that of the folding of the Mesozoic sediments. As this folding probably took place immediately after their deposition, it appears that the norite can hardly be of Post-Mesozoic age.

The volcanic rocks extending from Mount Egmont, Ruapehu, and the Bay of Plenty northward have not received much attention, so far as general statements are concerned, since Hochstetter's time. Apparently he made extensive collections, but only a few of his specimens appear to have been submitted to microscopical or chemical examination. A few of them, however, were described by Zirkel.* All of them are classified as rhyolites, though with very different structures in the different specimens. Of those examined, the majority were collected near Taupo and near Rotorua, though there were examples of obsidian from Tuhua as well. Mica was identified in many examples, but no rhombic pyroxene.

As a result of his observations, Hochstetter† classed the whole of the volcanic rocks of New Zealand in two divisions, called an older and a younger series. The different occurrences in the region under discussion were classed as follows :—

I. Older volcanic rocks. Tertiary and older Quaternary (Pluto-volcanic).
  (*a.*) Northward of Auckland Harbour, on the west. Andesite and dolerite breccias, with dykes of basalt.
  (*b.*) South of Manukau, and thence to Aotea Harbour. Basalt conglomerates and basalts without distinct cones.
  (*c.*) Volcanic table-land between upper and middle Waikato. Pumice and trachyte tuffs, with old extinct craters of trachytic, andesitic, and doleritic rocks.

II. Younger volcanic formation. Acid and basic products. Cones with distinct or stuffed-up craters.
  (*a.*) Taupo zone. Rhyolitic and trachytic lavas. Obsidian and pumice important. Includes the large volcanoes around Taupo.
  (*b.*) Mount Egmont. This may belong to the older period.
  (*c.*) Auckland zone. Sixty-three eruption-points, with distinct craters and lava-flows.
  (*d.*) Bay of Islands. Between Hokianga and Bay of Islands. Similar to Auckland zone.

Since Hochstetter's time important work has been done by Professor Thomas. The results of his first paper‡ may be thus summarised: Augite-andesites were found at Mount Edgecumbe; Ngauruhoe; Ruapehu, west side; Wanganui River,

* "Reise der 'Novara': Geologie," vol. i, p. 109.
† "Reise der 'Novara': Geologie," vol. i, p. 200.
‡ Thomas, Trans. N.Z. Inst., vol. xx, p. 306 *et seq.*

on west side of Taupo; Whangamata Bay, West Taupo; Titiraupenga. Rhyolites were found in several places. Some contained quartz, brown hornblende, and augite. Spherulitic and axiolitic types were mentioned, and a banded type from Motutaiko Island, in Lake Taupo.

In a second paper* the rocks of Tongariro are described as typical augite-andesites, but in a few instances there was a little olivine—*e.g.*, the summit of Tongariro, at the red crater, and at Otukou. It is noticeable that in all of Professor Thomas's descriptions there is no mention of the occurrence of rhombic pyroxene.

Captain Hutton† described many rocks from this district. Rhyolites are recorded from Taupo; hornblende-rhyolite, from Lake Tarawera and Lake Rotorua; augite-rhyolite, from Ateamuri; enstatite-rhyolite, from Lake Taupo; chlorite-rhyolite, from Okaro; pitchstone, from Maketu, Tauranga, and Mayor Island; spherulitic pitchstone, from Rotorua; obsidian, from Mayor Island, Taupo, and Lake Rotoiti. Trachyte is recorded from the Sugarloaves, Taranaki, but subsequently Hutton classified this rock as an andesite‡; from Whangarei, based on an identification of Cox§; from Runanga, Napier–Taupo Road, based on an identification of Hector‖. Hornblende-andesites are recorded from Sugarloaves, Taranaki; Mount Egmont; eastern base of Mount Ruapehu; Tokatoka; Kaipara. Augite-andesites, from Mount Egmont; Mount Pirongia; Okaro; Mount Tarawera, eruption of 1886. Enstatite-andesite, from Sugarloaves, Taranaki; Ruapehu; Horohoro; White Island; Puponga, in Manukau Harbour; Helensville; Kamiti, in Kaipara Harbour; Whangarei Heads. Olivine-andesite, from Mount Egmont. A dolerite is recorded from Kakepuku; and basalt from Mount Eden and Rangitoto, near Auckland.

Thomas,¶ in a report on the Tarawera eruption, published by the New Zealand Government in 1888, has mentioned the rocks of Mount Edgecumbe as augite-andesite, and the lava emitted as bombs from Tarawera in 1886 is also described under the same name.

Hill** has described the rocks of Ruapehu as basalt, trachyte, and andesite.

* Thomas, Trans. N.Z. Inst., vol. xxi, p. 349 *et seq.*
† Hutton, Royal Soc. N.S.W., 1889, p. 102 *et seq.*
‡ Hutton, Trans. N.Z. Inst., vol. xxxi, p. 483.
§ Cox, Geological Reports, 1876–77, p. 95.
‖ Hector, Geological Reports, 1870–71.
¶ Thomas, "Report on Eruption of Tarawera," pp. 13 and 58.
** Hill, Trans. N.Z. Inst., vol. xxiv, p. 617; also Trans. Aust. Assoc. Adv. Sci., vol. iii, p. 170.

Park* has mentioned dolerite, phonolites, porphyritic trachytes, and pitchstone as occurring on Ruapehu; but neither of these last two authors appears to have made anything more than a field examination of the rocks.

Rutley† has described a large number of rhyolites from the Rotorua area. Several of these suffered from geyser-action and have become more or less silicified. Descriptions of rocks from Tuhua (Mayor Island), in the Bay of Plenty, are included in this paper.

A different type of rock, a pantellaritic liparite lava, has recently been described by F. von Wolff‡ from Mayor Island. This is the only mention of soda-rich types from the district —at any rate, in technical descriptions.

During the presence of the "Discovery" expedition in New Zealand, rocks were collected by Ferrar near the Aratiatia Rapids, on the Waikato River. They have been described as rhyolites and andesites by Rastall.§ Reference is here made to a peculiar reddish pyroxene that it is stated may be strongly soda-bearing.

The Auckland rocks have also been described by Shrewsbury,‖ who classed them all as basalts.

The literature referring to the Thames rocks and those of the Cape Colville Peninsula is quite extensive, but there is a very general agreement as to the rock-types and the succession of lavas. The most recent publication on the district appeared in 1905, from the pen of Professor Sollas¶, with descriptive notes by A. McKay. Photographs of many of the rock-types appear in this work.

It is recognised by all workers in this field that the andesites are very varied in type and structure. They range from dacites to hypersthene andesites, with some olivine. Augite and hornblende types occur as well, but there are no unusual minerals present. Sollas speaks in several places of the micropœcillitic structure as peculiar. The mineral with which this structure is most commonly associated he has identified as quartz. Coarsely spherulitic rhyolites from this locality have received considerable attention from Rutley** and Sollas.†† The spheru-

* Park, Geological Reports, 1886, p. 70.

† Rutley, Quart. Journ. Geol. Soc., vol. lvi, p. 493 *et seq.*

‡ F. von Wolff, "Centralblatt für Mineralogie, &c., 1904," p. 208 *et seq.*

§ Geological Mag., Decade v, vol. ii, p. 403 *et seq.*

‖ Shrewsbury, Trans. N.Z. Inst., vol. xxiv, p. 366.

¶ Sollas, "Rocks of Cape Colville Peninsula," 2 vols.; Government Printer, Wellington.

** Rutley, Quart. Journ. Geol. Soc., vol. lv, p. 449 *et seq.*, particularly p. 466; also vol. lvi, p. 509.

†† Sollas, "Rocks of Cape Colville Peninsula," vol. i, pp. 120, 121.

lites are nearly an inch in diameter at times, and have irregularly curved radiating arms. Rutley regards the objects as a result of refusion of the rhyolite. Sollas rejects this explanation, and states that these features, as well as certain isotropic feldspars, have resulted from processes of decomposition. This explanation he afterwards withdrew, but did not substitute another.

A peculiar type of rock with a semi-brecciated appearance is called by Professor Sollas "wilsonite." He suggests that its peculiar structure is due to the association of fragments of lava ejected during an eruption which retained their viscosity until they reached the ground.

A very complete bibliography of the literature of Cape Colville geology is given in the introduction to Professor Sollas's work.* Unfortunately, it is impossible to represent the results of different authors here. This is less regrettable because they are in essential agreement as to all the main features. Reference, however, should be made to the geological map of the district in the second volume, and a similar map by Professor Park.†

In the second volume of Professor Sollas's report there are descriptions of rocks collected by McKay on the western spurs of the Kaimanawa Range.‡ Some of these are probably material ejected by Ruapehu and its neighbours, for the rocks agree with those of the volcanoes in all essential particulars. Others agree with rocks near Lake Taupo. Other descriptions are given of rocks from the Sugarloaves, Taranaki. The only special feature to notice is the occurrence of hypersthene‡ in one example as a core of a hornblende crystal.

Fox,§ in a paper on the volcanic rocks near Auckland, has described certain tuff-beds as being formed of fragmentary matter ejected by the Cape Colville eruptions, and others as formed during the eruptions of the Waitakerei volcanoes.

The physiography of this region has been referred to by many authors. Hill, in particular, and Park have described the physiography of the Ruapehu region, and further descriptions have been added by Von Friedlander,|| who visited the district after the eruption of Te Mari in 1896. Marshall and Alison have also written on the subject in the volumes of the "New Zealand Alpine Journal." Thomas, in papers quoted above, has dealt fully with Tongariro. An accurate map of Tongariro has been drawn by Cussen.

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* Sollas, "Rocks of Cape Colville Peninsula," vol. i, p. 124.

† Park, "Geology and Veins of Hauraki Goldfields," N.Z. Inst. Min. Eng., 1897.

‡ Sollas, "Rocks of Cape Colville Peninsula," vol. ii, pp. 160–65.

§ Fox, Trans. N.Z. Inst., vol. xxxiii, p. 452 *et seq.*

|| Friedlander, Trans. N.Z. Inst., vol. xxxi, p. 498.

The general features of the physiography of the whole district were, of course, fully outlined by Hochstetter,* who travelled throughout the district in 1864. The general results of his work require no very great modification, though, of course, there has been much change in the Tarawera and Rotomahana district as a result of the eruption of 1886.

Another description has been given by Marshall† and by Gregory.‡ Cussen§ has written papers on the changes in the course of the Waikato River, as well as a paper on the country to the west of Taupo, that is still very imperfectly known.

McKay‖ has lately discussed the locality of the eruption, from which all the pumice was dispersed.

In regard to the age of the outburst of volcanic action in this part of New Zealand, we have Hill's¶ statement that there is a pumice-bed interstratified with Miocene (Cretaceo-tertiary) clays at Tolaga Bay. Park** states that the activity of Ruapehu and Egmont began in the newer Pliocene. In the Thames district Park†† gives the Upper Eocene age for the commencement of volcanic action. Hector‡‡ states that the Thames andesites are of Cretaceo-tertiary age. Hutton§§ places the Thames andesites doubtfully in the Oligocene, and the volcanic rocks of the central region in the Pliocene. Afterwards‖‖ he states that the eruptions began in the Miocene.

In this paper an attempt will be made to combine the results obtained by the various authors named above with the observations made by the author of this paper.

AGE.

A recent paper by Professor Park¶¶ has revised the classification of the Cainozoic rocks of New Zealand. Nearly all the Cretaceo-tertiary rocks of Hector, as well as his Eocene rocks, are referred to the Miocene as a result of a fresh examination of typical sections. If this reasonable conclusion is adopted, an

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* Hochstetter, "New Zealand," 1867.

† Marshall, "Geography of New Zealand," p. 73 *et seq.*; Whitcombe and Tombs, 1905.

‡ Gregory, "Australasia," vol. i, pp. 577–82; Stanford.

§ Cussen, Trans. N.Z. Inst., vol. xx, p. 316; vol. xxvi, p. 398.

‖ McKay, Mines Reports, 1899, p. 16.

¶ Hill, Trans. N.Z. Inst., vol. xx, p. 304.

** Park, Geological Reports, 1886, p. 71.

†† Park, "Hauraki Goldfields," p. 13.

‡‡ Hector, "Outline of New Zealand Geology," p. 87.

§§ Hutton, "Geology of New Zealand," Quart. Journ. Geol. Soc., 1885, p. 192.

‖‖ Trans. N.Z. Inst., vol. xxxii, p. 172.

¶¶ Park, Trans. N.Z. Inst., vol. xxxvii, p. 491.

important change must be made in the age of the Thames andesites, which rest on rocks that have hitherto been classed as Cretaceo-tertiary. They must be accepted as of Upper Miocene age at the earliest.

Hill's observations prove the Miocene age of some acid eruptions, probably that of the interior region near Taupo; so it appears that volcanic action commenced in the Thames and Taupo regions almost simultaneously towards the end of the Miocene period.

At Auckland, Fox has shown that the scoria-beds in the Waitemata series are of the same nature as the Waitakerei rocks, and, as the Waitemata beds are Upper Miocene, there can be no doubt that the great series of Waitakerei andesites are of Upper Miocene age. The main features of the Waitakerei rocks, stratigraphical, petrographical, and physiographical, are repeated at many points further north, notably at Kamiti, Kaipara Harbour; Manaia Peaks, Whangarei; the entrance to Hokianga; St. Paul, and the surrounding district, Whangaroa; south of Mangonui; North Cape district. It therefore seems reasonable to refer all these areas to eruptions of Upper Miocene age. In making this correlation, it must be remembered that the rocks have most striking characteristics in common, and that in several cases actual stratigraphical evidence that warrants such a correlation is to be found.

There is little evidence as to the age of the rocks of Karioi and Pirongia. Stratigraphically they rest upon Miocene limestones, and are possibly of late Miocene age. The rocks are dolerites, and differ markedly from all other volcanic material of the North Island, so far as my experience goes.

Another group of rocks about which there is at present but little information is that of the older basalts between Kerikeri and Orotere, and, further on, between Mangonui and Ahipara. I know of no stratigraphical evidence as to their age, and they are here termed "older" merely because of the mineralogical changes of serpentinisation that they have undergone, and because of the extensive weathering changes by which their surface has been altered. At Kerikeri they rest on Miocene rocks.

There appear, then, good evidences of great volcanic activity towards the close of the Miocene; but this activity was more pronounced in the northern part of the district than in the southern, for in all the extensive Miocene rocks near Wanganui there are no pumice or fragments of volcanic rock to be found, even in the upper rocks of the series. That this period of activity extended into the Pliocene is possible, though, owing to the general absence of Pliocene deposits, there is no absolute proof of the statement. Such Pliocene deposits are, however, found in the Hawke's Bay and Wanganui districts. The former district has been described by Mr. Hill,* who mentions pumice and volcanic material in the Upper Pliocene only. From this it appears that the volcanic action which distributed pumice in the Miocene became dormant in the Upper Pliocene, or became extinct, and a new district became active in its place.

At Wanganui, Park† has stated that volcanic material is found in the Upper Pliocene only. This agrees with Hutton's‡ statement and with that in his geological history of New Zealand.§ With these statements my observations entirely agree, and I would add that the lower gravels of volcanic material in the Upper Pliocene at Wanganui contain a much larger quantity of pebbles of Mesozoic sediments and of rhyolites than the higher strata of gravels, which consist almost entirely of andesitic pebbles. This suggests that in the early Pliocene the sediments of the range west of Taupo had not become so nearly obliterated by volcanic ejecta as now, and that the Ongaruhe was then cutting its gorge vigorously through the white rhyolite, while the Wanganui did not have its head-waters obstructed, in bringing gravels from the Kaimanawas, by the huge andesitic masses of Ruapehu and his fellows. Later on, as Ruapehu grew, the source of sedimentary pebbles was cut off, and the steep slopes of Ruapehu yielded more and more material to the streams that coursed down its sides.

Further north the volcanic cones at Auckland are of extremely recent age. Their lava-streams flowed down valleys that still exist. So recent are the lavas that streams still flow beneath them through the loose scoriaceous matter of their lower surface. In no instance has a stream cut a higher-level channel on the surface of the lava. The same remarks apply to the volcanic matter at Whangarei and at the Bay of Islands. This volcanic action, however, appears to have lasted a considerable time. The rocks of the plateau of the lower Waikato are similar to those of the Auckland caves. Though still quite fresh at a little distance from the surface, there is a deep and fertile soil formed from the lava, and streams have cut deep channels through it. The same remarks apply equally to the Bay of Islands. It appears, then, that though the present cones and their lava-flows are of extremely recent age, they represent only the final effort of a long period of activity, which may have commenced in the Pliocene.

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* Hill, Trans. N.Z. Inst., vol. xx, p. 301.
† Park, Geological Reports, 1886, p. 71.
‡ Hutton, Trans. N.Z. Inst., vol. xix, p. 339.
§ Hutton, Trans. N.Z. Inst., vol. xxxii, p. 173.

Physiography of the District.

So many writers have already discussed this aspect of the subject that little need be added here. There are, however, a few matters that seem to have, in part, escaped attention previously, and others which allow of very different interpretations.

The actual craters of the large volcanoes have often been described. It will, perhaps, be interesting to make a few remarks on the crater of Ngauruhoe, which I have visited six times since 1891.

The two earliest accounts, by Dyson and Bidwill, represent the crater as a profound abyss which could not be descended on any side, nor could the bottom be seen.

In December, 1890, it was possible to walk all over the bottom of the main crater, though steam-jets of some size were to be found in many places. Round each steam-jet there was a small cone of sulphur. The small scoria cone on the north rim of the main crater was then much more active than the main crater itself.

A year later the crater had completely changed, and there was a large pit near the centre of the main crater. This pit was the scene of rather violent activity, and it was impossible to see to the bottom of it.

But little change has taken place since that time, though the pit has become larger, and has changed its position rather to the west, so that in December, 1906, its western side coincided with the western flank of the mountain. At this time the mountain was rather inactive, and it was possible to see to the bottom of the pit. It was about 250 ft. in depth, with nearly vertical sides, which were encrusted with sulphur, and from which steam issued in clouds. At the bottom of the crater was a pond of water of a bluish-green colour. There was a scum, apparently of sulphur, and the water was in ebullition. Sulphuretted hydrogen was being emitted in small quantity, but sulphur-dioxide was in far larger amount. The small-rim crater to the north was nearly quiescent.

In February, 1907, the mountain became rather violent, and emitted large quantities of dust, which fell over the country to leeward. The mountain was ascended in March, during the continuance of the active phase. The crater appeared to have undergone no material change, but the shower of acid rain and mud prevented me from making more exact observations. The mud was six inches deep on the rim of the crater, and extended 2000 feet down the side of the cone.

The craters on Ruapehu and Tongariro have undergone no material change within the period of my observations, and they have been accurately described by many observers.

The violent eruptions of Tarawera in June, 1886, have been so fully described by Hector, Hutton, Percy Smith, and Thomas, as well as a host of other writers, that it is unnecessary to refer further to them here. The features of this volcanic area have lately been examined by Bell,* and the changes that have occurred since the eruption are described by him.

An important feature of the physiography of the district is described by Cussen.† This is the range of old folded sediments here referred to as Mesozoic, though stated by Cussen, in conformity with the usual custom, to be Carboniferous. The range commences ten miles to the west of Tongariro, and extends throughout the country to the west of Taupo. There is little doubt that, though the old sediments have actually been found only in few places on this range, it is really an old denuded range which has been smothered beneath the accumulation of volcanic material. This range was first discovered by Hochstetter.

The deep dry valleys found at intervals in the pumice country are deserving of some notice. They are especially frequent on the north of Taupo. In many of them no water has ever been known to flow, yet they are 150 ft. to 200 ft. in depth, with nearly vertical sides, and 30 or 40 yards wide, and often of great length. Even if heavier rainfall is assumed to have taken place in the past, it is hard to account for these. The eruption of Tarawera afforded a clue to their origin, for the torrential downpours of condensed steam and mud which succeeded the eruption caused the erosion of such channels in several places, notably near the road between Rotorua and Wairoa. It seems reasonable to suppose that the dry channels have generally been formed in this way.

Another physiographical feature which is most striking is the steep, straight-sided form of many of the hills in this region. Horohoro is a well-known example. The straight sides are formed of rhyolitic lava in most cases, though Cussen states that Titirangenga, in which straight sides are noticeable, is formed of augite-andesite. These remarkable hill-forms have been described as fault-lines along which the surrounding land has fallen in. Hochstetter first held this view, and more recently Gregory‡ has adopted it, and the theory was mentioned by Marshall.§ Gregory describes one fault-plane along the

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* J. M. Bell, Geograph. Journal, 1906, p. 369.
† Cussen, Trans. N.Z. Inst., vol. xx, p. 320.
‡ Gregory, "Australasia," vol. 1, p. 582; Stanford.
§ Marshall, "Geography of New Zealand," 1905, p. 183.

flank of the Paeroa Mountains parallel to the Tarawera fissure. These vertical scarps are general in the whole district. They are noticeable at Ngatira, on the Rotorua line, where the railway enters the plateau. They are prominent on the Rotorua side of this plateau and on the flanks of Ngongotaha, on Tarawera itself, and in the southern portion of the district such scarps are very prominent on the sides of all the streams that cross the railway-line between Mokau and Porootarao. It is evident that these features are most general, and, as in the southern district there can be no doubt that they are due to the resistant nature of the rhyolite, there is no reason why the same explanation should not be accepted for Horohoro and its fellows. If these features are due to faulting, it is remarkable that the eruption of Tarawera should have occurred in solid rock, midway between two profound adjacent faults parallel to it, for the sides of Tarawera have notably this scarped form.

The distribution of pumice has long attracted attention. Cussen has suggested that it was derived from the Taupo basin, for he noticed that the pumice on the west of the lake became coarser as the lake was approached. McKay has, for reasons of a similar nature, stated that eruptions probably took place somewhat to the east of Taupo. He rightly states that the distribution of the pumice is so great that it is almost impossible that it should have been the product of a single volcano. He supposes that many of the vents have afterwards been smothered in the products of other volcanoes. This statement of McKay probably represents as near an approach to exactitude as can at present be made. At the same time, it is reasonable to regard the lake-basins of the volcanic region as areas that have been affected by violent explosions, possibly of a hydrothermal or perhaps of a truly volcanic nature. That lake-basins can be formed by such explosions we have good evidence in Lake Rotomahana, and its contours are not strikingly different from those of the other lakes. If the explosion were accompanied with volcanic action and emission of acidic tuff, we have in the present depressions of the volcanic plateau sufficient points of emission to account for the distribution of pumice. The form of Lake Taupo is particularly suggestive of an explosive origin, though its present dimensions do not probably represent merely the area of the exploded depression. Such a cataclysm causes the outlet to be stopped up, and the gathered waters gradually spread over the adjacent lowlands.

It is noticeable that though the actual melted rock at Tarawera was andesitic, yet pumice of an acidic nature was more widely dispersed than the andesitic tuff. If this view is correct, the lakes of the volcanic country must be regarded as filling explosion cavities, as Lake Rotomahana actually does. It is perhaps advisable in connection with this part of the subject to state that there is every reason against the supposition that the pumice was derived from any of the present volcanic cones. Without any known exception, all the cones of the district are formed of andesitic rocks from top to base.

So far as the nature of the rocks is concerned, I am able to make a few additions to the descriptions given, and, in view of the large amount of literature now available, to generalise rather more widely as to the distribution of various rock-types.

Rhyolites of many types are found throughout the district. The purely glassy type, obsidian, is found at Mayor Island and near Tarawera; spherulitic obsidians are common at Rotorua and near Wairakei. The glassy base is usually trichitic. Spherulitic rhyolites are very abundant. The coarse types, from the Cape Colville Peninsula, contain nests of angular quartz grains and some tridymite. I am quite unable to agree with either Rutley or Sollas as to the origin of the spherulites. While being somewhat diffident in this matter, I cannot regard them as either due to refusion or to decomposition. They appear to be essentially original, though the exact conditions necessary to their formation cannot at present be defined. They are the last objects to form during consolidation of the rock. At Lake Taupo and in many other places there is a banded rhyolite. When examined microscopically the darker bands are found to consist of axiolitic structures of indefinite length, and the other portion consists chiefly of microscopic spherulites, and sometimes the micropœcillitic structure of Sollas is distinct. The rhyolites in the eastern portion of the district, in the valley of the Ongaruhe, have a groundmass in which there is little individualisation of minerals, and the rock has markings that somewhat resemble the damascened patterns on a gun-barrel. Tridymite is common in this type of rock, but quartz is absent. The minerals which have crystallized out are not very numerous. Quartz occurs quite infrequently, but its place is generally taken by tridymite in very small aggregates. In the spherulitic rhyolites of Tairua quartz is found in nest-like aggregates, and distinct grains are found in some Taupo rhyolites and in the silicified tuff of the Huka Falls. Feldspar is found in all but the more glassy varieties. Often it is confined to minute radially arranged microlites in the spherulitic types, but distinct crystals are found in the rocks that are not particularly glassy. It is most abundant from rocks in the south and west of the district. Sanidine is relatively infrequent, for nearly all the crystals belong to triclinic forms, apparently between albite and oligoclase.

Of other minerals, hornblende is sometimes found, but is not very frequent. Biotite is still more uncommon. Hypersthene is by far the most usual of all ferro-magnesian minerals, especially in the southern portion of the district, though further north its place is taken by hornblende in some measure. Augite is uncommon. The pumice offers no special peculiarities, for it is merely vesicular scoria of the rhyolites.

Few analyses of the rhyolites have been published. Hochstetter* quotes some analyses of hot-spring deposits near Rotorua. Some of these appear to be silicified rhyolites. Maclaurin and Pond† give analyses of pumice. The percentages of lime and magnesia are somewhat higher than is usual in this type of rock. Determinations of silica are given in "Rocks of Cape Colville Peninsula."‡ The percentage is rather more than 70.

There appears to be no record of rhyolites occurring anywhere to the north of Cape Colville, except in the Great Barrier Island. The only example known to me is a dyke penetrating the Manukau breccias at Karekare: it resembles those from the Ongaruhe Valley.

Trachytes: The only example of this group of rocks that I have had was taken from one of the small hills near the Kaipara. It is composed almost entirely of feldspar microlites, but there is also a little biotite.

Andesites: These rocks have a wider occurrence than the rhyolites, and differ among themselves more in mineralogical composition, but less in structure.

Dacites have a considerable distribution in the Cape Colville area, and many of them are coarsely porphyritic. Sollas has described them under several names. Hornblende, pyroxene, and hypersthene dacites all occur. The last are least frequent. The minerals occasionally occur together, though hypersthene and hornblende are not associated in more than two or three specimens of dacites.

Outside of the Cape Colville area dacites have not been recorded, so far as I know. I have, however, had specimens of hornblende-dacite from the Hen and Chickens Islands, and in the main volcanic area Tauhara is formed of a hornblende-hypersthene-dacite. The hornblende has a peculiar reddish colour.

Of other andesites there is a great variety. The Cape Colville Peninsula has numerous representatives of almost every

* Hochstetter, "New Zealand," p. 435.

† Pond and Maclaurin, Trans. N.Z. Inst., vol. xxxii, p. 233 *et seq.*

‡ Vol. ii, pp. 303, 304.

type, though I do not know of descriptions of any mica-andesite. Hornblende-andesites are less usual than hypersthene-bearing varieties, and augite-andesites are not very common. Two or more of these minerals may occur together. The structures, too, are many. Besides the ordinary structures of andesitic rocks, Sollas has described the micropœcillitic, in which quartz forms grains of relatively large size, with highly irregular boundaries, and in the grains are included the constituents of the groundmass. Spherulitic varieties are also described in some number.

Mount Egmont consists entirely, so far as my researches go, of andesitic rocks. The usual type is a hornblende-augite-andesite, in which the augite is a pale green. The hornblende is sometimes completely resorbed, and an augite-andesite results. Occasionally a little olivine is found. This description agrees with that of other workers, though Hutton first described the Sugarloaf rocks as trachytes, and he has also mentioned a hypersthene-augite-andesite from this locality. Sollas mentions a little hypersthene in one type: I have found none in any of my sections. Mr. R. Browne sent me some fine lamellar specimens of hæmatite which were obtained from a tuff-bed on the lower slopes of Mount Egmont.

Ruapehu and its neighbours are entirely formed of hypersthene-augite-andesite, so far as I know. Specimens have been collected all over the east and south sides of the mountain, and from the west and north sides collections have been made from streams. The augite is pale brown, and the hypersthene is strongly pleochroic. There is no hypersthene in the groundmass, which is usually hyalopilitic, though sometimes pilotaxitic. A little olivine is occasionally found. It is usually surrounded by numerous hypersthene crystals. I have found no hornblende in any of my numerous specimens, and no examples of phonolites, basalts, or trachytes, mentioned by Park and Hill. In Thomas's descriptions of the rocks of these mountains there is no mention of hypersthene. This must be regarded as an oversight, for the mineral occurs so invariably in my specimens that I cannot fail to think that some, at any rate, of his must have contained it.

Hypersthene-andesites are recorded by Hutton from many other localities, and augite-andesites from many by Thomas. The latter mentions this rock as the product of the eruption of Tarawera in 1886. This statement has been confirmed by Hutton and Rutley. The specimens I have gathered from this volcano are hypersthene-augite-andesites again, but the rock is very fine-grained, and identification of the minerals is not easy, but there is no doubt that hypersthene occurs.

In the present state of our knowledge one appears justified in making the statement that nearly all the cones that rise above the rhyolite plateau are formed of hypersthene-augite-andesites. Tauhara appears to be the only exception recorded.

It may here be stated that Hochstetter referred to many of these rocks as trachydolerites, and that this name has been widely adopted in the reports of the Geological Survey of the past.

Hypersthene-andesites have a considerable development further north. All the specimens that I have gathered from the Waitakerei region belong to this type, and from the Little Barrier Island a pure hypersthene-andesite was given me by Mr. Cheeseman, F.L.S. At Whangarei Heads, Parua Bay, a similar rock was found. At Whangaroa hypersthene-andesites and hornblende - hypersthene - andesites were obtained from St. Paul's Dome. One is probably justified in assuming that these rocks occur in the other regions where the typical Manukau breccia occurs—viz., at Hokianga and at the North Cape.

In the central region it can be clearly seen that distribution of pumice succeeded earlier eruptions of the Ruapehu region, for at Waiouru and in the Onetapu Plains pumice rests on the surface of andesitic rocks. That the distribution of pumice was succeeded by eruption of andesitic matter is shown by the andesite tuff that rests on the pumice in the same localities.

Basaltic rocks show less variation, and have a wider occurrence. Pirongia and Karioi appear, from the specimens that I have collected, to be formed entirely of a porphyritic rock of this class, which is perhaps best called a dolerite. The olivine is much serpentinised, augite in large crystals is plentiful, and andesine-labradorite feldspar as well. The groundmass is augite feldspar and magnetite. Amongst New Zealand rocks this type resembles some of the dolerites of Dunedin more closely than any others that I have seen.

The older basalts which occur north of Kerikeri, and between Kaitaia and Ahipara, are very fine-grained; olivine much serpentinised, and fine; feldspar very plentiful, as well as augite and magnetite. I do not know the localities from which the eruption of these took place.

The rocks of the cones at Auckland and of the Waikato plateau, as well as those of the Bay of Islands, have always been classed as basalts. All that I have examined prove to be basanites. The nepheline is not present in any quantity, but it can be detected by gelatinisation and staining, as well as by the cubes of salt obtained when the solution derived from treatment of the rock-powder with hydrochloric acid is evaporated. These basanites are usually fine-grained, though this character is far less noticeable in the specimens from the Waikato area, which are relatively coarse but even-grained, and thus different from the Karioi-Pirongia rocks.

A consideration of these statements will show that our knowledge at present allows us to classify the products of volcanic action as follows:—

1. Later Miocene,—
   (*a*.) Andesites of Cape Colville Peninsula.
   (*b*.) Andesites of Manukau breccias in their many occurrences.
   (*c*.) Rhyolites of north of Taupo.
   (*d*.) Dolerites of Pirongia and Karioi.*
   (*e*.) Older basalts of Kerikeri.*
2. Later Pliocene,—
   (*a*.) Hornblende-andesite of Mount Egmont.
   (*b*.) Augite-hypersthene-andesite of Ruapehu and other cones of the plateau.
   (*c*.) Hypersthene-dacite of Tauhara.
   (*d*.) Basanites of lower Waikato.
3. Recent,—
   (*a*.) Andesites of Ngauruhoe and Tongariro.
   (*b*.) Basanites of Auckland and Bay of Islands.
   (*c*.) Andesite of Tarawera.

A very interesting type of basanite is found in the Domain volcano, Auckland, in the form of ejected blocks only. The iron-ore is ilmenite; feldspar is oligoclase-andesine; olivine in elongated crystals; augite is violet, and shows strong pleochroism, and sometimes has a fringe of ægerine; nepheline idiomorphic and small; ophitic and micrographic structures are well shown, the latter as typically as in the celebrated type from the Labauer Berg.

SUMMARY.

There is little evidence in regard to the structural meaning of the direction of the North of Auckland Peninsula.

That the plutonic rocks of Mangonui and Ahipara are diorites and norites, but no evidence is available as to whether they are intrusive or older than the Mesozoic sediments.

Volcanic rocks are chiefly rhyolitic in the central region, but the rhyolites are penetrated by andesitic pipes, over which large cones have been built up.

The lake-basins are probably areas of violent hydrothermal explosions, and from these explosions pumice was distributed.

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* Perhaps early Pliocene.

The sharp scarps of many of the rhyolite hills do not indicate the action of faults, but are due to erosion.

The sequence of eruptive rocks is suggested.

NOTE.—Specimens lately collected by Mr. R. Speight show that hornblende-andesite with much hypersthene occurs on the north slope of Ruapehu, and also on A Tama. This confirms Hutton's statement. The rock resembles that of Egmont in some respects, but must be scantily distributed on Ruapehu.

Since the above was in type I have received specimens of rock from the Patua Range, north of Mount Egmont, from Mr. N. Cochrane, and others from near Albatross Head, Kawhia, from Mr. R. Browne. In both instances the rocks are similar to those of Mount Egmont, except that pyroxene is entirely absent.

EXPLANATION OF PLATE XIII.

1. Recent and Pleistocene. Sands, gravels, and pumice.
2. Cainozoic. Chiefly Miocene limestones and marls.
3. Mesozoic. Chiefly Triassic shales and sandstones.
4. Rhyolite. Eruption began in Miocene.
5. Hornblende-andesite, Mount Egmont; dacite, Tauhara.
6. Andesites of Cape Colville. Eruption in Miocene.
7. Manukau breccia. Hypersthene-andesites, Miocene.
8. Volcanoes of rhyolite plateau. Hypersthene-andesites, Upper Pliocene to Recent.
9. Dolerite of Pirongia and Karioi (Miocene ?).
10. Basanites. Waikato, Auckland, &c.
11. Older basalts of Kerikeri.
12. Diorites and gabbros. Age uncertain.

NOTE.—The map, Plate XIII, is largely based on the work of McKay, Park, and Cox so far as the boundaries of the sedimentary and volcanic rocks are concerned. The author alone is responsible for the boundaries of the different divisions of volcanic rocks.

ART. VI.—*Fossils from Kakanui.*

By J. ALLAN THOMSON, B.Sc.

Communicated by G. M. Thomson.

[*Read before the Otago Institute, 8th October, 1907.*]

Plate XIV.

THE fossils treated of below were collected in 1903, when the author was working at the gem gravels of Kakanui. After a preliminary determination of the species, they were submitted to Captain Hutton, and agreement was reached as to the names. He recommended that the generic names in Zittel's "Text-book of Palæontology" (translation, C. R. Eastman, 1900) should be uniformly applied, and also that publication should be delayed till his revision of the Tertiary *Brachiopoda* came out.* In the meantime the author removed to England, and found it necessary to send off the manuscript of his paper on the gem gravels of Kakanui† before receiving the revision. Consequently the latter paper, which gives an account of the beds from which the fossils were taken, does not always employ the names to which in the former paper Captain Hutton gives his authority. The necessary corrections will be made by substituting *Terebratula* for *Liothyrina*, and *Terebratulina* for *Notothyris* (on p. 488 *et seq.*), and filling in the new species from those described below.

CORALS.

Isis dactyla, Tenison-Woods.

1880: "Corals and Bryozoa‡ of the Neozoic Period in New Zealand," p. 7, fig. 1.

This species is common in the limestones at Kakanui. Some specimens agree well with the description; the condyles in some cases are more conical than those figured by Tenison-Woods, while others have the condyles depressed, with a small central cone.

Isis hamiltoni, nov. sp. Plate XIV, fig. 1.

Short, thick, cylindrical, often branched, sides irregularly longitudinally striated, sometimes striæ branching; condyle depressed, with a small central cone; radiately striated.

This species seems to be the same as one figured by Duncan.§ With regard to the identification of the genus, he says in another paper,¶ "The calcareous bodies form little trunks or columns varying in height and in the amount of external striation. The branches commence from the calcareous bodies, and not from the horny matter. It is this branching from the calcareous body which distinguishes the genus *Isis* from *Mopsea*, in which the branching starts from the horny substance. Hence, if branching calcareous bodies are found, they may be safely attributed to the first-named genus; but if calcareous bodies with-

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* "Revision of the Tertiary *Brachiopoda* of New Zealand," Hutton, Trans. N.Z. Inst., vol. xxxvii, p. 474.

† "The Gem Gravels of Kakanui, with Remarks on the Geology of the District," Thomson, Trans. N.Z. Inst., vol. xxxviii, p. 482.

‡ This was published as part iv of "Palæontology of New Zealand" by the Colonial Museum and Geological Survey Department.

§ Quart. Journ. Geol. Soc., 1875, p. 675, and pl. xxxviii, figs. 1 and 1*a*.

¶ "On some Fossil *Alcyonaria* from the Australian Tertiary Deposits," *tom. cit.*, p. 673.

out branches present themselves, they may belong to *Mopsea*, or to parts of *Isis* where no branching occurs. Usually, however, the *Mopseæ* have extremely slender polyparites, so that probably all stout and simple calcareous bodies belonging to the *Isidineæ* should be classified as belonging to the genus *Isis*."

The specimens now described, being often branched, are therefore placed in the genus *Isis*.

This species differs from *Isis dactyla*, Tenison-Woods, in that the condyles are radiately, not concentrically, striated. It is abundant in the greensands accompanying the limestones at Kakanui.

Graphularia, sp.

Quadrate calcareous axes referable to this genus are frequent in all the limestones of the Oamaru district. They are very similar to *Gr. robinæ*, McCoy.*

Brachiopoda.

Terebratula gravida, Suess. Plate XIV, fig. 2.

† 1865: *Waldheimia gravida*, Suess. Reise der "Novara," Palæ., p. 56, pl. ix, figs. *5a* and *5b*. 1886: *Terebratula*, sp. (figure only), Hector, "Catalogue of the New Zealand Court, Indian and Colonial Exhibition," p. 57, fig. 6. 1905: *Terebratula gravida*, Hutton, Trans. N.Z. Inst., 1905, p. 475.

The larger *Brachiopoda* occurring abundantly in the quarry limestone were originally labelled *W. gravida* by Hutton, as specimens in the Otago Museum show. When, however, in Canterbury, he obtained specimens showing the brachial arms, he hesitated to identify it with Suess's species, and labelled it merely *Terebratula*, sp. The Kakanui shell differs from Suess's description in showing no deltidium, as the thickened anterior wall of the foramen grows forward over the umbo of the dorsal valve. But as Suess's figures show no deltidium and no brachial arms, this identification should hold good.

This species is extremely abundant in the quarry, and occurs in all stages of age. That figured is an old-age form, showing a fold in the dorsal valve. It is not unlike some British oolite species. Younger forms are smoother, the walls of the foramen are not so thickened, and the umbo is more produced.

It also occurs in the the limestone underlying the mineral breccia. At Oamaru Cape the individuals are smaller, and the umbo is more produced.

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* Prodrom. Palæ. Vict., Dec. v, p. 32, pl. xlviii, figs. 2–4.

† The references to species in this paper do not have any pretence to completeness. For the sake of brevity, only such are given as bear on the name and priority of the species.

Terebratulina suessi, Hutton. Plate XIV, fig. 5, *a*, *b*, and *c*.

1865: *Terebratulina*, sp., Suess, Reise der "Novara," Palæ., p. 57, pl. ix, fig. 6. 1873: *Terebratella suessi*, Hutton, Cat. Tert. Moll. N.Z., p. 37. 1905: *Terebratulina suessi*, Hutton, Revision, Trans. N.Z. Inst., p. 475.

In the "Novara" palæontology* Suess refers to this species as *Terebratulina*, but in the description of the plate (ix) he calls it *Terebratella*, sp.; and Hutton, in his earlier paper (1873), followed him in this, correcting the genus in 1905. The similarity to *T. scouleri*, Tate, is most marked, and the latter may have to disappear. The ear-like processes on the dorsal valve characteristic of *Terebratulina* have not been noticed in earlier descriptions.

This species is abundant in the quarry limestone, and also occurs in the fossiliferous layers of the Kakanui breccias, as well as on Oamaru Cape.

Photos of the shell, and of the interior of the dorsal valve, showing the loop, are given. The photos show two varieties of shape and ornamentation, between which all intermediate forms may be found.

Magellania sinuata, Hutton. Plate XIV, fig. 3.

1873: *Waldheimia* (?) *sinuata*, Hutton, Cat. Tert. Moll. N.Z., p. 26. 1885: *Terebratella* (?) *sinuata*, Hutton, Quart. Journ. Geol. Soc., 1885, p. 553. 1905: *Terebratella sinuata*, Trans. N.Z. Inst., 1905, p. 478.

Captain Hutton considered these specimens to be the same as his *Waldheimia sinuata*. They agree also with specimens in the Otago Museum labelled by him. They differ, however, from his description in having a deltidium conspicuous, if small, and in having a sharply keeled umbo. The description should, then, read: "Shell orbicular-trigonal, valves subequal; beak very short, umbo keeled; hinge-line angular; deltidium conspicuous. Ventral valve with a broad marginal sinus; dorsal valve convex; margin much sinuated."

There is no evidence that the brachial loops are twice joined to the septum, so the original generic determination is sustained, except that *Magellania* has now replaced *Waldheimia*.

This species is abundant in the Kakanui greensands, and presents considerable variety in form, partly due to crushing. The margins in stout shells are little sinuated. It approaches *M. lenticularis*. Some rather similar shells were considered by Captain Hutton as new, but the amount of material gathered does not justify the description of new species.

* Suess, Reise der "Novara," Palæ., p. 57.

Terebratella kakanuiensis, Hutton. Plate XIV, fig. 4.

1905: Trans. N.Z. Inst., p. 479.

The specimens on which Captain Hutton founded this species were furnished by the author; they were collected from the quarry, North Head, Kakanui.

The following description, prepared before the receipt of Captain Hutton's revision, will simplify in some particulars his description: Broadly ovate; greatest width at middle; slightly longer than wide; valves equally convex, a ridge on the ventral valve, extending from umbo to margin, dividing it into three lobes; dorsal valve with a deep sinus from the centre to the anterior margin; umbo produced and slightly curved, bluntly keeled; foramen large, incomplete; deltidium a small triangular plate on either side. Surface smooth, with inequidistant lines of growth; loop short, reflexed, and doubly attached.

This species differs from *T. rubicunda* in its much deeper dorsal sinus and shorter loop. Captain Hutton considered it the probable ancestor of *T. rubicunda*. It somewhat resembles the figures of *T. woodsii*.*

LAMELLIBRANCHS.

Pecten sectus, Hutton.

1873: *Pecten secta*, Hutton, Cat. Tert. Moll., p. 30. 1886: *Pecten sectus*, Hutton, "Mollusca of the Pareora and Oamaru Systems of New Zealand," Proc. Linn. Soc. N.S.W., p. 235.

Two types of *Pecten* differing from known species were considered by Hutton to be the young of this species. Their description may be of value:—

(*a*.) Left valve slightly convex, orbicular-trigonal; angle as long as high; ears unequal; the anterior one with 4 radiating ribs and fine transverse striæ. The whole shell is thrown into 10 plicæ, each dividing at the margin to 2 ribs, the hollows being also occupied by 2 slightly smaller ribs; the ribs spring from the middle zone of the shell; concentric lines of growth; margin crenulate and sinuous. Size, $\frac{3}{4}$ in.

(*b*.) Right valve flat; shell thrown into 10 plicæ, each splitting into 3 ribs near the bottom, the hollows with 1 rib; surface with very fine concentric striæ, and also oblique striæ.

Cardita benhami, nov. sp.

Shell very convex, subquadrate, slightly inequilateral; 26–30 large radiating ribs, nodulose, a little smaller than the inter-

* Tate, Trans. Phil. Soc. Adelaide, 1880.

spaces; lunule small, cordate; umbones recurved. Height, $\frac{7}{8}$ in.; length, $\frac{7}{8}$ in.

This species differs from *C. australis*, Quoy, as described by Hutton* as *Venericardia australis*, in having always more than 22 ribs. It would, however, be included under the more general description of the same species by G. F. Harris.† He, however, admits several of Tate's Australian species, which do not differ more from *C. australis* than does this variety; hence the foundation of a new species for the purposes of comparison with Australian Tertiary shells is justified. Of these, *C. benhami* resembles most *C. delicatula*, Tate, and *C. granulicostata*, Tate.

The only locality observed was in the fossiliferous layers of the tuff underlying the limestone on the cliffs, North Shore, Kakanui. It is here, however, fairly abundant.

GASTEROPODA.

Turbo marshalli, nov. sp. Plate XIV, fig. 6.

Shell turbinate-conical, imperforate; spire depressed, whorls 5–6, convex, acutely keeled; 2 keels on the body-whorl; ornamentation; tubercles on the keel, about 13 to a whorl, but none on the second keel on body-whorl; between keels and upper suture of each whorl are spiral granulose lineations, absent between the keels and the lower suture. Aperture subcircular, entire; outer margin thin. Operculum elliptical.

This species has the same occurrence as the last. It resembles no other known New Zealand *Turbo*.

EXPLANATION OF PLATE XIV.

Fig. 1. *Isis hamiltoni*; natural size.
Fig. 2. *Terebratula gravida*; natural size.
Fig. 3. *Magellania sinuata*; natural size.
Fig. 4. *Terebratella kakanuiensis*; × 3.
Fig. 5. *Terebratulina suessi*; × 4. *a, b*, two extreme varieties; *c*, interior of dorsal valve, showing arm-loop.
Fig. 6. *Turbo marshalli*; natural size. *a*, *Turbo marshalli*; *b*, side view of operculum; *c*, face of operculum.

* Cat. Tert. Moll. N.Z.
† Cat. Tert. Moll. Brit. Mus., 1897, part i, Australasia.

Art. VII. — *Recent Observations on New Zealand* Macro-lepidoptera, *including Descriptions of New Species.*

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

[*Read before the Wellington Philosophical Society, 1st May, 1907.*]

Plate XV.

Anosia plexippus.

During May, 1906, two specimens of this rare and handsome butterfly were brought to me, having been captured at Makara Beach; a third was seen in the same locality, and a fourth observed flying about the Queen's Wharf in the city.

The appearance of this rare insect at an exposed locality like Makara Beach, almost in the middle of winter, is remarkable, and cannot at present be explained.

Limnas chrysippus. Plate XV, figs. 6, 7 (under-side).

Mr. Edwin C. Sherlock informs me that in March, 1904, a boy captured a specimen of this butterfly about four miles from the Thames. Mr. Sherlock at once visited the locality, and was fortunate enough to see another, but he could not capture it. No other specimens have since been taken, and, so far as I am aware, these are the only recorded instances of the insect's appearance in New Zealand.

The figures which accompany this paper were copied from Mr. Sherlock's specimen, and the following is a brief description of the same insect: The expansion of the wings is almost 3 in. The forewings are bright orange-brown, darker towards the costa, and very broadly bordered with black at the apex, tapering off at the tornus; there is a number of clear white spots near the apex. The hindwings are paler orange-brown, with three obscure brownish-black spots near the middle, and a broad black terminal band containing one or two paler spots. On the under-side the forewings are very broadly shaded with rich blackish-brown; there is a large patch of dull greenish-yellow above the white spots near the apex. The hindwings are bright ochreous-yellow with a black border, containing numerous white spots, and three central black marks bordered with white.

This species somewhat resembles *Anosia plexippus*, but may easily be distinguished from that insect by its smaller size and by the veins on the upper side of the forewings not being marked in black.

According to Mr. W. F. Kirby, *Limnas chrysippus* occurs throughout Africa, west Asia, the East Indies, and Greece.

Diadema bolina.

Two specimens of this fine butterfly have occurred at Wellington during this summer — one captured by Leslie Roskruge near the Government Buildings in April, and another captured by Mr. Bannehr in Cuba Street.

Melanchra omoplaca, Meyr., Trans. N.Z. Inst., vol. xix, p. 24. (*Melanchra umbra*, Hdsn., Trans. N.Z. Inst., vol. xxxv, p. 243.)

Mr. Meyrick informs me that the species described by me as above is identical with *M. omoplaca*.

Orthosia fortis, Butl. (*Miselia iota*, Hdsn., Trans. N.Z. Inst., vol. xxxv, p. 243.)

During a recent examination of the collection of New Zealand *Lepidoptera* formed by the late Mr. R. W. Fereday, and now in the Christchurch Museum, I detected an insect labelled "*Orthosia fortis*," which is clearly identical with the species described by me as *Miselia iota*.

Ophideres maturna, Lin. Plate XV, fig. 5.

Two specimens of this extremely handsome species have been recently found in New Zealand—one captured at Makara Beach by Mr. Cook in May, 1906, and kindly given to me by Mr. W. R. Morris; another captured at Dunedin by Mr. George Howes, F.E.S., in March, 1907. Mr. Froggatt informs me that this is one of the banana-moths, and I conclude that it has been artificially introduced into New Zealand amongst consignments of that fruit. The following is a brief description: The expansion of the wings is about $3\frac{3}{4}$ in. The head and thorax are pale reddish-brown. The forewings are very broad, triangular, with the termen slightly waved and bowed, pale yellowish-white, entirely covered with numerous brown and reddish-brown short wavy stripes; the central portion of the wing has strong bronzy-golden reflections, this portion being divided into three fairly defined patches by two oblique whitish bands; there are two large and two small bright reddish-brown spots in the centre of the wing. The hindwings and abdomen are rich orange-yellow, with a terminal black band and two round black spots near the middle.

Xanthorhoe chlorias, Meyr., Trans. N.Z. Inst., vol. xvi, p. 80. (*Venusia princeps*, Hdsn., Trans. N.Z. Inst., vol. xxxv, p. 244.)

This correction is also necessary.

Lythria siris, n. sp. Plate XV, fig. 1.

This very neatly marked little species was discovered by Mr. J. H. Lewis on the Old Man Range, Central Otago, at an elevation of about 4,000 ft.

The expansion of the wings is a little over $\frac{5}{8}$ in. The forewings are slaty-grey, with light reddish-brown, black, and pale-yellowish markings; there is a very small grey area at the base, followed by a wavy transverse reddish-brown band; next two yellowish-white bands enclosing a very narrow yellowish-brown area; then a strongly waved whitish line, followed by a narrow black line and a broad reddish-brown line; the central area is broad, slaty-grey, with a reddish-brown discal dot; this is followed by an extremely sharply angulated series of lines, consisting of a narrow reddish-brown line, a narrow black line, a narrow yellowish-white line, and a shaded orange-brown line; the termen is shaded with dark-brown with a very fine, wavy, whitish line and a series of small reddish-brown spots. The hindwings are golden-yellow, the basal and terminal portions broadly clouded with black, and a very wavy central black line. The cilia of all the wings are brownish-grey. The female is paler, and much less distinctly marked than the male.

The perfect insect appears in February.

Notoreas orphnæa, Meyr. Plate XV, figs. 2, ♀: 3, ♂.

In January, 1905, I captured two specimens of this very distinct species on the Humboldt Range, at the head of Lake Wakatipu, at an elevation of about 4,500 ft. above the sea-level.

The expansion of the wings of the male is nearly $1\frac{3}{8}$ in.; of the female, $1\frac{1}{8}$ in. The forewings of the male are very dark greyish-black, speckled with paler grey; there are several small black marks on the veins, and an obscure yellowish-brown transverse line at about $\frac{3}{4}$; the hindwings are dark-grey, speckled with paler grey; the cilia of all the wings are pale greyish-white, strongly barred with blackish-grey. The body is black; the head and thorax are densely clothed with long black hair; the antennæ are heavily bipectinated. The female is much paler, with numerous obscure blackish transverse lines on both fore and hind wings; the forewings are faintly clouded with yellowish-brown towards the base and termen, and all the wings have a terminal row of small but conspicuous oblong black marks. The antennæ are simple, and the head and thorax are moderately clothed with short black hairs.

This species may be at once distinguished from any of the varieties of *Dasyuris hectori* by the hairy clothing of the head and thorax, and the strongly bipectinated antennæ of the male.

Paragyrtis inostentata, Walk. (*Dichromodes griseata*, Hdsn., Trans. N.Z. Inst., vol. xxxv, p. 244.)

This correction is also necessary.

Dichromodes simulans, n. sp.

This species was discovered by Mr. J. H. Lewis on the Old Man Range, Central Otago, at an elevation of about 4,000 ft.

The expansion of the wings is about $\frac{7}{8}$ in. The forewings are dull bluish-grey, with two obscure slender yellowish-brown bands; there are three jagged blackish transverse lines, one at $\frac{1}{4}$, one near the middle, and one at $\frac{3}{4}$; there is a series of black and bluish-grey marks on the termen. The hindwings are yellowish-brown, clouded with dull-brown towards the base and termen, leaving the central portion paler. The cilia of all the wings is yellowish-brown mixed with black.

This species has a deceptive resemblance to *Notoreas fulva*, from which it differs in the following respects: The wings are somewhat broader, the transverse lines more indented, the cilia not strongly barred, and the antennæ of the male unipectinated.

The perfect insect appears in February.

Porina senex, n. sp. Plate XV, fig. 4.

This interesting species was discovered by Mr. J. H. Lewis on the Old Man Range, Central Otago, at an elevation of about 4,000 ft.

The expansion of the wings of the male is about $1\frac{5}{8}$ in. All the wings are very sparsely covered with hair-like scales. The forewings are very pale ochreous, irregularly mottled with blackish-grey. There are two rather large irregular patches of the pale ground-colour on the dorsum near the base, and two obscure oblique bands parallel with the termen. The hind-wings are brownish-grey, with the veins and termen strongly marked in dark-brown. The body is ochreous-brown, with several tufts of very pale ochreous hair near the middle. The antennæ are strongly bipectinated.

A single male specimen of this insect was bred in February from a pupa found under stones as above.

The only other New Zealand *Porina* with pectinated antennæ is *P. dinodes*. The present insect may be immediately distinguished from that insect by its very much smaller size.

DESCRIPTION OF PLATE XV.

Fig. 1. *Lythria siris*, male.
Fig. 2. *Notoreas orphnæa*, female.
Fig. 3. *Notoreas orphnæa*, male.
Fig. 4. *Porina senex*, male.
Fig. 5. *Ophideres maturna*.
Fig. 6, 7. *Limnas chrysippus*.

Art. VIII.—*Description of a New Ophiuroid.*

By H. Farquhar.

Communicated by Professor H. B. Kirk.

[*Read before the Wellington Philosophical Society, 2nd October,* 1907.]

Ophiocoma bollonsi, n. s.

The disc is somewhat irregularly round, slightly swollen above, with a thick rounded edge; about 18 mm. in diameter. The arms are about 60 mm. long, 3 mm. wide at the base, and tapering evenly to a fine extremity. The disc is covered above with microscopically rough granules, evenly and closely placed at the centre, but somewhat more open and irregular towards the edge, with a few irregular bare patches; the granules extend a little beyond the edge of the disc on the plates of the oral surface in the interbrachial spaces, where they are longer than those above, a few being like small spinelets. The scaling on the oral surface is fine and even. The mouth-angles have four or five irregular, bluntly pointed mouth-papillæ on each side, those within smaller than the others. The tooth-papillæ are very numerous and small, like small bluntly-pointed spinelets. The mouth-shields are round or slightly oval, with a small peak within; side mouth-shields triangular, with rounded angles and emarginate sides, meeting, or almost meeting, within. The upper arm-plates are diamond-shaped, with rounded angles, slightly overlapping. The side arm-plates are prominent, meeting neither above nor below; they bear five or six (six near the disc) rounded, somewhat flattened, tapering, bluntly pointed, granular arm-spines, the lower ones shorter than those above; the length of the longest is 6 mm. There are two rounded, leaf-like tentacle-scales, about twice as long as broad, on the lower edge of the side arm-plates adjacent to the lowest arm-spine. The under arm-plates are broader than long, and rounded without. The colour of the dried specimen is chocolate-brown above and paler below, the spines being brownish-grey.

The unique type specimen, which is in the Dominion Museum at Wellington, was dredged up by Captain Bollons, of the Government steamer "Hinemoa," in 16 fathoms of water, between Stephen Island and the mainland, when laying a telegraph cable to Stephen Island lighthouse. This is the first species of the genus *Ophiocoma* found in New Zealand waters. I have to thank Mr. Hamilton, Director of the Dominion Museum, for the opportunity of describing this species.

The type specimens of *Ophiactis nomentis*, described in the last volume of the Transactions, are in the Dominion Museum at Wellington.

ART. IX.—*A Heteropterous Hemipteron of New Zealand.*

By G. W. KIRKALDY.

[*Read before the Philosophical Institute of Canterbury, 3rd July*, 1907.]

IN vol. xxxii, pp. 408–9, of the Transactions Mr. T. White published a short paper on some supposed spiders (" Arachnids: the Small Pond in the Forest "). I would suggest that these were a species of the heteropterous hemipteron *Microvelia*, a tiny sort of water-strider, the account of the behaviour of the " spiders " applying very well to that of *Microvelia*.

Some years ago I described a species of this genus from New Zealand, and, as it was published in a French journal perhaps little accessible to most residents in New Zealand, I append a translation now :—

Microvelia macgregori (Kirk.).

Aydræssa macgregori, Kirkaldy, 1899: ' Revue d'Entomologie," xviii, 91–2.

Apterous Form.—Long and fairly narrow, about $2\frac{1}{2}$ times as long as wide. 4th segment of the antennæ about twice as long as the 3rd, which is about $\frac{1}{4}$ longer than the 2nd, the latter subequal to the 1st. Rostrum reaching as far as the base of the pronotum. Pronotum rugose, not carinate. Femora neither tuberculate nor dentate; fore femur $\frac{1}{4}$ longer than the tibia, which is $\frac{1}{3}$ longer than the tarsus; middle femur a little longer than the tibia, which is $\frac{1}{2}$ longer than the tarsus, the 2 tarsal segments subequal; hind tibia $\frac{1}{4}$ longer than the femur and $2\frac{1}{5}$ times as long as the tarsus, the 2 tarsal segments subequal.

Blackish, with a narrow band of silvery pubescence on the interior lateral margin of the eyes; antennæ lurid or flavo-testaceous, the 4th segment always lurid; a wide band across the anterior margin and a narrow band across the posterior margin of the pronotum, reddish-yellow; coxæ and femora yellowish, testaceous; tibiæ and tarsi more or less lurid. Beneath, greyish-black.

Length, $2\frac{1}{4}$ mm.; width, nearly 1 mm.

Hab.—New Zealand.

This description is incomplete, as it lacks notice of the winged form. The little bug is surely well distributed in all ponds, water-troughs, &c., and I will be much obliged to any one who will favour me with a good supply for a revised description.

Art. X.—*The Scheelite of Otago.*

By A. M. Finlayson, M.Sc.

Communicated by Dr. Marshall.

[*Read before the Otago Institute, 8th October, 1907.*]

Plate XVI.

Scheelite occurs in greater or less quantity in a large number of the auriferous-quartz veins in the Otago goldfields. The country rock of the veins is for the most part a quartzose mica-schist, graduating into phyllite and slate. It is included in Sir James Hector's "foliated schists,"* and in the Wanaka and Kakanui series of the late Captain Hutton.†

Only those veins which carry scheelite in exploitable quantity will here be considered, and these may be conveniently grouped into two classes—(1) fissure-veins; (2) bedded or segregated veins. The latter occur exclusively in the Macrae's district; the former class includes all other known scheelite-veins.

(1.) Fissure-veins.

Glenorchy Reef.

This outcrops on the steep left bank of the Bucklerburn, a mile and a half above its mouth at Glenorchy. The country rock is a slate, striking north and south, and dipping to the west at from 30° to 50°. The vein strikes east and west, and dips to the north at a mean angle of 15°. It has been followed on the surface for about half a mile, is well defined, with fairly smooth walls, and carries a strong continuous seam of quartz throughout. Its width between walls varies from 1 ft. to 5 ft.

In accordance with the varying width of the walls, the vein is lenticular in longitudinal section, a feature which evidently indicates some displacement of the walls of the original fissure (fig. 1).

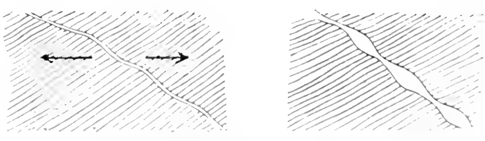

Fig. 1.

* Sir J. Hector, "Outline of New Zealand Geology" (1886), p. 83.

† Captain F. W. Hutton, "Geology of Otago" (Dunedin, 1875), p. 29.

The accompanying sketch section (fig. 2), along No. 2 level, illustrates this feature.

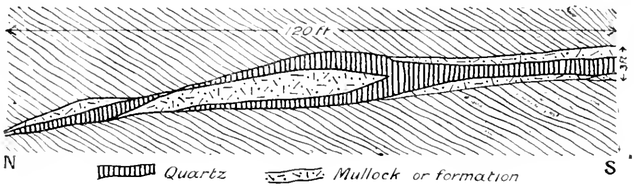

FIG. 2.—SECTION ALONG NO. 2 LEVEL, GLENORCHY REEF.

The seam of quartz generally occupies the centre of the lode-formation, being separated from the walls by a few inches of pug. Frequently, however, the seam splits into two branches, leaving a horse of country rock between (fig. 3).

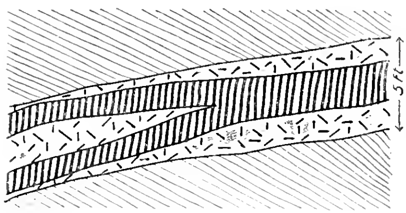

FIG. 3.

The quartz is seamed throughout with thin parallel strings of mullock, highly pyritized.

The reef carries scheelite, not generally in very clean patches, but more or less quartzose. It does not cling particularly to either wall, but is generally seen along mullock stringers. The bands or seams of scheelite, though discontinuous, are fairly well defined. The lode is auriferous, but its assay value for gold is very small.

Recent prospecting in the Rees Valley and Bucklerburn has disclosed other reefs carrying scheelite, some of which are now being developed.

Alta Reef, Bendigo.

This lies at the head of a small gully just over the western spur of Bendigo Creek, and about three miles to the east of the old Bendigo battery. Its strike is 116°, and it stands almost vertically, with frequent irregularities. The country rock is a flat-lying quartzose schist, and the outcrop of the reef has been proved for nearly half a mile.

Near the east end of the old workings the vein is thin and the seam of quartz insignificant. Followed west, it increases in

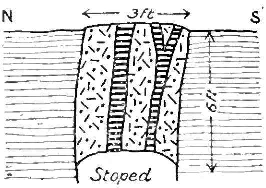

FIG. 4.—SECTION ACROSS ALTA REEF.

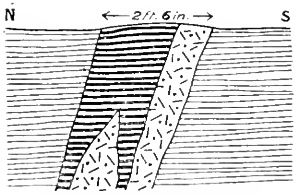

FIG. 5.—SECTION ACROSS ALTA REEF.

width, and has a sinuous and irregular course, with numerous leaders coming in on both walls. The accompanying sketches (figs. 4 and 5) illustrate the characters of the vein.

Near the end of an adit driven close to the old battery-site scheelite is seen in conspicuous bunches on and near the south wall, which is here poorly defined (fig. 6).

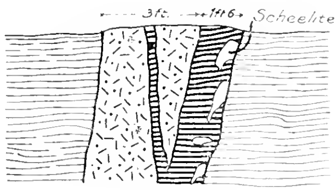

FIG. 6.

The scheelite in this reef has never been exploited, but the reef was successfully worked for gold in the early days.

Veins on the Lammerlaw Range, Waipori.

Several of the small gold-bearing veins on the Lammerlaw and Burnt Ranges, near Waipori, carry scheelite, sometimes in considerable quantity, but they have never been developed to any extent.

A notable occurrence of the mineral is in the antimony-reef at Stony Creek, nine miles from Waipori Township. At one point in this reef scheelite and stibnite were found in close association, and accompanied by gypsum. This last is evidently a product of secondary origin, resulting from oxidation of the sulphide ore and interaction with the scheelite.

Among other occurrences, scheelite has been found in the Barewood reef, and in the Saddle Hill reef.

(2.) BEDDED VEINS.

The reefs of Macrae's are bedded or segregated veins, and are of peculiar interest in that they embrace all the veins of this class in Otago. The Macrae's goldfield occupies an area of two hundred square miles between Dunback and the Taieri River, and extending from the Mareburn in the north to the Stoneburn in the south.

The country rock is an argillaceous mica-schist, with much interfoliated quartz. With few exceptions, it has throughout the area a uniform strike—north-west and south-east—and a north-easterly dip of from 10° to 20°. The veins consequently all have that dip, allowance being made for local irregularities.

A description of the features to be seen in Messrs. W. and G. Donaldson's mines will sufficiently illustrate the characters of the veins.

Donaldson's Reef, Mount Highlay.

This outcrops 10 chains up the hill to the west of a small creek running north to the Mareburn. The hanging-wall is very ill defined, and for a distance of 40 ft. beyond the wall the country rock is impregnated with pyrite, and crossed by frequent slides. Near the hanging-wall a few lenticular bunches of segregated quartz appear.

The vein, near its outcrop, is cut by a north–south fault, which has dragged it down in a very striking manner, and open-cast work along the fault-line displays a good section (fig. 7). Both walls are here smooth and slickensided, as a result of the faulting, and the hanging-wall country is much twisted and broken.

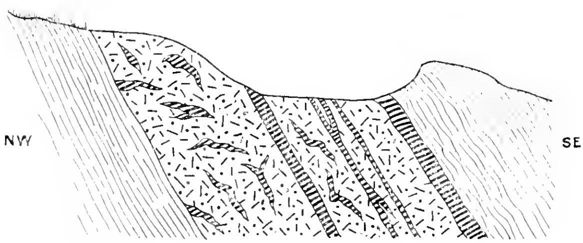

FIG. 7.—SECTION ACROSS DONALDSON'S LODE, AT FAULT-LINE.

Followed west up the flank of the hill, the foot-wall continues well defined, with a varying seam of quartz, but the hanging-wall loses its individuality, the lode-material grading off into crushed and veined country rock.

The reef carries from 10 dwt. to 15 dwt. of gold per ton, and scheelite in places.

Golden Point Reef.

This outcrops on the right bank of the Deep Dell, directly south of Mount Highlay. It has a mean north-easterly dip of 10°, and has been opened up by a considerable amount of tunnelling.

In general, the reef varies in thickness from 1 ft. to over 6 ft., its mean width being 3 ft. The foot-wall is generally smooth and fairly defined, the hanging-wall indistinct. As in the Glenorchy reef, and from the same cause, frequent rolls occur, illustrated in the section (fig. 8).

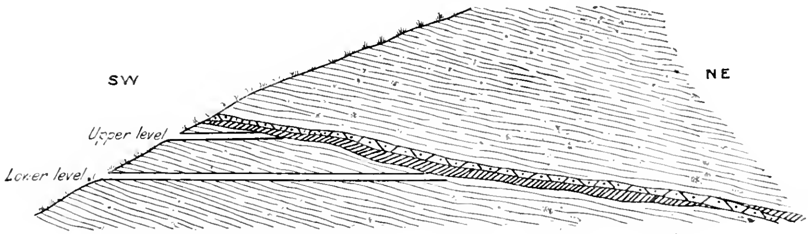

Fig. 8.—Longitudinal Sketch Section, Golden Point Reef.

The quartz occurs in a seam from 6 in. to 4 ft. thick, the remainder of the lode-formation being composed of soft structureless pug, graduating into veined and crushed country rock, and crossed by frequent slides. The seam generally follows the foot-wall, but sometimes divides into two, one on each wall. It occasionally crosses from one wall to the other, and a seam may wedge out on one wall, while another comes in on the other wall immediately opposite.

The Ounce Reef.

This lies four miles south-east from Macrae's Township, on the left bank of a small stream running into Murphy's Creek. The outcrop of the reef is anticlinal, due to a local rock-fold, and the vein peters out on the limbs of the anticline (fig. 9).

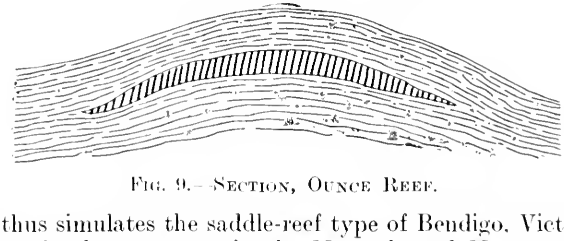

Fig. 9.—Section, Ounce Reef.

It thus simulates the saddle-reef type of Bendigo, Victoria.

Several other outcrops in the Macrae's and Mount Highlay districts have been prospected and intermittently worked for gold, but nearly every one that has been developed has been found to carry more or less scheelite. The gold-value of the lodes varies from 4 dwt. to 12 dwt., mostly free-milling.

It is significant that all the reefs in this district outcrop on a single plane in the schist. This indicates that the horizontal shearing movement which localised the reefs followed a particular zone in the rock, although it is quite likely that there may be one or more zones or levels of lode-formation beneath the one now exposed.

(3.) THE SCHEELITE.

This mineral occurs, firstly, in segregated masses of varying size, typically seen at Macrae's. These generally cling to the foot-wall, and frequently pass right into the country rock, the foot-wall being then obscured. These comparatively pure masses grade off into highly quartzose ore scattered through the gangue. Secondly, it occurs in irregular veins in the quartz leaders and stringers, as well as in the larger quartz seams. It may constitute a whole vein, or it may have a broad or narrow selvage of quartz on either side.

The hand-specimen, which always contains some quartz, has a specific gravity of 5·12, that of the pure mineral being 5·9 to 6·1 (Dana). It is yellowish-white in colour, brittle and friable, with an irregular fracture. It shows interrupted cleavage-surfaces, and is massive in habit, no crystals being found, as far as my observations showed.

Microscopic Characters.

In section (Plate XVI, *a*, *b*), the mineral is dark-brown, with a high refractive index. In isotropic sections a faint positive uniaxial figure may be seen. The interference colours are more usually yellow and red of the first order. The individuals are large, with sharp boundaries and pointed or pyramidal terminations. Two interrupted sets of cleavage-traces crossing at 40° are seen in suitable sections, these being the characteristic cleavages, *p* (111) and *e* (101). The cleavage-lines are frequently crossed by irregular fractures, along which the mineral is dark and clouded. A faint lamellar structure is occasionally seen, resembling polysynthetic twinning. The lamellæ, however, are alternately broad and narrow, and can be distinguished, though with difficulty, in ordinary light. The appearance is probably a strain-effect.

Chemical Composition.

The following analysis indicates the average composition of Otago scheelite. Quartz is always present in intimate association, as shown in Plate XVI, *a* and *b*; in the analysis this constituent was eliminated, and the figures recalculated to 100 per cent.

	Per Cent.
WO_3	80·58
CaO	18·98
MgO	0·20
FeO	0·24
Fe_2O_3	Nil.
MnO	Nil.
CO_2	Nil.
	100·00

The FeO and MgO are probably present as isomorphous tungstates, and the mineral composition is then as follows:—

	Per Cent.
$CaWO_4$	97·63
$FeWO_4$	1·01
$MgWO_4$	1·36
	100·00

The commercial scheelite of Otago is thus not the pure calcium compound. The absence of manganese indicates that there is no admixture of wolfram.

The mineral carries distinct traces of molybdenum in varying quantities up to 1 per cent. The methods used in estimating this constituent were those of Rose,* of Ruegenberg and Smith,† and of Ibbotson and Brearley.‡ A search was made for cerium and the other rare earths, both chemically and spectroscopically, but with negative results.

Analyses by Traube§ of scheelite from various localities are here inserted for reference and comparison, and the universal association of molybdenum is of peculiar interest. In his figures for New Zealand scheelite, it will be observed that he records no iron and no magnesia, but the particular locality from which his samples were collected is not recorded.

Locality.	G.	WO_3.	MoO_3.	CaO.
Zinnwald	5·88	71·08	8·23	20·33
"	6·03	75·29	3·98	20·34
"	6·01	76·78	3·69	19·86
"	6·03	77·84	2·23	19·48
"	6·06	78·04	1·92	19·57
Altenberg	6·07	77·54	2·03	19·91

* H. Rose, Handbuch der Anal. Chemie (Sechte Auflage, 1871), p. 358.

† Ruegenberg and Smith, Journal Amer. Chem. Soc., vol. xxii, p. 772.

‡ Ibbotson and Brearley, Journal Chem. Soc., 1900, Abstr. ii, p. 445.

§ J. D. Dana, "System of Mineralogy," 6th ed. (1896), p. 987.

Locality.	G.	WO_3.	MoO_3.	CaO.
Schwargenberg(*a*) ..	6·12	79·94	Tr.	19·57
,, (*a*) ..	6·02	80·17	0·07	19·49
Schlackenwald	6·13	79·76	Tr.	19·67
Haslithal	6·14	80·16	Tr.	19·65
Traversella(*b*)	6·06	78·57	1·62	19·37
,, (*b*)	6·04	79·68	0·76	19·29
Carrick Fels.	6·01	79·97	0·35	19·27
Pot Mine, South Africa(*c*)	5·96	70·57	8·09	20·05
,, ,,	..	71·59	7·63	20·51
Mount Ramsay, Tasmania	6·09	79·77	Tr.	19·65
New Zealand	6·01	80·29	Tr.	19·44

(*a*) MgO, trace. (*b*) Ce_2O_3, trace. (*b*) CuO, 0·34.

(4.) DEPOSITION OF THE SCHEELITE.

Microscopic examination of the ore, and chemical analyses of the wall-rock of the veins, prove that the scheelite has been formed by metasomatic processes—namely, by combination of tungstic acid with lime-bearing minerals in the adjoining rock.

Microscopic Evidence.

The relations of scheelite and calcite, as seen under the microscope, are very striking. Plate XVI, *c*, shows scheelite in clear granules with fresh sharp boundaries enclosing a corroded core of calcite, and indicating the replacement process by which the ore has been formed. This phenomenon is best studied at Macrae's, where the country rock contains a considerable amount of calcite. In general, the scheelite is always fresh, the calcite where seen is much attacked and corroded. Several of the plates accompanying Mr. Lindgren's classic work on "Metasomatic Processes in Fissure-veins"* show very similar processes to that illustrated in the above plate.

A similar association of scheelite and calcite is occasionally seen in sections cut from Glenorchy ore. A characteristic feature of the Glenorchy mineral is the manner in which strings of pyrite occur along the border between scheelite and gangue (Plate XVI, *d*). The pyrite thus appears to have segregated along the line of most intense metasomatism. The process of osmosis, regarded by many authorities as the central factor in ore-deposition,† would evidently be equally favourable to the formation both of scheelite and of pyrite, the latter being, like the former, essentially a replacement product.

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* "Genesis of Ore-deposits," Trans. Amer. Inst. Min. Eng., 1901, p. 498.

† H. P. Gillette, "Osmosis as a Factor in Ore-formation," Trans. Amer. Inst. Min. Eng., vol. xxxiv (1903), p. 710.

Chemical Evidence.

The following analyses show the nature and extent of wall-rock alteration at Glenorchy :—

	1.	2.	3.	4.
H_2O	2·42	2·71	2·17	— 0·25
SiO_2	56·68	52·49	42·00	— 14·68
Al_2O_3	9·96	12·38	9·96	..
Fe_2O_3	5·92	6·12	4·97	— 0·95
FeO	6·77	2·42	1·94	— 4·83
CaO	9·96	6·58	5·26	— 4·70
MgO	1·55	1·19	0·95	— 0·60
K_2O	2·86	5·82	4·62	+ 1·76
Na_2O	2·41	2·86	2·32	— 0·09
MnO	0·21	0·12	0·10	— 0·11
TiO_2	0·56	0·48	0·40	— 0·16
FeS_2	Nil	5·61	4·48	+ 4·48
CO_2	Nil	1·25	1·00	+ 1·00
	99·30	100·03	80·17	+ 7·24
				— 26·37
				— 19·13

1. Unaltered rock.
2. Altered rock.
3. Altered rock, recalculated on a basis of constant alumina.
4. Gains and losses of altered rock.

The considerable loss of silica in the wall-rock is characteristic of the veins throughout Otago. The notable loss of lime and addition of carbon-dioxide and potash indicate that the mineralising solutions carried alkaline tungstates and carbonates. Reaction with the wall-rock resulted in the addition of carbon-dioxide, and in exchange between lime of the rock and potash of the solutions, with the formation of scheelite in the lode.

The next group of analyses indicates the processes at Macrae's (samples from Golden Point).

	1.	2.	3.	4.
H_2O	0·70	1·24	0·67	— 0·03
SiO_2	70·02	60·58	30·29	— 39·73
Al_2O_3	5·67	11·34	5·67	..
Fe_2O_3	3·68	4·88	2·44	— 1·18
FeO	3·38	2·56	1·28	— 2·10
CaO	7·80	4·31	2·15	— 5·65
Mgo	1·20	0·62	0·31	— 0·89
K_2O	0·78	3·01	1·50	+ 0·72
Na_2O	1·22	5·12	2·56	+ 1·34
FeS_2	Nil	4·27	2·13	+ 2·13
CO_2	6·42	2·92	1·46	— 4·96
	100·87	100·85	50·46	+ 4·36
				— 54·71
				— 50·35

1. Unaltered rock; specific gravity = 2·695.
2. Altered rock; specific gravity = 2·693.
3. Altered rock, recalculated on a basis of constant alumina.
4. Gains and losses of altered rock.

In this case the loss of half the total mass of the rock, including 40 per cent. of the original rock, is in accordance with the fact that the Macrae's veins are segregated veins. In other words, wall-rock + lode (gangue) = original rock. This approximate equation will hold good for volumes as well as for masses—that is to say, the wall-rock has suffered a corresponding diminution of 50 per cent. in volume. This explains why the specific gravity of the altered rock (2·69) is equal to that of the unaltered rock.

Further, there is to be observed in the wall-rock a depletion of lime and addition of alkalies, as at Glenorchy, and likewise due to the processes by which the scheelite was deposited. The notable loss of carbon-dioxide is no doubt due to the destruction of calcite during the metasomatic action.

The bunchy tendency of the ore, particularly at Macrae's, is evidence of the segregation of the mineral during the formation of the lodes.

(5.) GENESIS OF NEW ZEALAND TUNGSTEN-ORES.

J. D. Irving, in a description of the tungsten-deposits of the Black Hills of South Dakota,* deposits which occur in association with crystalline limestone, has divided tungsten-ore deposits into two classes:—

(1.) "Primary deposits," associated with granitic rocks, in veins with cassiterite, and minerals such as tourmaline, beryl, and fluor-spar. Such were concentrated by the pneumatolytic phase of activity of the granitic magma.

(2.) "Secondary deposits," formed by solution of bodies of the first type and metasomatic redeposition in higher levels.

The scheelite of Otago is thus a typical secondary deposit. As regards the other type, it is probable that the wolfram of Stewart Island, which has been described by Mr. Alex. McKay as occurring in the neighbourhood of granitic rocks, and in association with cassiterite, gahnite, and topaz,† is a primary deposit as defined above.

Further, it is evident that the tungstic acid of the scheelite has ascended through the schists by way of the lode-fissures,

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* J. D. Irving, "Wolframite in the Black Hills of South Dakota," Trans. Amer. Inst. Min. Eng., vol. xxxi (1902), p. 683.

† A. McKay, "Reports of Geological Explorations, 1888–89," p. 74.

and the fact that tungsten is a characteristic element in ore-deposits associated with granitic rocks leads to the inference that the magmas beneath were largely granitic in character.

(6.) The Scheelite-mining Industry.

Rise and Progress.

The history of scheelite-mining in Otago dates from about 1888, when the first mine was opened up on the Glenorchy reef by the Lake Wakatipu Scheelite Company, and an expensive ore-dressing plant was installed. Some 27 tons of dressed ore was shipped to Hamburg, but the price was low—£20 to £29 per ton; and after two years the demand ceased, and the company liquidated, after an outlay of £3,000.

About two years ago the mine was taken over by a new company, and a crushing and dressing plant installed. With a good market and improved methods of concentration, this company is making rapid strides.

On the Macrae's field scheelite was first exploited in 1893, by Messrs. A. B. Kitchener and William Donaldson, who sent 6½ tons of 40-per-cent. ore from the Golden Point Mine to London. The returns did not leave much profit, but the work was persevered with, and a later shipment realised £58 per ton. The market was subsequently transferred to Hamburg, and the demand and price steadily increased. Improved plant was installed, and considerable prospecting for scheelite was carried on, in consequence of the success attending Messrs. Donaldson's efforts. Up to date the Golden Point Mine has produced scheelite to the value of £24,000, the price having risen progressively in the last fifteen years from £20 to £160 per ton. During this period 400 tons of ore has been shipped from Macrae's, while the Glenorchy Mine during the last eighteen months has dressed 60 tons.

Present Mining Methods.

There are at present three working mines—Messrs. Reid and Lee's Glenorchy Mine, and Messrs. W. and G. Donaldson's two mines at Macrae's. The method in vogue of concentrating the ore is to pass the pulp from the battery where it is crushed over shaking-tables or vanners, where it is dressed to an average value of 65 per cent. of tungstic acid (WO_3), the impurities being quartz and pyrites. The ore thus concentrated is dried, bagged, and shipped.

For crushing the ore there are five stamps in operation at Glenorchy, ten at Golden Point, and a 5 ft. Huntington mill at

Mount Highlay. The concentrating-tables used are a Wilfley at Glenorchy and Mount Highlay, a Woodbury and Frue vanner at Golden Point. Of these, the Wilfley appears to find most favour. The Glenorchy company have lately installed a Wilfley slime-table, with the object of recovering the slight loss in the tailings.

The pulp is dried over small wood or coke furnaces, a method that would scarcely be suitable for a large output. Further, a more efficient method of drying—or, rather, roasting—would burn off the sulphur of the pyrites, and thus indirectly raise the percentage value of the ore, which is a desideratum in view of the fact that the price per unit or per cent. varies with the percentage.

Prospects.

The success of the industry in Otago has been due to the steadily improving market at Hamburg, to which the ore is now shipped, and to greater attention on the part of present firms to the securing of clean and high-grade concentrates. The problem of concentration is a very importatnt matter, as a poorly dressed ore will soon cause buyers to fight shy of the mine which ships it. The market, also, requires to be studied. In 1900, Messrs. G. P. Blackwell and Sons, metal-merchants, of Liverpool, reported thus : "The indiscriminate shipping of tungsten-ore from Australia and New Zealand is unwise, and has depressed the market, which is a peculiar one, and requires careful handling. Shippers should send their ore through one channel to a firm which understands the business, and can keep the market firm."*

In view of the steadily increasing demand for tungsten, the prospects of the scheelite industry in Otago must be considered bright. Unfortunately, the fluctuations which have hitherto occurred in the market affect the production of small mines. This can only be guarded against by insuring that the mines shall be backed by sufficient capital, which would render them secure against closing down in the face of a slightly lowered quotation, an event which has happened more than once in New South Wales and Queensland.

Considering the success of the present producing mines, it is highly desirable that the other scheelite-veins, both in Otago and Marlborough, should be taken up, and there can be little doubt, provided the market remains firm, that they would prove successful ventures.

* *New Zealand Mines Record,* 16th November, 1900, p. 176.

Conclusion.

I must here express my indebtedness to Messrs. W. and G. Donaldson, of Macrae's, and Messrs. George Reid and Robert Lee, jun., of Glenorchy, for the many facilities and liberties they allowed me during my examination of the mines. To Dr. P. Marshall and Mr. D. B. Waters, of the Otago School of Mines, my warmest thanks are due for much valuable advice in the laboratory and in the preparation of this paper.

EXPLANATION OF PLATE XVI.

a. Section of scheelite, showing cleavage, and quartz (white). × 36 diameters.
b. Scheelite, clouded, with quartz stringers. × 36 diameters.
c. Illustrates metasomatic replacement. Dark fragments of scheelite, with calcite in the centre of the photograph. × 36 diameters.
d. Scheelite (dark), separated from gangue (white) by strings of pyrite (black). The specimen was taken from Glenorchy. × 3 diameters.

Art. XI.—*Some Alkaline and Nepheline Rocks from Westland.*

By J. P. Smith.

Communicated by Dr. Marshall.

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Plates XVII–XIX.

The rocks about to be described were obtained from the gravels of the watershed of the New River and its tributaries. They embrace a series of hypabyssal rocks ranging from acid granite porphyries to basic lamprophyres and gabbro diabases. Very few of the examples have been found *in situ*, but there is every reason to believe that the whole of the series were set free by erosion from the northern slopes of the Hohuna Range and from the adjoining Te Kinga Mountain. The humidity of the climate and a heavy rainfall has clothed the hillsides of Westland with a dense forest growth and a depth of humus matted with roots which effectually conceals the rock-surfaces. It is only above the bush-line, or upon the precipitous side of some deeply incised creek, or in some artificial cutting, that exposures of the underlying rocks occur. These limited exposures afford sufficient evidence to permit the rocks of the different formations to be classified and the areas of the formations to be defined. They, however, give few opportunities to examine or locate any dykes which may traverse these formations. It is, therefore, only from the detrital rocks derived from the erosion of the now bush-covered mountains that a knowledge of many of the dyke rocks can be obtained.

So far as is known, the Arahura and Kanieri formations of the new geological survey are, with the exception of the Pounamu series, remarkably free from intrusions; but the Tuhua formation—an intrusive mass itself—is seamed in all directions with narrow dykes. Already in the Hokitika sheet of the new survey outcrops of the following dyke rocks have been located and the rocks described: Pyroxene and hornblende camptonites, pyroxene and hornblende porphyrites, diabases, and an augite diorite.

The Tuhua formation is a great granitic intrusion, with its major axis roughly parallel to the axis of the main range. As the flanks of the granite hills which expose this formation are in many places covered with detritus to a height of several hundred feet above sea-level, the outcrops are not continuous, but appear as huge bosses and isolated groups of hills. The Tuhua formation has been subjected to glaciation. The ice-sheet at the period of maximum extension flowed around and frequently over the summits of the granitic mountains. Enormous erosion resulted, and upon the retreat of the ice-sheet deep deposits of morainic matter covered the depression between the main alpine range and the granite range, and between the granite range and the ocean. The rivers emerging from the retreating ice-cap immediately began the reassortment of the glacial drift, and this work, with decreasing intensity, has continued on to the present time.

The rocks herein described were collected from the fluviatile gravels in the beds of the present streams and from the auriferous gravels deposited at higher levels by streams no longer existing. They were gathered from the beds of the New River and its tributaries on the right bank, and from the higher-level gravels between the New River and Arnold River basins, but not from the Arnold basin itself.

A rough estimate of the rock contents of the gravels was made in three or four localities; they contain about 80 per cent. of greywackes, some 10 per cent. of slates, phyllites, argillites, quartzites, sandstones, and conglomerates from the Arahura and Kanieri series, and 10 per cent. of rocks from the Tuhua series. Roughly, perhaps about 1 per cent. of the Tuhua rocks may be classed as of hypabyssal origin, of which the larger proportion are much-decomposed feldspar-porphyrites, and the balance consist of the rocks herein described. Locally, these rocks are known to the miners as ironstones. They are recognised by their dark-green to black colour, and by their tendency to weather in concentric layers. The shells of decomposed rock surrounding the boulder illustrated were more than 2 ft. in thickness. In some of the smaller boulders only a kernel of fresh rock remains (Plate XVII, fig. 1).

The basic and alkaline basic rocks collected have a wide range, and include an interesting series of tinguaites, tinguaite-porphyries, vogesites, camptonites, diabases, and rocks approaching monchiquites associated with theralites and gabbro-diabases. The latter may possibly be deep-seated representatives of the other rocks; but, until their plutonic or hypabyssal origin can be determined from outcrops in the field, they will be classed with the dyke rocks.

The numbers under which the rocks are described are the field numbers of the specimens as collected. Only those which represent the different types, or show transitional characters of an interesting nature, have been described.

The specimens collected numbered 131, from each of which one or more sections were prepared, and only in exceptional cases were any two rocks found to be exactly similar. They grade gradually from one type to another throughout the whole series. The suggested inference is that the whole series are genetically the product of one alkaline magma, which has undergone a gradual differentiation during the period in which the dykes were injected.

108. Tinguaite. Megascopically, a semi-translucent green rock, with vitreous fracture, resembling pitchstone. Microscopically, a network of ægerine crystals, with occasional phenocrysts of anorthoclase distributed in a groundmass of anorthoclase, cancrinite, and nepheline. The ægerine is brownish-green in colour, and occurs in crystals of blade-like habit, sometimes frayed at the ends. It gives straight extinction and moderate pleochroism, dark-green for vibrations parallel to the longitudinal axis, and yellow-green perpendicular to it. It also occurs as needles and microlites, without any approach to orientation. It is idiomorphic to all other minerals, the terminal ends of the individuals sometimes penetrating the feldspar. The feldspar occurs in two generations, the earlier being idiomorphic. Rectangular phenocrysts are sparingly developed; crystals of long blade-like habit are frequent. Although these consolidated after the pyroxene, they are only occasionally penetrated by it, but appear to have pushed the ægerine aside, or to have developed alongside the already crystallized pyroxene. A few of the broader crystals show Carlsbad twinning. The groundmass of the rock is composed of cancrinite, nepheline, and anorthoclase in allotriomorphic relations; the small plates of anorthoclase with ragged outlines give undulatory extinction.

The cancrinite is recognised by its low refractive index and its interference colours of the first order. It is completely dissolved in 40 per cent. HCl, and gelatinises when heated. In some parts of the rock it shows tendencies to form plates of rectangular outline, but is generally shapeless. The nepheline follows the same habit, and is difficult to distinguish by optical means; but when the two minerals are dissolved out of a slice with dilute HCl, and only the pyroxene and feldspar left, the quantity of nepheline present can be estimated by comparison with an untreated slice. It is present in about equal quantities with the cancrinite. Iron-ores are absent. A minute quantity of isotropic matter is present, which may be analcite, but more probably nepheline cut parallel to the base. Omitting the rectangular anorthoclase phenocrysts, which occur sparingly, the proportions of the respective minerals are approximately: Pyroxene, 10 per cent.; feldspar, 60 per cent.; cancrinite, 15 per cent.; nepheline, 15 per cent. Owing to the elongated and partly panidiomorphic habits of the feldspars in the groundmass, the structure differs from those of described tinguaites. It approaches most nearly to the Norwegian tinguaites described by Brögger, but is coarser textured, both as regards the development of the feldspars and the ægerine. The latter frequently attains a length of 0·5 mm., and the feldspars 0·75 mm. The structure somewhat resembles that of a fine-textured holocrystalline dolerite, and this structure is maintained in the groundmass with few exceptions throughout the whole of this series of tinguaites, tinguaite-porphyries, and some of the vogesites.

72. A finer-textured tinguaite, without phenocrysts of anorthoclase; it also differs from the former in that it contains less cancrinite, but has, in addition to the pyroxene, some almost completely resorbed crystals of an amphibole, probably hornblende, the iron from the alteration of which is present as granular magnetite. This rock also shows a fluxional arrangement of the ægerine needles and feldspars, which are rudely orientated in the direction of movement: this is most noticeable around the skeletons of the amphiboles. (Plate XVIII, fig. 8.)

114. A coarse-textured tinguaite, containing numerous phenocrysts of anorthoclase, and more rarely of microcline with corroded boundaries. The ferro-magnesian contents are represented by serpentine after augite and small plates of hornblende. Some of the augite cores remain unaltered. The order of consolidation is reversed in this rock. The feldspar nepheline and cancrinite in the groundmass are allotriomorphic to each other, but idiomorphic towards the serpentine and hornblende, which they penetrate in crystals with well-defined boundaries. As

the minerals of the groundmass present the same relations to both the amphibole and the pyroxene, the amphibole may be a secondary mineral, and possibly the augite sometimes passed over to serpentine and sometimes to hornblende.

34. Has a tinguaitic groundmass typical of this series, consisting of nepheline, cancrinite, and feldspar—much of which is perthite—with ægerine microlites. With the exception of the ægerine, the minerals of the groundmass are allotriomorphic. The rock contains well-developed phenocrysts of hornblende, in long needles and as prisms with polygonal boundaries, and also augite in prisms. There are large phenocrysts of perthite with marginal corrosion and of anorthoclase undergoing alteration to muscovite. (Plate XVIII, fig. 7.)

107. Is a similar rock to 114, but contains some remarkable examples of leucocrasia. Megascopically the appearance of the rock is peculiar, the tinguaitic portion being dark-grey to black in colour, whilst the leucocratic patches are almost white. In the field the white portions were mistaken for parts of the intruded rock attached to or included in the intrusive, but a section cut across what appeared to be the junction shows that such is not the case. The white rock consists of a hypidiomorphic even-textured aggregate of anorthoclase, the plates frequently measuring 2 mm. in diameter, and enclosing ophitically but sparingly ragged crystals of green common hornblende. The larger phenocrysts of feldspar in the tinguaitic portion are undergoing alteration to muscovite. (Plate XIX, fig. 11.)

32. Tinguaite porphyry. Though the previously described rocks are porphyritic by a recurrence of the feldspars in two generations, this is the first example in which the recurrence takes place with the essential mineral, the nepheline. Without the nepheline phenocrysts the rock is similar in all respects to No. 114, including the serpentinous mineral after augite. The porphyritic nephelines form good hexagonal tables, 1 mm. to $1\frac{1}{2}$ mm. in diameter. (Plate XVIII, fig. 6.)

With the disappearance of the nepheline and cancrinite the rocks pass into the family of the lamprophyres. Some of these have been classified as vogesites and others as camptonites. It will be noticed that those in which the dominant feldspar is anorthoclase have been classed as vogesites, which may not be strictly correct.

49. Vogesite. A groundmass of shapeless elongated and ragged crystals of anorthoclase, enclosing microlites, needles, lath- and blade-like crystals and polygonal tables of augite and hornblende. Many of the colourless augites and pale-brown hornblendes are surrounded by a resorption border of ægerine

or ægerine-augite in fine grains. This rock also exhibits the phenomena of leucocrasia. The patches consist of a hypidiomorphic aggregate of anorthoclase and a deep-green hornblende. In the normal rock the crystals of hornblende occasionally attain a length of 2 cm. The pleochroism—(*a*) very pale-brown, (*b*) brown, (*c*) dark-brown—shows the hornblende to be barkevikite; but in the abnormal rock represented by the leucocratic patches the pleochroism of the hornblende is—(*a*) very pale-yellow, (*b*) olive-green, (*c*) yellowish-green—and the mineral is probably common hornblende.

101. Vogesite. The groundmass of this rock is largely composed of an alkali feldspar, with panidiomorphic development, associated with a small quantity of a colourless mineral with a higher refractive index and low polarization tints. A chemical test for mellilite was made, but did not result in the precipitation of any gypsum needles. The mineral is therefore not identified. The phenocrysts are colourless to pale-pink augites and pale-brown hornblendes, with perfect outlines, and exhibiting a great variety of sectional shapes. Both minerals occur in two generations. The augite is often surrounded by a thin green resorption boundary of crypto-crystalline ægerine or ægerine-augite. Some of the larger hornblendes attain a length of 4 mm., and the pleochroism shows them to be barkevikite. (Plate XIX, fig. 12.)

95. A rock differing from the last described, in that the feldspar is distinctly determinable as anorthoclase, and occurs in smaller proportions. The augite in the groundmass is in shapeless colourless grains. Some of it is serpentinised, and the porphyritic augites are also attacked. Crystals of partially serpentinised olivine with a peripheral border of magnetite are not infrequent. The hornblendes, although not so prominent as in the former rock, possess good crystallographic outlines. (Plate XIX, fig. 14.)

116. This is an intermediate rock between the vogesites and the camptonites. It resembled No. 95, except that serpentinisation is more advanced, and plagioclase is present, but not to the same extent as the anorthoclase.

123. Is also an intermediate rock, the alkali and lime-soda feldspars being about equal in quantity. In addition to the hornblendes—which here assume a more tabular habit, with a tendency to lose their idiomorphism—there occurs an occasional plate of deep-brown biotite and a few large phenocrysts of perthite. The perthite is surrounded by a zone of partially untwinned plagioclase, and, in addition to simple Carlsbad twinning, some phenocrysts are Baveno twins. Pseudomorphs of serpentinous material after augite are present,

and a little ægerine more or less intergrown with the hornblende. The lime-soda feldspar is labradorite. A micro-chemical and staining test for nepheline was made without any results.

28, 51, 76. These are also fine-textured intermediate rocks, with very subordinate feldspar, and ultra-basic in composition. Microscopically, they bear a strong resemblance to Brogger's farrisite, but a chemical test failed to discover the presence of mellilite. The feldspar is partly anorthoclase, and the balance a basic plagioclase with the extinction angle of bytownite. 28 contains pseudomorphs of serpentine after augite, with occasional cores of the original mineral remaining. The hornblende occurs in two generations, with sharply idiomorphic outlines. 51 has, in addition to a sprinkling of magnetite dust, some plates of pyrite, probably of secondary origin. In 76 the augites are fresh, but these are serpentinous pseudomorphs after olivine. Without the accessory feldspar the rocks would be monchiquites, which they most nearly resemble. (Plate XVIII, fig. 5.)

100. Camptonite. The hornblendes differ from those in the vogesites and some of the transitional rocks in that, although preserving the same sharpness of outline, they do not tend to assume the elongated and belemnitic forms. The augite is partly serpentinised, and is subordinate to the hornblende, which constitutes nearly one-half of the rock. Borders of ægerine surround some of the hornblende phenocrysts, and small independent crystals of ægerine are present. The feldspar is labradorite, with a maximum extinction-angle of 32°. (Plate XIX, fig. 13.)

40, 82, 84, 97. Diabase and olivine-diabase. In the group represented by these sections the hornblende has almost disappeared, and only occurs as small granules, whilst the crystallization of the feldspar has preceded that of the ferro-magnesian minerals in the groundmass. The feldspar labradorite is in columnar crystals, with an occasional rectangular plate, but without law of arrangement. The augite, partially serpentinised, is in small grains, without definite shape, and interstitial to the feldspar. In some of these rocks there is a recurrence of the augite, which appears as phenocrysts. Olivine is frequently present, partly serpentinised, but generally with good kernels of fresh mineral surrounded by serpentine, and this again by a thin margin of finely granular magnetite, which gives the outline of the original crystal, and shows that before alteration the olivine possessed good crystal forms. In some of the sections there is a little isotropic matter. These rocks are classified as diabase and olivine-diabase according to whether the magnesian mineral is absent or present; but some of them, with the isotropic matter present, approach closely to the rocks named "teschenites" by Hohenegger.

57. A porphyritic diabase from the Te Kinga boss. Megascopically it appears to be a feldspar porphyry, but under the microscope the basic nature of the rock is apparent. The large feldspar phenocrysts are labradorite, with a maximum extinction-angle of 42°; they show incipient epidotization, and an alteration into muscovite. The groundmass consists of ragged crystals, needles, and microlites of a basic feldspar, with a tendency to crystallographic development, set in a micro-granular augite arranged interstitially to the feldspar. Iron-ore is plentifully distributed through the rock as dust, cubes, and longer rectangular sections; the two former are magnetite, but the longer sections may be ilmenite. Some of the augite is serpentinised.

91. A rock intermediate between the diabases and the basic lamprophyres. Here the feldspars have almost disappeared, but what there is still bear the same relations to the augite of the groundmass as in the diabases. Augite is the dominant mineral, and occurs in two generations, the intratelluric as plates idiomorphic towards the augites of the groundmass, but not possessing good crystal faces, and in the groundmass as granules. Another form, as diopside in phenocrysts, is present with good outlines. There is a little hornblende, which appears to be a secondary mineral, as is also a clear serpentinous aggregate occasionally seen in small plates. A little secondary quartz fills cavities in the rock. The accessory feldspar is labradorite.

By the gradual assumption of the hypidiomorphic structure these rocks pass into theralites and gabbro-diabases. From what is known of the Hohuna Range, a large granitic boss clothed with a dense mass of vegetation up to the winter snow-line, and with few exposed rock-surfaces below that altitude, it is doubtful whether the whole of the rocks herein described do not come to the surface in the hypabyssal form. Although many sections have been made of the granitic rocks from this and the Te Kinga boss by the author and others, so far no nepheline syenites with which tinguaites, camptonites, and allied rocks are usually associated have been found. It is possible the gabbro-diabases may form a marginal apophysis of the granite mass. As boulders the gabbro-diabases are no more common in the fluviatile gravels of the New River system than the vogesites and camponites, and do not occur so frequently as the tinguaites. In the beds of the mountain torrents draining the northern slopes of the Hohunas they appear to be more common, but there is no evidence that they outcrop at the surface in large masses, and the inference is they occur as dykes. The fact that some of the gabbros are theralites, and carry nepheline, points to the possible association of the already described hypabyssal types of rock with a gabbro-magma rather than with a syenitic one.

In the Te Kinga railway quarry, near the Rotomanu Station, one of the very few excavations made in the Tuhua rocks, in a face some two chains in length, two decomposed dykes are exposed, in addition to a mass of soft basic rock which never came to the surface, the exposed upper portion of which is surrounded by a halo of contact metamorphism from 2 ft. to 3 ft. in thickness separating it from the overlying granites. Sections made from this intrusion are described under No. 55, but the specimens collected were not fresh enough to enable a complete description to be written. In the "No. 1 Bulletin" of the New Zealand Geological Survey, Dr. Bell says, "The top of the Hohuna Range and its southern slopes are seamed in places with narrow basic dykes." The northern slopes above the bush-line have not been examined lithologically, but shepherds who have traversed this precipitous country say that black seams—probably basic dykes—are frequent in the granites. From the evidence in the Te Kinga quarry and on the Hohuna Range it would seem that in places erosion has removed so much of the granite that only a shell now covers a basic igneous rock.

The specification of the questionably plutonic representatives of the series is,—

119. Theralite. In the gabbro-diabases it is impossible to determine the presence of nepheline with certainty by optical means, and micro-chemical tests only revealed its presence in one rock. Half a gramme of the powdered rock was dissolved in dilute HCl, and the solution slowly evaporated in a beaker. Before dryness was reached water was added, and evaporation continued to remove excess of chlorine. When saturation was nearly reached, evaporation was finished on glass slides, with the result that quantities of crystals of sodium-chloride were deposited. Staining only revealed the presence of a mineral which, on the application of hydrochloric acid, formed gelatinous silica. The presence of nepheline thus determined places the rock in the family of the little-known theralites. It consists of large twinned crystals of schillerised ægerine, with good crystallographic outlines, a basic plagioclase, a brown hornblende, and a little nepheline in panidiomorphic relations, together with a small quantity of interstitial allotriomorphic augite converted into serpentine. A few cubes and grains of magnetite are present. The feldspar is labradorite, and appears both in columnar crystals and as rectangular plates with zonary banding.

Some of the hornblendes are ophitically enclosed in the large ægerines (Plate XIX, fig. 9).

3. Olivine gabbro-diabase. Large olivines and pink augites are relatively common; there is a quantity of biotite and brown hornblende in small narrow crystals. The feldspar-labradorite occurs in large plates and in columnar crystals. It is idiomorphic towards both the olivine and the augite, but the latter are allotriomorphic to one another. Some large columnar crystals of labradorite are ophitically enclosed in the olivine. Frequently where the feldspar penetrates an olivine one corner of the feldspar crystal is rounded. The iron-ore, which is plentiful and assumes crystallographic forms, is titaniferous. The rock is quite fresh.

121. Another olivine-augite-feldspar rock, with very subordinate hornblende. It has a typically diabasic groundmass of augite and labradorite, enclosing large grains of olivine without definite shape and phenocrysts of labradorite. One large feldspar crystal ½ in. in length has a narrow margin of clear labradorite; but the interior of the crystal consists of augite and feldspar in about equal proportions, together with a little ilmenite. The augite assumes the disposition of a graphic intergrowth; but, as the whole of it does not extinguish simultaneously, it is evidently an inclusion in the crystal. Grains of ilmenite are plentifully distributed throughout the rock.

99. Is an augite-feldspar rock, with very subordinate olivine. The phenocrysts are augite in conspicuous plates, with a tendency to idiomorphism and crystals of labradorite-feldspar changing to epidote and calcite. The groundmass consists of feldspar and augite in diabasic relations. The olivine is serpentinised into a clear pale-green mineral, with hardly perceptible dichroism and isotropic. Titaniferous iron-ore is common both as grains and with rectangular outline, and pyrite occurs in large crystals associated with a pale-green serpentine, which is birefringent in polarised light, shows no definite structure, but is rather a confused aggregate of fibres.

37. An olivine-augite-feldspar rock, contains the olivines in large shapeless grains, and has as phenocrysts large augites, perthites, and labradorites with idiomorphic outlines. The groundmass differs from any of the previously described gabbro-diabases in that it consists of a panidiomorphic aggregate of labradorite, partially serpentinised augite, hornblende, and ilmenite.

130. Another variety is interesting owing to the large development of the augite phenocrysts, some of which are more than ½ in. in length. There are inclusions of brown hornblende in the augite crystals. The phenocrysts present good crystal

faces, and are set in a panidiomorphic groundmass of labradorite, serpentinised augite, hornblende, and iron-ore, much of which is titaniferous.

55. A coarse-grained basic rock from the Te Kinga quarry, where it occurs projecting some 15 ft. up from the floor of the quarry into the solid granite, which covers it to a depth of 50 ft. The exposed portion, some 12 ft. high by 15 ft. wide at the base, evidently increases in size in depth. The granites show no signs of having been displaced by the intrusion, but the intrusive is surrounded by an aureole of completely altered rock between 2 ft. and 3 ft. in thickness, the result of the metamorphism induced by the contact. So completely altered is this envelope that it is impossible to say whether it belongs to the intruded or the intrusive. Near the granite it consists of a granular aggregate of quartz and biotite, which becomes more quartzose close to the granite contact. Part of the mica is in long rectangular flakes, with longitudinal striation, which does not always extend from end to end of the crystal; the balance is in shapeless plates. Nearer the intrusive the rock consists of a colourless mica, with chlorite, some very subordinate biotite and quartz, and a little iron-ore, apparently magnetite. The micas and quartz are allotriomorphic: the chlorite appears in radiating sheaves, with a rude suggestion of flow structure, and the rock would certainly be classed as a schist if it occurred under any other conditions. The intrusive rock is soft and close to the contact-zone, partially decomposed, but much fresher samples can be secured from the centre of the mass. It consists almost exclusively of augite, hornblende, and calcite, with very subordinate olivine feldspar and iron-ores. Some of the calcite may represent feldspar, but much of it is of foreign origin, and occurs in cracks. The magnetite is present as dust, and as grains with crystal boundaries. The augite and hornblende have a strong tendency to crystallographic development, and are idiomorphic to any feldspar that occurs. What little feldspar there is is principally anorthoclase, and a few crystals of basic plagioclase, with high extinction-angles. Patches of serpentinous mineral are present, usually in contact with the calcite. It is birefringent, with lattice structure, but more probably resulted from the alteration of the olivine than hornblende.

In addition to the basic and basic-alkaline rocks already described, there is an acid-alkaline series, which possibly resulted from a variation of the acid granitic magma from which the granites of the Tuhua series were genetically derived. With our present knowledge of magmatic differentiation it is within the bounds of possibility, although hardly probable, that the whole of the described rocks, including the granites, are the product of one differentiated magma, of which the granites represented the first phase. The differentiation would then appear to have been one of increasing alkalinity, followed by one of increasing basicity. The granitic magma was originally slightly alkaline, as microcline and microperthite are common accessory minerals throughout the intrusion, and become more important in the earlier variations represented by the aplites and the pegmatites. The next differentiation of which we have any evidence is that of a granite porphyry, a hypabyssal rock in which the alkalinity reached its highest point before it was masked by the increasing basicity, supposing the whole series to have the same genetic origin. Between the granite porphyry and any of the rocks already described there is a petrological gap both structural and mineralogical which may possibly be represented by the porphyries and porphyrites mentioned as occurring in the detrital rocks, but which are weathered too much for investigation. Chemically, the gap may not be so great as it appears. The author regrets that he had neither the time nor the means at his disposal to make a chemical analysis of the different rocks described, by which method alone could the extent of the apparent gap be determined. Whether further explorations in the field will throw more light on the subject remains to be seen. The granite porphyry is interesting in that it contains riebeckite, an amphibole the occurrence of which has never hitherto been recorded in New Zealand.

A description of one of the aplites and the porphyry is herewith appended.

115. Aplite. Megascopically, a fine-grained white rock resembling Carrara marble. Microscopically, that which for convenience of description may be called the groundmass exhibits granulitic structure, and consists essentially of roughly equidimensional grains of quartz, orthoclase, and microcline. In this mosaic, with a tendency to hypidiomorphic structure, occur somewhat larger grains of micrographic intergrowths of quartz and feldspar, microperthite, and microcline microperthite. A yet stronger development of microperthite is present in roughly rectangular plates without well-defined outlines, in which sometimes the mineral is twinned in accordance with the Baveno law. As accessory minerals, a brown biotite is sparingly distributed in small shapeless plates, and the iron-ores are represented by a little scattered magnetite dust and a few scales of hæmatite. (Plate XIX, fig. 10.)

19. Riebeckite granite porphyry. A rock with a cream-coloured ground, with brown spots. A small lens reveals the spherulitic nature of the groundmass sufficiently to enable the rock to be classified as a granite porphyry in the field. Under

the microscope the groundmass is seen to consist of complete spherules and sectors of spherules, with the interstices between their peripheral boundaries filled in with micropegmatite and a quartz mosaic. Approximately the area covered by the spherulitic growths is about two-thirds that of the total groundmass. Some of the individual spherules attain a diameter of 3 mm. The peripheral boundaries of the best-developed spherules are not perfect circles. The final consolidation of the rock appears to have taken place before the development of the spherules was completed. In parts the spherules have impinged upon one another, and the boundaries of the two individuals are coterminous. Where this happened further development could not go on, and this seems also to have been the case where the space between the two individuals is filled with a fine granular mosaic of quartz. Here the growth of the spherule ceased when no more feldspar matter was available; but where the intervening space is filled with a micropegmatitic intergrowth the spherule has continued to advance, and at the final consolidation a portion of the micropegmatite arranged itself in delicate fern-like outgrowths around and continuous with the spherule. A radial growth corresponding to sectors of a spherule occur around the phenocrysts, and extend some distance into the groundmass. The spherules are composed of a pegmatitic intergrowth of quartz and orthoclase varying in texture from cryptopegmatitic* near the centre to micropegmatitic near the circumference. Arranged radially to the centre, and sometimes extending nearly the complete radius of the spherule, are needles, long blade-like crystals and peg-shaped inclusions of riebeckite. This mineral is present in larger crystals, with ragged outlines and no definite shape in the groundmass, between the spherules; and in many portions of the slices the larger crystals occur with their longer axis tangentially arranged around the outer edge of a spherule. Riebeckite also occurs as minute inclusions in the quartz and perthite phenocrysts. By transmitted light the colour of the mineral is indigo blue, and the pleochroism—(*a*) black, (*b*) dark-blue, (*c*) brownish-yellow—appears to correspond most nearly with that of the riebeckite described by Le Verrier from Corsica; it also resembles that from Dongo Buro, described by Prior. The needle-like blades in the spherules attain a length of 1 mm. The phenocrysts are quartz and perthite. Some of the quartz crystals have sharp outlines and angles; in others the angles are rounded by corrosion. The quartz is relatively free from

* Perhaps this term is not strictly correct, as the structure can be resolved under a magnification of 400 diameters.

inclusions; and fluid-pores, so typical of the quartz of granite porphyries, are absent. A few minute glass inclusions without bubbles and the riebeckite inclusions already mentioned are all that can be made out. The perthite phenocrysts show less signs of corrosion and a greater variety of shape. Some are rectangular to square plates; others of elongated blade-like habit, occasionally reaching 7 mm. in length by 0·4 mm. in breadth. Those with elongated habit have undulose extinction. In many of the sections of the mineral both the component feldspars extinguish simultaneously; in others there is a distinct angular interval between extinction: and there is no crystalline continuity between the feldspars of the phenocrysts and the sectors of spherules radiating from them. In some of the perthites the feldspars are orthoclase and anorthoclase; in others the nature of the triclinic feldspar has not been determined. In some of the slices there is an occasional crystal of sphene. Omitting the rare accessory sphene and the iron-ores which may possibly be of secondary origin, the sequence of crystallization in the consolidation of the rock is: (1) riebeckite; (2) quartz and perthite phenocrysts; (3) spherulitic growths; (4) the quartz mosaic and micrographic intergrowths representing the balance of the groundmass. It is just within the bounds of possibility that the riebeckite may occur in two generations, that in the interstitial groundmass being the prior, and that in the spherules a subsequent crystallization contemporary with the growth of the spherules; but the evidence is strongly in favour of the amphibole having conformed to the normal order of consolidation, and only occurring in one generation. The development of the spherules appears to have proceeded in the following manner: Starting from a centre, the nature of which cannot be distinguished, the formation and consolidation of the cryptopegmatite proceeded outwards, the process of crystallization pushing the larger and broader plates of riebeckite before it, but turning the needle-like blades—which it ultimately enclosed—in the direction in which they offered the least resistance to the process—that is, radially. Needles of riebeckite which escaped this first capture were seldom included in the outer zone of the spherule. Any mass too large to be moved by the energy of crystallization was included in the radiating body of the spherule, the growth of which proceeded on the further side of the inclusion as if the obstacle did not exist (see Plate XVIII, fig. 4, where a grain of quartz is included between the centre and the periphery of a spherule). After the process had continued outward beyond the length of the included needles of riebeckite, the micrographic growth of the spherule is comparatively free from inclusions, and without any traces of secondary iron-ore dust, so that resorption of the amphibole in this zone did not take place. The outer zone of the spherule consists of a delicate fern-like growth of micropegmatite. The change from crypto- to micro-pegmatitic structure is gradual from the centre of the spherule to the circumference. The branching of the outward creeping fern-like growths did not generally occur until two or three fifths of the radius of the spherule had been attained. Optically the spherules extinguish in sectors as the stage or the nicols are revolved; in some the sectors are narrow, in others considerable areas are extinguished at the same time. (Plate XVIII, fig. 4, and Plate XVII, figs. 2 and 3.)

The sections of the rocks described have been compared with sections of rocks from the most notable alkaline petrological provinces of the world—viz., the Arkansas rocks, described by Williams; the Christiania rocks, described in Brögger's famous memoir; and the rocks of the Serro do Tingua, in Brazil, described by Hussack. For the loan of slides of these collections, and for his ready assistance and advice, I am deeply indebted to Dr. P. Marshall, of the Otago University

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EXPLANATION OF PLATES XVII–XIX.

Plate XVII.

Fig. 1. A gabbro-diabase boulder. The rounded water-worn appearance is due to spheroidal weathering. A part of the shell-like concentric weathered casing can be seen adhering to the stone beneath the right-hand end. Eight-mile Creek Diggings.

Fig. 2. (No. 19.) Grain of quartz enclosed in spherule; ragged crystals of riebeckite surrounding periphery of spherule.

Fig. 3. (No. 19.) Showing fern-like growths in outer part of spherules and sectors of spherules.

Plate XVIII.

Fig. 4. (No. 19.) Riebeckite in granite-porphyry.

Fig. 5. (No. 28.) Lamprophyre approaching monchiquite.

Fig. 6. (No. 32.) Tinguaite-porphyry, showing large crystal of nepheline.

Fig. 7. (No. 34.) Tinguaite, containing ægerine-hornblende-augite, nepheline, cancrinite, perthite, and anorthoclase.

Fig. 8. (No. 72.) Tinguaite, containing ægerine, nepheline, cancrinite, and anorthoclase, with some resorbed amphibole.

Plate XIX.

Fig. 9. (No. 119.) Theralite. Large twinned schillerized crystal of ægerine occupies the left-hand half of figure; the balance is labradorite, hornblende, nepheline and augite with iron-ores.

Fig. 10. (No. 115.) Microperthite in aplite.

Fig. 11. (No. 107.) Tinguaite, showing junction of normal rock with leucocratic patch.

Fig. 12. (No. 101.) Vogesite. The phenocrysts are hornblende and augite, the latter having a border of ægerine set in a groundmass of which the larger portion is an alkaline feldspar.

Fig. 13. (No. 100.) Camptonite. Augite and hornblende phenocrysts set in a ground of labradorite.

Fig. 14. (No. 95.) Vogesite. Crystals of augite and hornblende set in a groundmass of anorthoclase, with a little augite.

NOTE.—All the sections are to a magnification of 26 diameters.

ART. XII.—*Early Visits of the French to New Zealand.*

By DR. HOCKEN, F.L.S.

[*Read before the Otago Institute, 10th September,* 1907.]

THE visits of French voyagers to New Zealand form a feature of great interest in our early history, and it may with truth be added that by them much of the first work of exploration on these coasts has been performed. Their contributions to the scientific knowledge of the country were not only of an extensive character, and of the highest value, but were also the first made in point of time, if we except the comparatively scanty contributions made during Cook's first and second voyages, chiefly by Banks, and afterwards by the Forsters, father and son. If there be time, I shall refer to these more fully later on; but the subject grows so extensively under one's research and pen as to be incompressible within the limits of a single paper.

The strange charm and romance which always invested old New Zealand with a halo of glory peculiarly its own seemed to have an especial attraction for the vessels of the French. That halo has long since vanished, never to return, dissipated by the modern methods of colonisation and trade, steam, and electricity. Whilst New Zealand must ever remain the world's *ultima thule,* it has been dragged from its former obscurity, and upon it must henceforward beat that fierce light which so long has beaten upon the old communities. One reason for this great attraction to the French may have been the tragic occurrence of nearly one hundred and forty years ago, when Marion and so many of his crew were murdered by the Natives at the Bay of Islands as Cook called it, but the Bay of Treachery as Marion's countrymen renamed it.

The first visit of the French to New Zealand was made by Captain De Surville, of the "St. Jean Baptiste," so far back as

December, 1769, at the very moment when Cook was exploring the North Island. A further curious fact of this is that, though both voyagers were within a few miles of each other, neither knew of the other's proximity. On the 9th December, Cook discovered and named Doubtless Bay, and then sailed north; a week later, De Surville entered it, at which time Cook was just opposite, sailing down the west coast of the island, which here is but a few miles across. Unlike the great commander, De Surville was actuated by no spirit of scientific discovery, but by the greed of gain and the search for gold. Representing two or three speculators, he had sailed from Pondicherry, the capital of the French possessions in India, with the view of discovering a wonderful island which report said not only abounded in gold and other riches, but was populated by a curious colony of Jews. For six months he traversed the Pacific on this unsuccessful quest, until brought up by the New Zealand shores at Doubtless Bay, into which he sailed, giving it the very British-sounding name of Lauriston Bay, for which there is an interesting explanation. John Law, of Lauriston, near Edinburgh, is quite an historical person of an eventful career, which for present purposes may be summarised by saying that he emigrated to France in 1705, where he initiated various wild schemes and speculations, finally becoming Comptroller-General of Finance to Louis XV. His nephew was James Francis Law, with whom this story deals, and who was appointed Governor of Pondicherry, the capital of the French settlements in India. This gentleman seems to have been imbued with his uncle's speculative spirit, for it was he and a friend, M. Chevallier, who chiefly fitted out the "St. Jean Baptiste" on her wild-goose chase over the Pacific. Thus, in compliment, this bay was named Lauriston, and a creek within it Chevallier. There is always some value, and interest certainly, in recording the origin of place-names, so apt are they to become forgotten, and then unknown. Within this beautiful far-north bay now lies the Pacific Cable station, its small staff of workers alone representing the once teeming Native population which long ago preceded to Te Reinga those who now are so quickly following them. De Surville's stay extended over three weeks, and during this time he received the utmost hospitality from the Natives—a hospitality which he shamefully requited. Many of his sailors suffered from severe illness, and it was necessary to bring them ashore; here the Natives showed every kindness to the invalids, assisting them with food and shelter. Their miserable state was rendered still more so by a furious storm of hurricane force, of which Cook makes mention; in it one of the boats was missing, which strict inquiry and search failed to recover.

De Surville, rightly or wrongly, suspected the Natives of having stolen it, and on this assumption resorted to most cruel measures, burning their houses and canoes, maltreating them, and finally taking as a prisoner on board his vessel the chief Naginoui, who had proved himself the sick sailors' most faithful friend, and had offered his whare to them as a shelter. The surgeon of the vessel, Duluc, thus continues the story: "I was greatly surprised to see that the Indian who had been carried on board, tied hands and feet, was the chief who, directly he had selected a site suitable for the sick, brought me some dried fish in the most feeling manner, asking for no payment. No sooner had the poor fellow recognised me than he threw himself at my feet, and with tears in his eyes implored me, so far as I could guess his words to mean, to protect and intercede for one who had helped me when I myself so greatly needed help. I explained as well as I was able that he should suffer no harm. He clasped me in his arms, pointing to the land of his birth, from which he was being torn. Happily for me the captain took him to his cabin, for I was distressed beyond measure to witness this unfortunate man's dread of the fate before him." Poor Naginoui did not long survive. The sweetness of man's flesh, of dried shark, and pounded fernroot were for him no more, and within two months after his cruel abduction he died, and was cast overboard, when the vessel was off Juan Fernandez. Those who contend for retributive justice may here recognise an example in the conclusion of this sad story. A fortnight later, De Surville was drowned whilst attempting, in the ship's boat, to cross the bar of Chiloa, on the coast of Peru. Thus was perpetrated, so far as New Zealand is concerned, the first of many acts of cruelty and injustice on the part of the white man from which the Natives have subsequently suffered. Well may the savage take *utu*, or vengeance, out of all proportion to the wrong which his rule and practice impel him to right. The Abbé Rochon, who collected the account of this expedition and of that which follows, published them in a volume of great rarity, concluding it thus: "But the manner in which he treated those Natives who had the misfortune to come across him, his seizures of defenceless men who trusted to his faith, the artifices he adopted to deceive those who had the good sense to mistrust him, will always be a stain on his memory in the eyes of those who have any sentiment of humanity and justice." Those words retain their weight and application until to-day.

The next visit in point of order was a most eventful one, and ended in terrible catastrophe. It was an expedition undertaken in 1771–72 by Captain Marion du Fresne, an able and zealous officer of the French marine, who, like others of his countrymen at this time, was fired by the desire of making discoveries in the comparatively unknown South Seas. It consisted, as was usual in those days, for mutual assistance and support, of two companion vessels—the "Marquis de Castries," commanded by the Chevalier Duclesmeur, and the "Mascarin," commanded by Marion, who had also charge of the expedition. The vessels sailed from Mauritius, or the Isle of France, as it was then called. The course taken was by the Cape of Good Hope, Van Diemen's Land, New Zealand, Guam, Manila, and thence home. For six days they anchored in Frederick Henry Bay, Van Diemen's Land, searching, but unavailingly, for water. Their reception by the natives was of a very unfriendly and, indeed, ferocious kind. One incident serves to show how easy it is to misinterpret the actions of savages, and what unexpected results may follow therefrom. When M. Marion landed, a savage stepped out from the group of Natives and offered him a firebrand, apparently in order to light a little pile of wood. The commander, thinking that this was a ceremony intended to show that he was credited with pacific intentions by the islanders, did not hesitate to light the pile. But it immediately appeared that this was quite wrong, and that the acceptance of the brand was an acceptance of a defiance, or a declaration of war. Thereupon, with a fearful cry, the whole mob of Natives attacked the party with stones and spears, wounding several. The Natives are described as of ordinary height, black, with woolly hair tied in knots and powdered with red ochre. Several had on the skin of the chest those white ornamental scars or cicatrices which it is known are so common amongst Australian blacks. Finding the country as wild as its inhabitants, Marion sailed for New Zealand, and it is here that the mournful interest of his voyage lies. For a month—this was in April, 1772—the vessels were lying off and on the west and north coasts of the North Island, and here Marion pays a high tribute to the chart which had already been laid down by Cook, and by which he was steering. "I found it," he says, "of an exactitude and of a thoroughness of detail which astonished me beyond all powers of expression, and I doubt much whether the charts of our own French coasts are laid down with greater precision." At last the anchor was dropped in the Bay of Islands, not far from the island of Motuara, upon which the sick were placed and a guard picketed. The Natives speedily came on board, unarmed, and with the greatest confidence, and soon created a most favourable impression upon the visitors—a very different one, indeed, from that of the Van-Diemonians. A small trade or barter sprang up, and in a few days there was the most affectionate feeling between the two people. The Frenchmen were invited to visit the various settlements, an invitation which they accepted, always, however, taking the precaution to go well armed. The description given of their villages and pas, food, implements, clothing, and personal qualities is alike minute and interesting. The careful observations made and the critical faculty displayed in this voyage compare well with those of present ethnological methods, and it is satisfactory to see in that accomplished compendium of research on the Maori and Polynesian which has recently appeared that Professor Brown has availed himself of Marion's details. Every assistance was given them whilst procuring kauri spars. They were invited everywhere, everything was shown them, and every gratification and dalliance in the power of the savages to bestow was bestowed. And so passed, for the rough sailors, a delightful time—a whole month in paradise. Gradually any fears or suspicions first entertained regarding their hosts were lulled. They penetrated considerable distances into the country, returning far in the night, and accompanied by joyous escorts of Natives, who carried them when tired. So far, indeed, was confidence established, that Marion gave orders that boats visiting the shore should go unarmed, though this was in spite of the warnings of his lieutenant, Crozet, who constantly reminded him of Tasman and Massacre Bay. At last came the catastrophe. Marion, with fifteen officers and men, went ashore, and did not return at nightfall. This, however, excited no suspicion on board the vessels. The following morning the long-boat, with eleven men, was sent ashore for wood and water. Shortly afterwards one of this number was descried swimming towards the ship. A boat was lowered at once, and the man picked up, badly wounded. His story filled every one with consternation and fury. It appeared that on landing the sailors of the long-boat were, as usual, met and accompanied by the Natives; they separated to collect their supplies, and were then attacked furiously by the Natives, who murdered every one with the exception of the narrator, who succeeded in hiding himself in the dense bush. It was at once apparent that Marion and his party must have shared the same fate. An armed detachment was immediately sent on shore to render aid to two or three little depots or outposts. This was successfully accomplished, and Lieutenant Crozet skilfully managed to collect all his tools and firearms, and to conduct his party of sixty strong along the sea-shore to the point of re-embarkation. Now came the exciting moment. They were followed and half surrounded by an ever-gathering throng of wild savages intent upon an attack, who, with loud yells, tauntingly shouted, "Tacouri *mate* Marion, Tacouri *mate* Marion"—Tacouri has killed

Marion. With difficulty Crozet restrained his men from firing into the crowd, promising them vengeance when safety was insured. A thousand men had crowded on them by the time the boats were reached, and these were launched with the greatest difficulty. With a wild yell the savages then rushed forward to the attack, but a well-directed volley, followed by another and another, struck them with panic, and averted otherwise certain massacre. The remainder of their stay in New Zealand, whilst collecting material for the further voyage, was one of incessant watch, harass, and skirmish, and concluded with that general reprisal which all craved for—villages and canoes were burnt, and as many Natives were shot as failed to keep out of harm's way. Abundant evidence was discovered as to the sad fate of their lost comrades. Articles of clothing were found or seen on the persons of the Natives ; Tacouri, who kept well out of reach, was wearing Marion's scarlet and blue mantle. The most sickening proofs of cannibalism abounded. Gladly at length the voyagers pursued their homeward voyage, conferring on the scene of their terrible disaster the name of Port de la Trahison—Bay of Treachery—Bay of Islands, as it had been named by Captain Cook two years before. The North Island was taken possession of by Marion in the name of the King, and by him named France Australe, but it is needless to add that Cook had in this matter anticipated him. What was the cause of this savage outbreak, which, on the face of it, appears an instance of the blackest treachery ? Crozet says, " They treated us with every show of affection for thirty-three days, with the intention of eating us on the thirty-fourth." The Abbé Rochon—a friend of Marion's, and the editor of his voyage—considered it an example of the savages' *lex talionis*—revenge taken for injuries done by De Surville, and referred to above. Captain Dillon, the discoverer of the fate of La Perouse, was told by the Natives in 1827 that a quarrel arose with the seamen about a fishing-seine. Dr. Thomson, in his " Story of New Zealand," concludes that it was due to some violation of *tapu ;* and the Rev. Samuel Marsden, as the result of his inquiries, resorts to the same conclusion. I am, however, inclined to consider that, in the present instance at least, no other explanation is required beyond that of the perfidy and rapacity which are such eminently marked traits of savage character. Long afterwards the sickening circumstances of the event found a place in New Zealand song and story, and whenever Frenchmen visited these shores they were known as of the " bloody tribe of Marion "—an undeserved appellation. They were also called the " Wiwis," doubtless from the frequent use of their affirmative, *oui.* The work in which this eventful expedition is preserved was published in 1783, and is of great rarity. It was edited by the Abbé Rochon, who, whilst a cleric, was also an accomplished geographer and extensive traveller; he should, indeed, have formed one of this unfortunate expedition. The work was well translated, edited, and illustrated seventeen years ago by Mr. H. Ling Roth, who, unfortunately, omits the quaint plates and charts of the original (seven in number), the preface by the Abbé Rochon, and also his important appendix relative to De Surville. The omission is difficult to explain, though from the preface there seems to be some perplexity or doubt in Mr. Roth's mind as to whether there was more than one original edition. This difficulty, however, was laid to rest in a review by the present writer, written upon the appearance of Roth's translation. It will be observed that these voyages date about and shortly after Cook's first voyage and discovery of New Zealand in 1769–70.

The next of our visitors to these coasts were the members of that interesting expedition sent out by the French Government in 1791 to search for their lost navigator, La Perouse, of whom, it will be remembered, no tidings whatever had been received after his departure from Botany Bay in March, 1788. The vessels of the expedition were the "Récherche" and "Esperance," under the command of Captains Bruny Dentrecasteaux and Huon Kermadec. These names will be recognised in connection with the Huon pine, the Kermadec and Récherche Islands, and Dentrecasteaux Straits. Two or three days in March, 1793, were spent off the north coast of New Zealand in intercourse with the Natives, but, remembering the fatal disasters that had befallen Marion, no attempt was made at landing, and the vessels passed on to Tongatabu. The history of this voyage was written by Labillardiére, the celebrated naturalist. It was he who first brought to Europe plants of the New Zealand flax, which he successfully cultivated and experimented on with regard to the comparative strength of its fibre. It may be added that though the quest of the expedition was extensive, and extended over two years, no clue whatever was found of La Perouse's missing vessels, the "Astrolabe" and "Boussole." The mystery that for forty years had enveloped them like an impenetrable cloud was dissipated by a countryman of our own, Captain Dillon, an old ship-captain, who nearly a century ago plied amongst the Pacific islands, and had an intimate knowledge of the New Zealand wild life of that date. Following up the slight traces of a few glass beads, buttons, and ornaments, he discovered in 1827 the undoubted fate of La Perouse, and the wreck of his vessels, which occurred at Vanikoro, the southernmost island of the Santa Cruz group.

For these services he was made by the King of France a Chevalier of the Legion of Honour, and received a pension of 4,000 fr. a year. The account of his adventures, and of this search, is of the most enthralling kind, and was published in 1829, followed by a French translation in 1830.

Returning from this digression, a period of thirty-one years elapsed between the visit of Labillardiére in 1793 and that of Lieutenant Duperrey in 1824. But during this period New Zealand had been rapidly emerging from her age-long obscurity. Not only was that faint figure on the map—so like a note of interrogation—which Tasman had allotted to her now replaced by her true position and shape, but the rough whalers and sealers were around her coasts, and for ten years Mr. Marsden and his missionaries had endeavoured to introduce to her the blessings of the Gospel and civilisation, but, alas! so far with but little success. Duperrey commanded the corvette "La Coquille" during her voyage round the globe, and he spent a fortnight of April in the Bay of Islands, which was the rendezvous of vessels for rest and refreshment. Unfortunately, the history of this portion of his visit was not included in that magnificent work published by the French Government descriptive of the voyage. The atlases contain, however, eight fine plates of the Natives, their implements, &c., and view of the mission premises at Kerikeri. This deficiency is, however, the less to be regretted, being greatly supplied by some personal observations of M. Dumont D'Urville, a junior officer of the expedition, to whom later reference will be made, and a geographical memoir on New Zealand by M. de Blosseville, also a junior officer. Both were most assiduous in collecting information from whaling captains, Natives, and other sources, with the result that much curious and valuable information not met with elsewhere is given on many points. D'Urville describes the secrecy and mystery with which a chief entered his cabin, carefully shut the door, and then produced from under his mat a beautifully tattooed head, which he offered to sell for a little gunpowder. With great delight he told its story, and pointed out its beauties, showing where and how the fatal blow had been delivered, and where a dog had made off with part of the jaw, beside a few other similar details; but, as no sale was effected, the chief declared that he would restore the head to the tribe with which he was at war, and so restore peace—another way of offering the olive branch. Whilst the sailors revelled in the *haka* and other dances of the women, the chief viewed them with sovereign disdain and contempt. But let there be a war-dance, his aspect changed at once, and he could no longer preserve the dignity and constraint he imposed on himself in the presence of his new friends: his features lighted up, his eyes rolled in their orbits, his knees shook convulsively, he thrust his tongue out of his mouth, and presently, in spite of himself, he joined heart and soul in the yells and leaps of the warriors. The "Coquille" brought down with her from Sydney, in polite compliance with Mr. Marsden's desire, Mr. George Clarke and family, who had been awaiting a suitable opportunity to proceed to the Bay of Islands as one of the band of missionary settlers there. Mr. Clarke's name is well known in early New Zealand history as Protector of Aborigines, an appointment conferred on him by Governor Hobson in 1840, and filled by him with advantage to both colonists and Natives during the stormy period of those early days.

The next visit to be recorded is that of Captain D'Urville, who circumnavigated the globe during the years 1826 to 1829. On this occasion he commanded the old vessel in which, as junior, he had sailed two years before with Duperrey; but now her name was changed from the "Coquille" to the "Astrolabe," in memory of La Perouse, whose sad fate was yet shrouded in mystery, and still unceasingly deplored. Her crew were eighty in number, thirteen of whom were officers and scientific men, and as such their names will ever be held in repute—Quoy, Gaimard, Lesson, and De Sainson. The stay in and about the coasts of New Zealand extended over two months—from January to March, 1827—during which time D'Urville sailed up the west coast of the South Island from about Cape Foulwind, through Cook Strait, and along the whole east coast of the North Island, finally departing from the Bay of Islands. Throughout this course he added greatly to our geographical knowledge, though gained in the face of violent storms, and beset more than once with imminent danger of shipwreck. This was especially the case whilst exploring Massacre (or Tasman's) and Blind Bays. With these his name will ever be associated in D'Urville Island, Astrolabe Roads, the Croixelles, and the famous French Pass, through which at ebb and flow the waters rush with all the fury of a cataract. He first sailed through these tumultuous waves, pointing out to the mariner how he might thereby save twenty miles of his course; and the story of those few but exciting moments is told with such dramatic force as to be worth repeating. He is now about to proceed northward from his anchorage in Tasman's Bay to Admiralty Bay, through the French Pass. "Throughout the evening and the night the unvarying east wind blew with fury and in violent gusts. Our position was still more precarious than on the previous nights, for, had we drifted, the wind would have driven us directly upon the reef of the pass, and there our lot could not have been doubtful. At last day broke, with better auspices, which seemed to promise me a favourable wind. Not to neglect any precautions in my power, I pulled to the S.E. point of the pass, and climbed to the summit of the hill which overlooked it. This was no easy matter, owing to its steepness and the dense fern which clothed it. Arrived at the top, I took in the whole position, and concluded that, taking every precaution, I could sail through the narrow channel. Still, my eyes were not blind to its danger, and to the fact that failure meant catastrophe. Involuntarily my gaze turned to the corvette, so beautiful, so well equipped in all respects to perform her long and important voyage, and so full of her living freight. And then I thought that by a word from me her destruction might be accomplished amongst the rocks at my feet, and that my whole crew of officers and men, who so long had dwelt aboard as in a home, might be cast on the inhospitable shores, perhaps to perish, never again to see their relatives and friends. Thoughts such as these shook my resolution, but only for a moment, and I then returned on board determined to try my fortune. At 7 o'clock the anchor was hove and dropped again 6 fathoms nearer the vessel. Soon after, the breeze becoming steadier and more moderate, and the sea quieter, I determined to get under sail, so as to better handle the vessel. We had taken up the stream cable astern, and faced the bows so as to catch the wind the moment the anchor was raised. All this was quickly done. At the same moment the storm trysails, foresail, and foretopsail were unfurled, and for some minutes we steered well; but the moment we entered the pass, the impetuous current swept us to port In vain I put the helm hard down, and clewed the sails so as to stand in for the land. The corvette refused to steer, and, mastered by the current, she could not avoid being carried towards the rocks which terminated the reef, and on which I knew there were not more than 10 ft. or 12 ft. of water. Shortly after, the 'Astrolabe' touched twice; the first shock was slight, but with the second there was an appalling grinding noise, followed by a prolonged shock. In a moment the corvette stood still, and listed over to port, which gave me some hope that she was neither on the rocks nor stove in. At this moment the crew raised a terrified cry. With a bold voice I shouted out, 'It is nothing; we are clear.' And, indeed, the current, sweeping the vessel along, forbade her from resting on the fatal rock, and then the breeze springing up enabled us again to steer, and thus, freed from our fears, we glided with filled sails into the peaceful waters of Admiralty Bay, our sole loss being a few fragments of the keel, which floated in the eddy around us. My preoccupation in sailing the vessel prevented me from seeing anything else around me, but those of my companions who could give more attention said it was a magnificent sight to see the 'Astrolabe' bending down as though to allow the surrounding whirlpools to engulf her, and then, gracefully rising, sail with majesty through them to the quieter waters beyond." Such is the thrilling story of this courageous and resourceful sailor who first sailed through and named the French Passage. Even now, though steam has robbed it of every danger, the passenger traverses it with awe and bated breath. The remainder of M. D'Urville's stay in New Zealand was marked by further dangers, due to tempestuous weather, which seems to have been raging round its coasts. His visit to the Bay of Islands, however, greatly made amends. It was of over a week's duration, and he was warmly received by his former friends the missionaries, the brothers Henry and William Williams especially. He made extensive surveys along the eastern coast, and collected valuable information regarding the Natives and the natural history of the country. One of his remarks exhibits singular prevision where treating of possible future settlement in the country. His points of selection were the neighbourhood of Cook Strait, and then the Hauraki; fourteen years later at these spots were founded Auckland and Wellington. On his return to France the results of this expedition were printed by the Government in the most elaborate and sumptuous manner in eleven octavo volumes of letterpress and six folios of accompanying maps and illustrations. These consist not only of the history of the voyage, but of scientific contributions to most departments of science, and all are of great value. Two of the volumes are devoted to New Zealand, and really form a standard reference on the subject, and although, unfortunately, but little known, are well worthy of translation. In one closely printed volume of 800 pages is brought together from every source what may be considered the chronicles of New Zealand from the discovery by Tasman to date. Altogether our indebtedness to this great voyager and his celebrated companions is not to be overestimated. His name remains with us not only attached to important surveys, but also to many of our New Zealand plants.

In October, 1831, Captain Laplace, in the discovery vessel "La Favorite," spent a week at the Bay of Islands to rest and refresh his crew, enfeebled and almost decimated by diseases of tropical climes. Short as the stay was, he made an accurate survey of portions of this large bay, many of its inlets, the Kawakawa River, and adjacent country. The charts are remarkably accurate, of artistic beauty, and with all the finish of engravings. To him again are we indebted for further early and complete surveys. The results of Laplace's interesting voyage were, like those of his predecessors, issued by the French Government in the same magnificent style of type and illustration, and again showed the right of France to stand in the foremost rank of cultivated nations, and of her splendid recognition and aid of scientific labour. Unlike D'Urville, who abounded in facts and observations, and rejoiced in the details of his travel, Laplace prefers to treat his subjects from a speculative or philosophic side, whether they be the manners and customs of a savage people, the usages of people more advanced, or the growth and policy of a young colony. His style is most interesting, as where, for instance, he discusses the policy of France and England in distant seas, the punishment of crime by penal servitude, and the development of England's colonies of New South Wales and Van Diemen's Land. Short though his sojourn was, and disagreeable as we must conclude it to have been, it nevertheless resulted in the making of some early history, and hence has a special interest for us. He describes the Natives as filthy and detestable, the chiefs as not worthy of the name, and the women, excepting the young girls, as disgusting specimens of humanity. Nor has he much good word for the missionaries; he compares them unfavourably with those of his own Church, accuses them of greed, and bitterly complains of their refusal to render assistance to his sick sailors. He states, what was certainly untrue, that they spread the report amongst the Natives that the great French vessel, with four hundred men on board, had come for the purpose of avenging the death of Marion and of seizing the country. It is certain that he saw in New Zealand no man's land, and, unappropriated as it was, a country admirably suited for French possession in the Pacific, and it is probable he took no pains to conceal such an opinion. Be this as it may, the following interesting document was sent to King William by thirteen chiefs, who thus sought his protection. It was signed by them the day after the "Favorite" had dropped anchor at Kororareka, hence her arrival was not unexpected:—

To King William, the gracious chief of England.

King William.—We, the chiefs of New Zealand, assembled at this place called the Kerikeri, write to thee, for we hear that thou art the great chief of the other side the water, since the many ships which come to our land are from thee. We are a people without possessions. We have nothing but timber, flax, pork, and potatoes. We sell these things, however, to your people, and then we see the property of Europeans. It is only thy land which is liberal towards us. From thee also come the missionaries, who teach us to believe in Jehovah God and in Christ His Son. We have heard the tribe of Marion is at hand, coming to take away our land, therefore we pray thee to become our friend, and the guardian of these islands, lest the teasing of other tribes should come near to us, and lest strangers should come and take away our lands. And if any of thy people should be troublesome or vicious towards us (for some persons are living here who have run away from ships), we pray thee to be angry with them, that they may be obedient, lest the anger of the people of this land fall upon them. This letter is from us, from the chiefs of New Zealand.

This curious document evidently bears the impress of the missionary hand, which, like that of Laplace, shows patriotic sentiment. It would be foreign to the idea of this paper to pursue this episode further, and it must suffice to add that the outcome and reply was the appointment in 1833 of Mr. James Busby as British Resident at the Bay of Islands. The letter of the chiefs was forwarded to the Colonial Secretary at New South Wales by the hands of the Rev. William Yate, the missionary, in order to be transmitted to the King.

An interval of more than six years now elapsed before the next two visits of the French, and these followed in close succession, creating increased suspicion and alarm amongst the Natives. In April, 1838, the corvette "Héroine," under command of Captain Cécile, anchored in the Bay of Islands, where she remained for more than a month. Like that of her predecessors, part of her business was to survey the adjoining shores, and to facilitate the work small flags were erected on various points. The Natives concluded that this indicated the first steps towards seizing their country, and in great excitement sought the opinion and advice of their friend and principal missionary, Mr. Henry Williams, who laughingly allayed their fears. The wildest reports fly abroad in times of panic, and now it was reported that, as the missionaries were inciting the Natives to attack the "Héroine," the captain had taken the precaution of double-shotting his guns.

Another source of distress and alarm which specially involved the missionaries was the arrival shortly before of the French missionary, Bishop Pompallier. This was followed by great excitement and ill feeling, the Natives taking sides, and more than once placing the bishop in some jeopardy. To quell or allay this was one of the objects of the corvette's visit, and, though amidst military salutes and salvos of artillery the episcopal dignity was speedily secured, no real peace was made between the contending parties, and old settlers began to wonder what was the next move on the board.

A few months later, in October of the same year, the frigate "La Vénus," also on a voyage of scientific and other discovery, came into the Bay of Islands, under the command of Captain Du Petit-Thouars, and also remained a month. The vessel had then arrived from Tahiti, after inflicting most severe—and, as many considered, most unwarranted—punishment on Queen Pomare and her unfortunate subjects. The offence alleged was that two Roman Catholic priests who had landed, desirous of promulgating their faith, were forbidden to remain, and, refusing to leave, were gently if forcibly removed. A full account of this peculiar transaction, which finally ended in the cession of Tahiti to France in 1843, is given in "Polynesian Reminiscences" by Mr. Pritchard, the British Consul at Samoa and Fiji. As with the other voyages published by the French Government, that of the "Vénus" is magnificently produced. Three hundred and fifty pages relate to New Zealand, the Natives, Bishop Pompallier's mission, the Rev. Dr. Lang's "Letters to the Earl of Durham" regarding New Zealand, and to Baron de Thierry, who was so curiously connected with the early history of New Zealand, and of whom many pages might be written. In the folio atlas is a view of a Native village, an excellent chart of the Bay of Islands, and other illustrations.

In March and April of 1840 the intrepid D'Urville paid his third visit to New Zealand, whilst in command of another voyage of discovery round the world and towards the South Pole. One of the vessels of the expedition was his old corvette the "Astrolabe," the other the "Zélée." An additional feature of interest to us in connection with this visit is that New Zealand had become a British colony two months before, so that no longer might France covet its possession. The Treaty of Waitangi was signed, Captain Hobson was in supreme command, and the infant settlement was full of speculation and excitement. All this is well described by D'Urville, who is unsparing in his criticism of these events. His first stay, however, was at the Auckland Islands, at that time full of the bustle and activity of whaling and sealing parties, and he relates something of this wild life and adventure. Brought up by a wall of ice, his efforts to reach the South Pole abruptly terminated after reaching the latitude of 64° S. Returning slowly north, and roughly surveying the coast past Stewart Island, the Molyneux, and Cape Saunders, off which he was nearly wrecked, he sailed inside the Otago Heads, then a whaling settlement belonging to the brothers Weller, of Sydney. The description of the scenes around him is not cheering. The Natives especially inspired him with disgust—so different from those whom he had seen on his previous voyage in 1828. Contact with the whalers had ruined them. No longer were they the proud and haughty savage warriors: they were like impudent mendicants, dressed in filthy rags, their hovels miserable and poisonous, with a little straw on the ground for bedding. Old Taiaroa is specially singled out for description. The whole settlement appears to have been of the most debased kind; but it is not necessary to describe it further. Still proceeding up the east coast, a short stay was made at Akaroa and Banks Peninsula.

Five months later—in August, 1840—the French vessel "Comte de Paris" entered the Akaroa Harbour with sixty emigrants on board, only to find her arrival anticipated by the English man-of-war "Britomart." With a more detailed account of this incident this paper may be fitly concluded. It is very probable that D'Urville had knowledge of the expected arrival of this vessel, in which case his visit to Akaroa—a harbour somewhat difficult of approach by a sailing-vessel—is explained. He did not, however, hold it in any estimation as a place for settlement; it was somewhat superior to Otago, and that was the outside of its merits. His sojourn at the Bay of Islands was of four days' duration; but, as already intimated, the amount of information he and his officers collected regarding the new condition of things was very extensive, varied, and certainly not favourable to the English, whom he apparently viewed as interlopers, about to drive away all trade but their own, and usurp to themselves the Bay of Islands, hitherto free to all nationalities. Many little incidents occurred to mark as well as mar his short sojourn. Shortly after his arrival at the Bay of Islands Captain Hobson's secretary paid him an official visit, offering, on behalf of Captain Hobson, any assistance or services which could be rendered. The interview was formal and trivial, and any discussion on the subject of taking possession was avoided by D'Urville, who concluded the interview by informing the secretary that, whilst happy to return the visit, it must be to Captain Hobson simply as an officer of the Royal Navy, and not as the Governor of a British colony. D'Urville could not therefore have been astonished, on returning the visit, to find the Governor "out," and not expected to return until the evening. He called upon Mrs. Williams, the wife of the missionary; her reception, he remarked, was cold, but polite. Still, he had something his own way. The 1st of May was the anniversary of King Louis Philippe's accession to the throne, and this he celebrated with ceremonial proper to the occasion. The vessels were dressed in flags, and a thundering salute of twenty-one guns broke the echoes of the surrounding hills—a proceeding thrice repeated during the day. The British man-of-war "Buffalo," from Sydney, dropped her anchor early the same morning, but neglected for a long time to display her flag, in compliment and in accordance with the etiquette obtaining between ships of war of different nations. The "Buffalo" was evidently sent down on patrol duty, and to watch D'Urville's movements, for as his vessels finally left the harbour the "Buffalo" followed, to see them, as it were, safely off the premises—a proceeding, says D'Urville, "which did not in the least touch our susceptibility, but amused us greatly." Upon his return to France, D'Urville devoted himself to the publication of his great voyage, aided by many collaborators. Its various parts—twenty-three volumes in all, octavo and folio, costing nearly 1,500 fr.—were not completed until 1853, but they appeared in all the splendid rendering that the French Government knew so well how to bestow upon them. Alas! D'Urville was not destined to see much of his *magnum opus* through the press. In the prime of his life and vigour—for he was but fifty-two years of age—his labours were abruptly terminated by a frightful catastrophe. He, his wife, and only son took train for Versailles on the 2nd of May, 1842—being less than two years after his return—for a day's pleasure. Shortly after starting the axle of one of the carriages broke when the train was at full speed, involving a total wreckage. The carriages and engine, piled together, took fire, and seventy-four of the unfortunate passengers, locked in the carriages and thus helpless, were incinerated. Amongst them was D'Urville and his family, their remains being recognised with difficulty. So perished this eminent sailor, a loss to his country and to science, and who, despite the chagrin and annoyance expressed in his last pages relating to New Zealand, had a warm sentiment and affection for British people.

In conclusion, and to complete this sketch, I return to the "Aube," the last of our early French visitors, to which is attached another episode in our history. The full and authentic story—for it has had variations—was told by me in a former paper many years ago, and again in the columns of the *Argus* during the progress of a somewhat warm discussion. It need not, therefore, be now recounted at great length. Years before this colony became a bright ornament of the British Crown, its shores were constantly frequented by whalers of all nationalities. Amongst them was one Captain Langlois, who professed to have bought from the Natives, in 1836, 30,000 acres on Banks Peninsula, including the site of the present Town of Akaroa. On his return to France he induced several gentlemen—members of mercantile houses in Havre, Nantes, and Bordeaux—to form themselves into an association for the purpose of founding a colony in New Zealand. It is said that Louis Philippe furthered the project with substantial assistance. In March, 1840, accordingly, the whaling vessel "Comte de Paris" sailed, under the command of Captain Langlois, with sixty souls on board, and, after a voyage of five months, reached Akaroa on the 16th of August. The day before—the 15th—the corvette

"L'Aube," one of the French squadron maintained for the purpose of looking after the interests of the French whalers in the Pacific seas, arrived at Akaroa from the Bay of Islands to act as tender or convoy to the expected emigrant vessel. What must have been the intense chagrin and annoyance of her commander, Captain Lavaud, to find that H.M.S. "Britomart," Captain Owen Stanley, had anticipated him by four days, and that the British flag was floating and British authority already established! The fact was that immediately on learning the mission of the French war-vessel Captain Hobson despatched on this service the "Britomart," then lying at anchor in the Bay of Islands. That old and well-known settler Captain William Barnard Rhodes—familiarly known as "Barney Rhodes"—did a good service at that time which should here be recorded. In November, 1839, he and his partners, Messrs. Cooper and Holt, who conjointly traded between New South Wales and New Zealand, sent several head of cattle to Akaroa. Receiving private information that the French emigrants might be expected there, Captain Rhodes lost no time in erecting a large flagstaff on the spot now known as Green's Point, and gave instructions to Green, who had charge of his cattle, that when the French arrived he was to hoist the British flag, drive the cattle under it, and inform the officer on landing that the South Island had been taken possession of for the Queen by Messrs. Rhodes, Cooper, and Holt. Whatever may or might have been the legal value of such precautions taken by a non-official subject of Her Majesty it is needless to discuss; but they, at any rate, exhibited patriotism, foresight, and ingenuity. Probably the deeds of both Captain Stanley and of Captain Rhodes were really unnecessary, inasmuch as Colonel Bunbury had taken formal possession of the South Island at Cloudy Bay on the 17th June, 1840, two months previously.

Long ago has the warm sentiment of mutual respect and friendship dissipated the envy and ill feeling which once disfigured the great French and British nations. Now they are close friends and allies, and through the long future may there be but one rivalry between them—that of best helping forward whatever advances the progress of humanity and knowledge.

Art. XIII.—*The Passing of the Maori: An Inquiry into the Principal Causes of the Decay of the Race.*

By Archdeacon Walsh.

[*Read before the Auckland Institute, 8th July, 1907.*]

That the Maori is gradually though rapidly passing away there can be no doubt. Any one who has lived for even a few years in the Maori country, or who has visited the Native districts from time to time, has the fact forced upon him. The large *kaingas* have shrunk to a fraction of their former size; many of the smaller ones have disappeared altogether; tribal gatherings that ten or twenty years ago mustered thousands now barely muster hundreds; the Native contingent is less and less conspicuous at the race meetings, agricultural shows, and other country gatherings; while the picturesque groups and figures that once gave such interesting variety to the city and town populations are now the exception rather than the rule. In spite of various statements, based on census returns and on local personal observation, that the Maori is holding his own, or even increasing in numbers, the fact is patent that, taking it as a whole, the race is fast dying out, and that, if the decay continues at the present rate, a comparatively short time will witness its extinction, though perhaps for a few generations some gradually diminishing traces of mixed blood may be observable in the white population. The object of the present paper is to try and trace some of the principal causes that have combined to produce this wholesale and rapid decay.

Maximum Population.

Most of the present Maori tribes trace their origin from the great *heke* or Polynesian migration which occurred some five hundred years ago; but there is abundant evidence that the country was already occupied by a numerous population, with whom sooner or later the Polynesian immigrants came into collision. These original inhabitants seem to have been of a peaceable disposition, and tradition states that they were often the victims of a wholesale slaughter. As is usual in such cases, once the strength of the beaten party was sufficiently broken the remnant of the able-bodied men would be taken for slaves and the women for wives, when the aboriginals would be absorbed in the invaders, who increased and multiplied until they practically occupied all the open fertile land of the North Island, as well as a considerable portion of the South.

At what period this mixed race—to which the present inquiry is confined—reached its maximum it is quite impossible to say, nor can we even approximately guess the number they may have reached. Doubtless the population was at all times a fluctuating one; and as the tribes grew in strength, a natural desire for expansion, a dispute over territory, or some other cause would bring them into collision, and the quarrel once started would often develop into a war of extermination. In these disputes allies would be sought on either side, combinations of adjacent tribes would be formed, and the fight would go on to a finish, or until both sides were exhausted, and by the time the final battle was fought, or a truce arrived at, a whole district would be almost depopulated. By degrees, however, the tribes that were not wholly extinguished would be nursed up again: new alliances would be formed, and in time, under favourable conditions, the population would be brought up to, or might even exceed, its former numbers.

Captain Cook estimated the Maori population at the time of his visits to New Zealand (A.D. 1769–74) at about a hundred thousand; but his estimate is no more than a rough guess based on very imperfect data. It must be recollected that his observations extended only to a very partial acquaintance with the coast-line, that he never penetrated inland, and that even on the coast he entirely missed some of the most populous districts. Waikato, the Hot Lake country, the Auckland Isthmus, Kaipara, Hokianga, and many other places teeming with population had for him no existence, and any information he might have acquired from Native sources would be too vague to form the basis of an opinion.

There is abundant evidence to prove that Captain Cook's estimate was far too low. This evidence lies chiefly in the marks of occupation which the Maoris have left in the multitude of fortified positions and in the immense area of land bearing traces of former cultivation. The number and size of the *pas* throughout the length and breadth of the North Island is amazing. Judge Maning states* that from the top of one *pa* he had counted twenty others within a range of fifteen or twenty miles, and along the Oruru Valley a range of hills four or five miles long has nearly every summit scarped and terraced, some of the works being so extensive that it would take a thousand men to hold the position and probably a far greater number to construct the works. In regard to the area of land formerly

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* "Old New Zealand," Chap. xiii.

under cultivation, practically all the open fertile country of the North Island shows unmistakable signs of agricultural operations. The clay hill-sides of the north are covered with surface drains, the volcanic plains of Taranaki are perforated with the *ruas* or storage-pits, all over the Waikato delta the pumice land has been excavated for sand to spread over the *kumara* plantations: every narrow river-valley, every little shingle patch along the coast, and every sheltered nook under the sea-cliffs has been utilised; even on the rocky scoria flats the loose stones have been laboriously gathered into heaps to clear the ground for the early crops.

It is not, of course, to be supposed that anything like the total number of the *pas* or the entire area of cultivated land were occupied at any one time. Tribes would be driven off, and whole tracts of land would be deserted, perhaps, for a long period; and, even where the inhabitants were unmolested, the land would be temporarily worn out and new pieces brought under cultivation. Many of the *pas*, moreover, were built only to serve some temporary purpose, while many more would be deserted for a new site to suit the varying fortunes of the occupants. If the fighting strength of a *pa* was much reduced, a large fortification would be untenable, and a new one of more modest dimensions would be constructed on another spot; while, if the numbers greatly increased, a more roomy situation would have to be found. Still, taking all this into consideration—and even allowing that many of the *pas* may have been of pre-Hawaikian origin—the traces of occupation are so extensive that it is safe to estimate the population before the decay commenced, not at one, but at many hundreds of thousands.

Commencement of Decay.

Some writers, in attempting to account for the rapid disappearance of the Maori, have put forward a theory that the race was already in an advanced stage of decay by the time of Captain Cook's discovery. It is, of course, possible that a period of internecine strife of more than common intensity may have occurred which for the moment would have reduced the population; but the Maoris were a healthy, vigorous, and prolific race, and a season of comparative political rest would have soon brought them up to their normal numbers. They had not yet entered on that condition of decadence whose lines are gradually though surely converging to a vanishing-point. However humiliating to the self-esteem of the white man, it must be confessed that it is the contact with European civilisation that has proved the ruin of the race. From the moment that the *pakeha* found a footing in the country, by an inevitable chain of causa-tion the thousands have dwindled into hundreds, and the hundreds to tens, until the dying remnant, of lowered physique and declining birth-rate, are the sole representatives of perhaps the finest aboriginal people the world has ever produced.

Firearms.

One of the first steps towards the extinction of the Maoris was the acquisition of firearms. Two or three guns made a war-party practically invincible when the enemy was unprovided with these weapons. When the Maoris heard the report, and saw the warriors fall without apparently being struck, they thought that some of the *atuas*, or ancestral deities, had come down to join in the fight, and a wild panic and general stampede would ensue, when they would be butchered without resistance with the spear and *mere*. "We can fight against men," they said, "but who can fight against the gods?"

The first recorded instance of the use of the new weapon in Maori warfare was in the case of a small party of Ngapuhi who, with only two old flint-lock guns, made a raid down the west coast of the North Island in about 1818. After every battle they stopped to feast on the slain, and took care that no survivors were left to carry the alarm to the next settlement. About the same time another party of the same tribe made a similar expedition along the east coast as far as Tauranga. But these adventures were as nothing to those carried out a few years later by the great chief Hongi Ika, who about this time became head over the various branches of the Ngapuhi, who extended from the Bay of Islands to Hokianga.

Hongi was well acquainted with the ways of the *pakeha*, and had already witnessed the effect of his weapons. If he could only secure a sufficient supply of arms and ammunition he could make himself supreme ruler of the whole Maori race. He had helped to welcome the Rev. Samuel Marsden to the country, and had taken the infant mission settlement at Rangihoua under his protection; and when in 1820 one of that body—Mr. Thomas Kendal—proposed to go to England to help in bringing out a Maori dictionary and grammar, he volunteered to accompany him and assist him in the work. On his arrival Hongi was presented to King George IV, and made the acquaintance of a number of influential persons, who were greatly taken with his intelligence and his professed desire for the improvement of his people. His modest request for a bodyguard of twenty soldiers was discouraged, and his attempt to procure any quantity of weapons met with no success. The King, however, made him a present of a suit of armour, while the good people who credited his benevolent intentions gave him a number of ploughs, harrows, &c., to help him in his work of civilisation.

On reaching Sydney—at that time the distributing port for the colonies—he managed to exchange his stock of agricultural implements for a number of muskets, which, with others that his people had already acquired from the whalers in the Bay of Islands, brought his armoury up to three hundred pieces, with a proportionate amount of ammunition. Landing in New Zealand, he found his own people at war with the Natives of Hauraki, or Thames district, and here for the first time he tried the effect of his new weapons, when, after burning all the villages and killing hundreds on the field of battle, he brought two thousand prisoners home to the Bay of Islands.

This was in 1821, and for the next ten years Hongi kept the whole country in fire and bloodshed, making an expedition every year. If a tribe helped the people with whom he happened to be engaged that tribe would be the next to receive his attention. When preparing for a campaign he would hoist his flag—a red blanket—over his *pa*, and send messengers to the various subtribes in the neighbourhood; and should any of these have the hardihood to refuse to supply a contingent, they had to reckon with him on his return. In this way he successively raided the Thames, the Waikato, the Auckland district, Rotorua, Poverty Bay, Kaipara, &c., finishing with Whangaroa, where he received a shot through the lungs, which eventually caused his death. It is estimated that at least one-fourth of the total number of Maoris in New Zealand perished in these wars, and probably another fourth were swept away in the raids of Waharoa, Te Wherowhero, and Rauparaha, the latter of whom penetrated as far as Kaiapohia (Kaiapoi), in the middle of the South Island. When we reflect that the warriors engaged were the very flower of the Maori people, we can understand that the loss to the race was quite beyond numerical computation.

The Price of the Guns.

Once the deadly effect of the new weapon had been realised, the possession of a sufficient number of muskets became absolutely necessary for the existence of a tribe, and the whole country—from the northern peninsula to Cook Strait—became engaged in a frantic struggle to obtain the wherewithal to purchase a supply. Dressed flax (*Phormium tenax*) was the only article of sufficient value to offer in exchange. A ton of this material fetched £120 in the Sydney market, and a ton was the price of a gun worth perhaps half that number of shillings. In order to waste no time, and to be near their work, the Maoris deserted the high and airy situations of the *pas*, and lived in makeshift *whares* on the low swampy grounds where the raw material was to be found; and here, their cultivations neglected, overworked and half-starved, men, women, and children toiled night and day for months together—spurred by the penalty of death—scraping the flax-leaves strip by strip with a sharp shell. The mortality, as might be expected, was appalling. Men and women sickened and died, and few children were reared. In fact, the entire race was put to a strain from which it has never recovered.*

The flax was gathered up by traders from Sydney, who cruised round the coast in smart schooners, fitted with boarding-nettings, and carrying an armed crew. Their logs were not generally published, but many stories are told of the inhuman atrocities they committed in their intercourse with the Natives. Every skipper was a law unto himself, and he settled the "Native difficulty" in his own way as he went along.

One of the heaviest prices paid for the guns—and, in its far-reaching effects, one of the principal causes of the decay of the Maoris—was the institution known as that of the "ship-girls." From the time of Captain Cook, the unmarried women were always very free in their intercourse with the ship's companies, and as the visits of vessels became more numerous this intercourse took the form of an organized trade. About the beginning of the last century the Sydney whalers commenced to come to the New Zealand waters, and by the third decade they appeared in considerable numbers, as many as thirty-five large ships sometimes lying together off the beach at Kororareka, in the Bay of Islands, where about a thousand white people—escaped convicts, ticket-of-leave men, runaway sailors, and other adventurers—were congregated. The ships usually remained in harbour for several months every summer, victualling, refitting, &c., and during this time it was not uncommon for the captain to take a temporary wife, while a number of girls lived more or less promiscuously with the sailors and with the people on the shore.

Owing to the number killed in battle during Hongi's wars the women greatly outnumbered the men. Every year, at the commencement of the "season," the chiefs would muster the young widows and girls in the various outlying settlements, and convey them in parties to the Bay of Islands, when they were regularly farmed out, the district of Hokianga alone contributing some two hundred. For several months these future mothers of the race lived in the wildest debauch, the proceeds of the trade being chiefly spent in the purchase of guns and ammunition. Arms had to be got, whatever might be the cost.

* *Cf.* "Old New Zealand," Chap. xiii.

Though Kororareka bore such an infamous reputation as to merit the title of the "Alsatia of the Pacific," the place was not singular in this inhuman abuse. Wherever a ship put in, the same game went on to a greater or less degree. At Hokianga, when a ship came for a load of the *kauri* spars for which this port was noted, she would fire a salute as she sailed up the river, and by the time the anchor was dropped the canoes would be seen paddling down from the tributary streams filled with an excited crowd of men and women, the former to help to load the vessel and the latter to live with the sailors while the work was going on.

Long after the festive days of Kororareka and Hokianga were a thing of the past the traffic lingered on in the timber districts, and even the bushman on the tramp would have considered himself inhospitably treated if on arrival at a Maori settlement a young girl were not allotted to him, along with free lodgings and the best food the village could afford.

Waipiro.

It is stated that, contrary to what is usual amongst savage peoples, the Maoris on their first contact with Europeans did not take readily to ardent spirits. On the contrary, they showed such an aversion that they gave them the name of *wai-piro* (stinking water), and refused to touch them after a first trial. The taste probably first came with the association with the sailors just described, as well as with the shore whalers, who had their stations all along the coast from the extreme north down to Stewart Island. But after a time the craving for intoxicating drink became the ruling passion, and the money no longer required for the purchase of arms was spent in securing a supply. It almost seemed as if the system, weakened by the fatigues of war, privation, and vice, required some kind of a stimulant, and for many years every Land Court, tribal meeting, marriage, and funeral was the scene of unlimited indulgence. The evil would not have been as great as it was had the liquor been of even average quality; but a special brand was supplied for the "Native trade," which was maddening in its immediate effect and poisonous in its ultimate results. Casks of adulterated beer and kegs of doctored rum were carted out to the *pas*, while belated stragglers from the publichouses might be seen trying to struggle home, or lying by the wayside in a comatose condition—women unable to suckle their babies, and the men unable to help them along.

This craze went on for more than a generation, more or less, all over the country; but about twenty or twenty-five years ago the habit began to be given up. Wholesale drinking is now practically a thing of the past, and in most districts a drunken Maori is the exception rather than the rule. Still, the evil was done, not to be undone ; and its effect—especially on the children begotten and reared under the conditions described—is incalculable.

CHANGE OF HABITS.

The partial adoption of European customs and modes of living largely contributed to the decay of the Maori, and that which under other conditions might have been a blessing has only proved a curse. This is nowhere more apparent than in the case of their housing and clothing. It might appear at first sight that a dwelling built in European style—well lighted, floored, and properly ventilated—would be more conducive to health than the dark, smoky *whare*—hermetically sealed when the door was shut—in which the inmates slept on mats spread on the ground around a smouldering fire. The same comparison might be made between a comfortable suit of European clothes and the scanty waist-mat which hardly covered their nakedness —supplemented in wet weather by a clumsy rain-cloak which might keep the wearer dry, but scarcely kept out the cold. The converse is really the case. The *whare* was usually built on the sunny side of a hill, in a situation both airy and dry, and it was sheltered from cold blasts by the palisading of the *pa*. If the weather was damp or chilly, a handful of embers would raise the temperature to any desired degree. There was no trouble about wet clothes or insufficient blankets, and the double or triple coating of *raupo* which covered the walls effectually kept out the draughts, while if ventilation were needed the sliding door had only to be pushed back. Little inconvenience would be caused by the cramped dimensions of the domicile, as the *whare* was simply a sleeping-apartment, the porch formed by the projecting gable being used as the sitting-room, while the cooking and eating were carried on in a separate building, or, if the weather were fine, in the open air. The European style of dwelling would be very well if the Maori were able to live up to it; but, with the exception of the more fortunate Natives about the east coast who derive an income from the rent of their lands, and a very small percentage scattered throughout the country who have been able to adapt themselves to the new conditions, the Maori's attempt to live like the *pakeha* is generally a failure. In the first place, the house is usually in a bad situation. For convenience—to be near the cultivation—it is often built on the low ground, probably in the vicinity of a swamp full of stagnant water and decaying vegetable matter. Then, it is seldom finished. It is a bare shell of weather-board or split paling, often unlined and without paper or scrim. There is, perhaps, a chimney of slabs or galvanized iron; but no body of heat can be maintained, and the only effect of the fire is to draw in the cold air from the hills or the malaria from the marshy ground. Moreover, the Maori generally lives from hand to mouth, and has barely sufficient for present necessities. On a cold night, when a crowd of visitors come to put up with him—and his native hospitality forbids him turning any away—he has to share his scanty supply of bedding among them as far as it will go; and when he comes in out of the wet he rarely troubles to change his clothes, if, indeed, he have another suit to change into, but simply takes off his coat and boots, wraps himself in a blanket, and steams until he is dry. What wonder, therefore, that even when a Maori is possessed of a European house he often lives in it as little as possible, and prefers to squat by a fire in an open shed? It is the nearest he can get to the old Native system—the system that suits him best.

The adoption of European methods of cultivation was, of course, inevitable; and the Rev. Samuel Marsden, the founder of the mission to the Maoris, thought that when they were provided with ploughs and bullock-teams they would enter on a new era of progress. The new era certainly dawned, but it was not the era expected by that great humanitarian; or, to be more correct, the new era did not fulfil its early promise. In the pre-European days every kind of work was organized and regulated. Whether it was the breaking-up of land, or the planting or taking-up of the crop, the people worked in gangs under the direction of a leader, who marked the time with a song, to which the workers answered with a chorus. Each class of work had its appointed season, determined by recognised signs and portents, as the age of the moon or the blooming of a certain tree or flower, while in cases of doubt or uncertainty the time would be fixed by the *tohunga* and the regulation enforced by the chief. Growing crops were under strict *tapu*, and it was believed that any breach or neglect of the *tapu* would involve serious disaster. In this way punctuality was secured, the labour was greatly lightened, and the work done with cheerfulness and hope. All hands worked together like a well-ordered team, and each bore his full share of the common burden. For a time the new system seemed to promise very well, and as long as something of the old tribal spirit was kept up large quantities of wheat, maize, potatoes, &c., were grown, with the assistance of European implements, all over the country. But as the authority of the chief declined, the co-operative spirit passed away, while the mere fact that the work was easier induced an element of failure. The fatal indolence and procrastination of the Maori asserted itself, and the crops were often put in too late, or under improper weather conditions, to be neglected during the growing-season; or, perhaps, in the middle of a job a death would occur in the neighbourhood, or some other reason for a *hui* would eventuate, when all hands would clear out for a week or more, and leave the work to take care of itself. The consequence is that the Maoris have become disheartened, and the whole thing is done in an abortive and slovenly manner. There is less and less cultivation done every year; large areas of fertile land lie waste. In many districts there is a chronic shortage of provisions—often even semi-starvation.

INTRODUCED DISEASES.

In his original state the Maori seems to have been ideally healthy. As a usual thing he only died of old age, unless he were slain in battle or fell a victim to *makutu* or witchcraft. Tradition states that some six generations ago—perhaps 150 years—a plague, which appears to have been a kind of spotted fever, swept over the country with very fatal results. In Taiamai, a fertile and populous district inland of the Bay of Islands, the number of deaths was so great that the survivors cleared out in a general stampede, leaving the place to be occupied by the Ngapuhi, who spread from Hokianga. It is very probable, however, that as many of the deaths occurred from panic as from the effects of the disease. The visitation passed away, leaving no evil results; but with the advent of the *pakeha* new diseases came, and came to stay. Certain (venereal) complaints which appeared for the first time do not seem to have made the havoc that might have been expected, though there is little doubt that they helped to lower the system and weaken its power of resistance to other maladies. By great good fortune smallpox has never made its appearance among the Maoris, but measles and typhoid fever have proved most fatal. The former has swept through the country on several occasions, sometimes almost exterminating whole settlements—*e.g.*, when only two individuals escaped out of a population of three hundred in a *kainga* near the Molyneux River. The remedies used for the measles were often more fatal than the disease itself. Finding that a bath in cold water would cause the spots to disappear, whole parties would immerse themselves in a running stream, with—as might be expected—the most fatal results. Typhoid fever makes its appearance every few years, and once it has visited a settlement it is sure to recur whenever the atmospheric and other conditions are favourable for its development. Of late years many of the Native-school teachers have tried to cope with this insidious disease. They have supplied the Maoris with medicine, and have instructed them in the elements of the rules of health, but from want of proper sanitation, and from the impossibility of getting any course of treatment carried out, their efforts have been mostly unavailing. Besides, the Maori is at all times an unsatisfactory patient. Once his vitality falls below a certain point he loses heart, and frequently dies from the mere want of an effort to live. From an epidemic of typhoid fever a hundred died in a village in the north out of a population of five hundred a few years ago, at a time when almost every settlement had a similar visitation. Asthma and consumption probably always existed among the Maoris to a certain extent, but under the healthy conditions that obtained in their primitive state their prevalence was greatly limited. There is no doubt that the receptivity of the Native for these and their contingent diseases—bronchitis and pneumonia—has proportionately increased with the generally lowered tone produced by the causes already enumerated. At the present time, throughout the north—the region in which the contact between the races has been the longest and most intimate—it is rare to find a really sound Maori. Most of the old people are troubled more or less with asthma, while amongst the young and apparently the most robust cases of consumption develop with marvellous rapidity.

The Hui.

One of the most fatal mediums for the propagation and spread of disease is the modern *hui*. There have, of course, always been *huis*. They are, in fact, an essential feature of Maori economy; but the modern *hui* possesses certain elements which did not obtain in the old days. A *hui* is a gathering of the tribe, the *hapu*, or the family, and may be held for any purpose of common interest, whether political, social, or religious—for a tribal meeting, for the welcome of distinguished visitors, for a marriage, or a funeral. Any Maori is free to assist at a *hui*, and European visitors are always made welcome. In a very large *hui*, to which parties come from a distance, it is not unusual for them to bring contributions of provisions, but the *tangata whenua*, or local Maoris, are always considered as the entertainers, and it is a point of honour for them to supply as large a quantity of the very best that the tribe or settlement can afford, even if they have to go short for months afterwards. Up to some twenty years ago it was customary for the entertainers to erect temporary sheds of *raupo* or *nikau* to serve as sleeping-places for the visitors, the discussions being carried on in the open air. Of late years, however, it has become the practice to have in every settlement of importance a large hall, built of sawn timber, to serve the double purpose of hostelry and meeting-house. Although the style and dimensions vary considerably with the importance of the settlement, the general plan is the same. The hall is a long building, entered from the end. A bare strip some 8 ft. or 10 ft. wide runs up the centre of the floor, and the space between this and the side walls is littered down with fern or *mangemange*, covered with mats of green flax. This serves as a sleeping-place for the Maoris, who lie with their heads towards the wall, from which they are separated by a kind of narrow trough filled with fern, which acts as a general spittoon. Each Maori, on entering, takes his place —a kind of seniority being observed—the principal men occupying the upper end, and the women and children gathering near the door. The food, which is cooked outside, is set on the floor in the central space, the Maoris squatting in a row along each side. The business—if there is any to be done—is conducted by a sort of informal debate, which is often carried on far into the night; and the *hui*, for whatever purpose it may have been called together, usually lasts until the stock of provisions shows signs of giving out.

It would be impossible to conceive of a more perfect medium for the dissemination of disease than the *hui* as it is now conducted. As it is important to have plenty of food, the larger meetings are held, if possible, soon after the crops have been harvested—that is to say, in the late autumn, when the weather is often cold and wet. A crowd of men, women, and children are packed together more closely than the passengers on an emigrant-ship. A large percentage are suffering from some pulmonary complaint, or from some inherited constitutional delicacy which renders them peculiarly accessible to infection. Night and day they are lying in damp clothes—as they never wholly undress—and breathing a mephitic atmosphere, poisoned by the exhalations from so many bodies and from the general spittoon. A person suffering from influenza comes in, and in a few hours the disease has gone the round of the house. Sometimes a death occurs, and the body is kept for days in the vicinity of the food, while the *tangi* (mourning) goes on. Diseases contracted at the *hui* are taken away to the homes of the visitors, where fresh centres of infection are started; and, although a new supply of bedding is provided, the germs remain about the building, to be nursed into life on the next occasion it is used.

WARS WITH THE EUROPEANS.

It was only to be expected that sooner or later the Maoris would come into conflict with the invading race. This first happened when, in 1845, Hone Heke cut down the flagstaff in the Bay of Islands. This action resulted in a war that lasted for two years, and included a good deal of sharp fighting. Owing, no doubt, to the spirit introduced by the missionaries, and the influence of their families, the contest was prevented from developing into a war of extermination. It was conducted on new and civilised lines. There was no cannibalism or slaying of the wounded. With the exception of the Kororareka episode, property was respected, and non-combatants were unmolested. It was, in fact, more of a tournament than a war—a trial of strength, which left no sting behind it.

But it was very different with the war of 1860. This war began in Taranaki, and lasted for ten years, spreading over a third of the North Island, including Taranaki, Waikato, and the districts about Poverty Bay. Ten thousand men were engaged on the European side; and it is estimated that some £12,000,000 was expended before the contest was brought to a conclusion. Considering the large forces engaged on both sides, the number of men killed in the field was comparatively trifling; but the effect of the campaign as a factor in the passing of the Maori was deep and far-reaching. Multitudes of the most robust and vigorous men were withdrawn from the work which in normal times was barely sufficient to maintain them in comparative comfort. These had to be fed, and the production and transportation of the food more than taxed the ability of the women and non-combatants. Houses and cultivations had to be abandoned in the country accessible to the troops, and hunting and fishing grounds were deserted. For years this kind of thing went on. The whole population of a vast area extending from sea to sea was kept in a state of unnatural tension, and it would be impossible to estimate the numbers that perished from sickness and privation.

On the conclusion of the war all Native land beyond a certain line was confiscated by the Government, and the Maoris had to fall back and form new settlements as best they could, often with the total loss of any live-stock they might have possessed.

Te Whiti.

The long delay of the Government in fulfilling their promise to allocate land to those Natives who, though living within the confiscated area, had not taken up arms caused much disappointment and distress. Brooding over their wrongs, and seeing no hope of redress, they at last found a mouthpiece in Te Whiti, who arose as a prophet in 1880, and established himself at Parihaka, a few miles south of New Plymouth. It was assumed that he was about to start on the warpath like a second Te Kooti, and once more the country was got under arms. A large force of Constabulary and Volunteers was got together.

Redoubts were built and Parihaka was invested. But the expected uprising did not take place. The prophet had neither arms nor ammunition. He was really a "passive resister," and was quite willing, if necessary, to suffer martyrdom. Te Whiti had been educated by a Wesleyan missionary, the Rev. Mr. Riemenschneider, and had made a deep study of the Bible, which he seemed to know from beginning to end. He saw in his oppressed and downtrodden countrymen a type of the dispersed Israel, and he applied to them the promises of future restoration. In order to promulgate his doctrine he held meetings every month at Parihaka, with a grand festival in the month of March. To these the Maoris flocked from all quarters—at first from the *kaingas* near at hand, but, as the idea caught on, from settlements several days' journey away in the bush country. They came in hundreds and thousands—on horseback, in bullock-drays, and on foot—bringing cartloads of provisions; and when they returned they would repeat the wonderful message at their homes, and attract fresh visitors to the next meeting. There was to be no weapon lifted against the oppressor. Everything would come right by Divine interposition, when all the Maoris that had been slain in the war would come to life again, and the *pakeha* would retire into the sea and molest them no more. The only thing that could be construed into an overt act of rebellion was a sort of object-lesson intended to bring their grievances under the notice of the Government, when parties of Maoris were sent out to plough up some of the land in European occupation. This was taken as a declaration of war, and a great excitement arose among the settlers, when the Government, by way of bringing matters to a crisis, poured an overwhelming armed force into Parihaka. The Riot Act was read to a peaceable crowd of women and children, wholesale arrests were made, cattle and horses were seized, and houses and crops were destroyed,* while in order to bring the matter within the scope of the law the West Coast Settlements Act was passed, the legislation to have retrospective action. Te Whiti and a number of his followers were sent to prison, but on his return the meetings were held as before. The movement, however, gradually died out, and, although the prophet continues to prophesy, he has long ceased to be an active factor in Maori politics.†

Though no blood was shed in connection with the Te Whiti movement, it had, nevertheless, a very fatal effect on the Maoris among whom its influence extended. Half their time was spent

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* *Cf.* "Long White Cloud," by Hon. W. P. Reeves, p. 308.
† Te Whiti has died since this paper was written.

in going backwards and forwards and attending the meetings, while the hope of a future deliverance left them no interest for the practical work of the present. At the meetings multitudes were crowded together, without proper accommodation and with no attempt at sanitary arrangements. Fever took possession of Parihaka, and resulted in wholesale sickness and death, while the infection was carried home and spread through the settlements; and this, combined with the overstrain and excitement, the irregular living, and unhealthy conditions, caused a shrinkage in the population of Taranaki probably unequalled at any other time or place.

The Land Laws.

By the misconstruing of a clause in the Treaty of Waitangi,* the "right of pre-emption" has always been interpreted as the "sole right of purchase." This has prevented the Maoris from dealing with a private individual in the disposal of their lands, and has forced them to sell to the Government if they wish to sell at all. The result is that the Government can buy at their own price and sell in the open market, making perhaps 500 or 600 per cent. on the transaction. In the hope of some tardy justice, the owners have largely reserved their lands from sale, although they would willingly part with the greater portion if they could be sure of a fair price; and, though titular owners of vast estates, they are condemned to live in poverty and perhaps destitution.

Under the old *régime* the land was the property of the tribe as a whole, and the cultivation at each *kainga* was done on a co-operative system, under the direction of the local chiefs; but since the supreme compelling force has passed away, and the interests and ambitions of the various members of the tribe have become differentiated, it has become necessary to individualise the ownership, so as to secure to each man the fruits of his labour. In order to accomplish this, the Native Land Court was established, and of late years Native Committees elected by the tribal owners have been set up to allocate the various claims, their decisions to be confirmed or otherwise by a Judge of the Court on evidence taken amongst the claimants. The system seems simple and fair enough until it comes to be worked out, but then the trouble begins. The claims are made on such various and conflicting grounds that it is often impossible to come to a decision that will be satisfactory to all parties; while, from the fact that the Maoris are so interrelated, a clever and unscrupulous man, with little or no real right, can often

* See Appendix.

work up a claim that will satisfy the Court. The result is that a rehearing is applied for, and the Court sits again, perhaps after an interval of several months, and with no better satisfaction in the end. Meanwhile all the expenses of the Court come off the land, and as the sessions usually occupy several weeks, or perhaps months, these are very considerable. All this time the Maoris are excited and unsettled. Their home-work is largely neglected. Those who have come from a distance hang about the township in which the Court is held, and live in great discomfort in tents and makeshift *whares*, many of them spending their enforced leisure in drinking and gambling at the local hotel. It requires, however, a majority of the persons interested to bring a block of land before the Court; and, in view of the great expense attending the proceedings, as well as the frequently unsatisfactory nature of the decisions, it is often years before those who are desirous of having their claims defined can induce the rest of the tribe to undertake a step fraught with so uncertain issues. Meanwhile the enterprising and industrious Maori is severely handicapped, as, even if he obtain the tacit consent of the tribe to occupy and improve a piece of land, he has no guarantee that his home will not be broken up and the fruit of his labour go to another claimant whenever the land goes through the Court, as sooner or later it is sure to do. The consequence is that the whole settlement is kept back and discouraged. The man whose enterprise and industry would give a lead to his neighbours loses heart, while the rest are deprived of an example which would help to raise them in the scale of civilisation.

There is another point in which the land laws press very heavily upon the Maoris. In order to substantiate a claim to ancestral land the claimant is required to prove occupation. After much delay and contention—extending perhaps over a number of years—it is finally resolved to bring a block before the Court in order that the rights of the various claimants may be defined. During all this time every one aspiring to a share must have done something to demonstrate the fact that he is an owner. He must make a cultivation, build a house, sell some timber, assent to the making of a road, &c. He must, in fact, "shepherd his claim," or his claim will be jumped. But the house is not meant for a permanent dwelling; very often the fence is uncompleted, and the crop is allowed to take care of itself. The occupation is for the most part purely technical, but the work has to be done all the same, though it involve much useless labour and frequent journeyings to and fro over long distances; while, as the Maoris almost invariably take their wives and families along with them, these have to endure much hardship and privation, while the real home is often practically deserted for months at a time, and everything falls to pieces.*

The Gumfields.

Partly from the unsatisfactory nature of the land laws, occasionally from the failure of his crops, and very often from an innate love of change of occupation, the Maori throughout the northern district betakes himself to the gumfields. The gumfields are scattered over an immense area, extending from the Waikato to the North Cape. Wherever throughout this area the *kauri* is growing, or has grown in former times, the gum is found in more or less payable quantities. Surface gum has long since disappeared, and the article has now to be dug from the ground, where it has either exuded from the roots of the trees, or, falling from the tops, has been buried by landslips or by deposits from volcanic eruptions. Gum-digging may be roughly divided into two classes—viz., that on the "winter fields," or the high tea-tree ranges, where the ground is too hard to work in dry weather, and that on the "summer fields," or low swampy situations, where digging would be impossible during the wet season. Unless very hard driven, the Maoris seldom resort to the winter fields, but throughout the summer and autumn they are to be found all over the Auckland Province wherever the ground is in a fit condition to be worked.

The attraction of gum-digging is, of course, the hope of an immediate cash return, as the gum has a very high commercial value; but the return in the case of the Maori is usually very trifling. In contrast to the European, and especially the Austrian—who work in a more or less energetic and systematic manner—his operations are of a very desultory and superficial character. At starting he is generally in debt to the store, and the output of gum scarcely pays for the cost of the provisions consumed on the field. Meanwhile the living arrangements are most uncomfortable and unhealthy. The Maoris generally go out in parties—men, women, and children together. A calico tent, a light frame covered with sacking, or a *raupo whare* of the rudest description serves as a dwelling for each family. To be out of the wind it is often placed under the shelter of a clump of tea-tree, in some low, moist situation. Living on scanty rations of unaccustomed and unwholesome food, drinking bad water, working all day in the swamp, and exposed at night to the

* Since this paper was written certain amendments have been made in the land laws, but they have brought no satisfaction. The right of pre-emption guaranteed by the Treaty is not yet recognised, and the proceedings of the Court seem to be more involved and tedious than ever.

miasma from the marshy ground, many of the people suffer from pulmonary and enteric troubles; dysentery kills off the young children, and not infrequently an epidemic of typhoid fever takes heavy toll of the camp. The same thing goes on from year to year, for the Maori will never learn from experience, and there is no doubt that the work on the gumfields is sapping what is left of the vitality of the race throughout a very large section of the Maori people.

NATIVE SCHOOLS.

There is a very general belief that by a course of education according to European standards the Maori will be enabled to avail himself of the benefits of civilisation, and so raise himself towards the level of the white population. To this end the Government has established a system of Native schools all over the country. These schools are, in fact, the forlorn hope of a large section of the community who have the interests of the Maori at heart. We shall see how this hope has been fulfilled.

Tried by an examination test the system has been successful enough. The attendance is generally satisfactory, and the average of attainment is wonderfully good, especially when we consider that—at the commencement, at least—the teaching has to be imparted in a language imperfectly understood by the pupils. In some subjects—*e.g.*, drawing, mapping, singing, &c. —the average of proficiency is usually quite above that of the country district schools. Tried by another standard, however, the Native-school system is not so satisfactory. In the first place, the school is a " Native school ": the race-distinction is emphasized from the start, and carried on all through. In the next place, there is a good deal of time wasted that might be more profitably spent if a school career is to be considered as a preparation for adult life. The teacher conscientiously tries to keep up the attendance, and endeavours to attract the children by means of treats, games, singing-classes, and so on, while these, naturally preferring the excitement of the playground and the society of their mates to the dreary monotony of the *kainga*, have little or no opportunity of practising the duties of the house or the cultivation.

From a hygienic point of view, also, the Native school is generally prejudicial to the welfare of its attendants. The children are often only half-fed and imperfectly clothed, and after walking perhaps a mile or two in the rain, or lounging about on the wet grass of the playground, they have to sit for hours shivering in their damp garments. As a natural consequence the germs of pulmonary troubles are nursed into growth, their general health is undermined, and when an epidemic of typhoid or measles attacks a settlement it finds its readiest victims among the children of the Native school.

Though there are, of course, individual exceptions, still the vast majority of the Maori scholars find little or no opportunity in adult life of making practical use of what they have learned. The Maori is handicapped from the start and overweighted all through the race of life. His natural indolence and his love of change and excitement unfit him for the uninteresting monotony of steady effort, while his constitutional diffidence and his fear of putting himself in the wrong act as a bar to any real competition with the *pakeha*. Thus it is that numbers of young men with a sufficient educational equipment to fit them for employment in a lawyer's or a surveyor's office, or in a banking or mercantile establishment, are to be found cutting flax in a swamp, acting as ostler or boots at a bush publichouse, or driving bullocks at starvation wages for a country storekeeper. Nor are the girls any more fortunate. In the early days, when white women were scarce, many a settler found an excellent wife in a Maori maiden—not only as a practical helpmate, but as a refined and intelligent companion. But as European population has increased the race prejudice has correspondingly asserted itself, and, no matter how capable and attractive a girl may now be, she has very little chance of rising in the social scale. Her bright early promise is unfulfilled. Hope is soon lost, and she gradually sinks back to the general level of the tribe.

Looking at the question in all its bearings, it must be admitted that the Native schools have not fulfilled the hopes that have been reposed in them. In the vast majority of cases they have failed to bring the Maori into closer touch with what is best in the European civilisation. They have emphasized the race-distinction, and have deprived him of the opportunity of study and practice in many useful directions, while by the inevitable conditions that surround them they have largely contributed to his physical decay.

Summary.

I have enumerated some of the principal causes that have combined to produce the wholesale and rapid decay of the Maori people. I might go on to show how at almost every point at which the race has come into contact with the new civilisation it has suffered a shock from which it has been unable to recover. As Dr. Von Hochstetter observed more than forty years ago, "Despite the many advantages it has brought to the Natives, the European civilisation acts upon them like an insidious poison, consuming the inmost marrow of their life . . .

Compared with the fresh and full vigour with which the Anglo-Saxon race is spreading and increasing, the Maori is the weaker party, and thus is he the loser in the endless 'struggle for existence.'" *

The case of the Maoris is analogous to that of the New Zealand bush. The magnificent growth that has withstood the storms of countless centuries, and that has been able to renew itself after the ravages of volcanic fires and the deposits of ashes and mud, is gradually perishing before the advance of European settlement. Even the portions that have so far escaped the bushman's axe are unable to support the new conditions. The browsing cattle, the competition with foreign plants, the incursion of imported blights, all contribute their share in the general destruction, while even well-meant efforts at preservation often serve only to hasten the decay.

Doubly decimated by the guns of Hongi, of Te Rauparaha, and Waharoa; worn out with the agonizing effort to secure a supply of weapons and ammunition; their vitality sapped by the liquor traffic and the wholesale debauch of the mothers of the race; utterly wearied by the ten years' war and its disastrous consequences; discouraged by the injustice of the land laws; and disheartened by an ever-growing race prejudice, the Maoris of to-day are but a dying remnant of the once vigorous and populous tribes. The men and women of fabulous age once to be seen in every *kainga* have died off, and none are taking their place. On a late interesting occasion—the unveiling of the Marsden cross in the Bay of Islands in last March—the only chief within available distance that could remember something of the old times was a half-caste. It is becoming a rare thing in many districts to see a Maori above middle age. Young men and women apparently healthy and robust are cut off at a few days' notice by fever and rapid consumption, while children die wholesale from infantile diseases that would be easily thrown off by their white brothers and sisters, and the shrinking remnant is ever less and less able to resist the doom of their race.

The decay, on the whole, as I have attempted to show, has been rapid, but it has been fitful, and there have been times when it almost seemed as if there was a gleam of hope. Although the Rev. Samuel Marsden and the early missionaries were unable to restrain Hongi from going on the warpath, still, it is unquestionable that their influence largely contributed to the suppression of cannibalism, and helped to secure a better fate for the thousands of prisoners than they would otherwise

* Hochstetter's "New Zealand," pp. 220–221.

have met with. At the time that the horrors of the "ship-girl" and the liquor traffic were being enacted at Kororareka, order and decency reigned in the mission settlement at Paihia, on the opposite side of the Bay of Islands. The industrial and educational system of the Church station at the Waimate compelled the admiration of Charles Darwin, who visited the place during the voyage of the "Beagle."* The young women brought up in the missionaries' households were often sought as wives for the chiefs, and the effects of their training might be seen in after-life by the habits of order and neatness they imported into the *kaingas*.

With the gradual development of colonial life the close contact of the missionaries with the Maori came to an end, but its spirit has survived to some extent in other agencies. To the precept and example of the Maori clergy is no doubt mainly due the wholesale stamping-out of the drinking habit throughout the northern district, while the Te Aute College and St. Stephen's School, and the Hukerere and Victoria Girls' Schools have helped to give some of the youth of both sexes a hopeful start in life.

But all these checks, and any other that might be mentioned, have been but temporary and local. Taken altogether, their effect on the general result has not been great. They have failed to arrest the stream of tendency that is sweeping onward with ever-increasing power and volume, ever meeting with less and less resistance.

The Maori has lost heart and abandoned hope. As it has already been observed in the case of the individual, when once the vital force has fallen below a certain point he dies from the sheer want of an effort to live; so it is with the race. It is sick unto death, and is already potentially dead. As Von Hochstetter remarks again,† "The Maoris themselves are fully aware of this, and look forward with a fatal resignation to the destiny of the final extinction of their race. They themselves say, 'As clover killed the fern, and the European dog the Maori dog; as the Maori rat was destroyed by the *pakeha* rat, so our people also will be gradually supplanted and exterminated by the Europeans.'"

The Census.

According to a census taken last year‡ the Maori population stood at 47,721. This includes 3,938 half-castes living as Maoris.

* "A Naturalist's Voyage in the 'Beagle,'" Chap. xviii.
† Hochstetter's "New Zealand," p. 222.
‡ New Zealand Official Year-book, 1906.

The Official Year-book states that each time the census has been taken since 1896 there has been a considerable increase in the number. A similar statement will never be made in connection with any future census, and for the following reason: In former years it was impossible to arrive at anything more than a very casual estimate. The system of enumeration was more or less rough-and-ready, no particular care was taken in the appointment of reliable officers, and Maori information had to be largely relied on. The Maori mode of computation was based on the number of able-bodied men in a *hapu* or *kainga*, the women and children being thrown in by a rough guess; and, as the Maoris were somewhat suspicious of the motives of the Government, their returns were often purposely below the mark. As time went on the enumeration was made with increasing accuracy, but it was only on the last occasion that it was made on the lines of the European census—viz., by a systematic house-to-house visitation by properly qualified officials, who were accompanied on their rounds by intelligent and trustworthy Maoris. The rise in the figures is therefore only due to the increasing accuracy of the returns, numbers being each time included that would have escaped in former calculations. Finality has now been reached, and the next census will show that the Maori population, instead of increasing, has been diminishing all the time, and that if the present rate of declension continues it must soon reach the vanishing-point.

APPENDIX.

ARTICLE 2 OF THE TREATY OF WAITANGI.

"Her Majesty the Queen of England confirms and guarantees to the chiefs of New Zealand, and to the respective families and individuals thereof, the full, exclusive, and undisturbed possession of their lands and estates, forests, fisheries, and other properties which they may collectively or individually possess, so long as it is their wish and desire to retain the same in their possession; but the chiefs of the united tribes and the individual chiefs yield to Her Majesty the exclusive right of pre-emption over such lands as the proprietors thereof may be disposed to alienate, at such prices as may be agreed upon between the respective proprietors and persons appointed by Her Majesty to treat with them in that behalf."

Art. XIV.—*On a Soda Amphibole Trachyte from Cass's Peak, Banks Peninsula.*

By R. Speight, M.A., B.Sc.

[*Read before the Canterbury Philosophical Institute, 6th November, 1907.*]

The oldest rocks found on Banks Peninsula consist of slates, cherts, and greywackes of uncertain age; but the last show a marked lithological resemblance to Lower Mesozoic greywackes that occur at the Malvern Hills. The only exposure of these rocks on Banks Peninsula is near Gebbie's Pass, where they occupy a considerable portion of the main ridge, and extend down on both sides of it, but especially towards the head of Lyttelton Harbour. Here they form a large part of the solid floor of the valley in which Teddington lies. Over them lie solid flows of rhyolite and beds of agglomerate penetrated by dykes of rhyolite and pitchstone. The age of these beds is also uncertain, but they resemble very closely in lithological character the garnet-bearing rhyolites of Mount Somers, Rakaia Gorge, and the Malvern Hills, which are certainly of Cretaceous age, as rhyolite pebbles are found in conglomerates forming the lower members of the coal-bearing series, which, as well as the rhyolites, overlie unconformably Jurassic sedimentaries. At Mount Somers, too, rhyolite tuffs, according to S. H. Cox, are interstratified with coal-bearing beds. It is therefore highly likely that the Gebbie's Pass rhyolites are of Cretaceous age.

After a considerable lapse of time, during which the rhyolites were heavily eroded, the main mass of Banks Peninsula was formed, consisting chiefly of andesites of basic type and basalts. These were poured out as subaerial lava-flows, and thrown out as scoria and ashes from two craters which now form Lyttelton and Akaroa Harbours. Onawe Peninsula probably marks the centre of the latter volcano, as the extremity of the peninsula is composed of a syenite, and this is the only occurrence of a plutonic rock in the locality. The remaining part of this small peninsula near the narrow isthmus is principally formed of intercrossing dykes; it thus shows the structure which characterizes the neighbourhood of the pipe of an old volcano. Sir Julius von Haast suggests that a third centre of eruption, belonging to this period, occurs in the valley of Little River. He is not very definite about it, and says that the remains of the lavas that were poured out from it are not very extensive. I believe, however, that he modified his views somewhat at a later date, and considered that the peninsula was built principally from the centres of Lyttelton and Akaroa. I cannot speak definitely from personal observation as regards this point, but from what I have seen I am inclined to think that it is unlikely that a crater occupied the valley of Little River, but that the lavas occurring there were poured out from both Lyttelton and Akaroa, and that the form of the valley can be well explained as the result of prolonged stream erosion. When all the lavas are basalts and basic andesites, and good sections showing their relations are practically absent, an accurate estimate is extremely difficult to make. Good sections showing contacts of the andesites with the earlier rhyolites are also rare, owing to the completeness with which the soil covers over everything. However, a section near the end of the spur which divides Gebbie's from McQueen's Valley affords convincing proof of their relative age. Here the actual contact is seen, and andesites undoubtedly overlie denuded rhyolites.

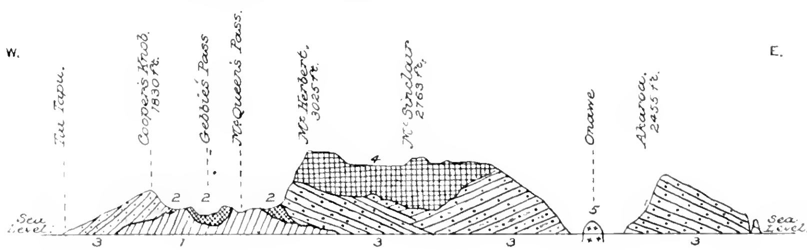
The andesites always contain augite, with a small amount of olivine generally added, and thus show close relations to the basalts; but the silica percentage of some varieties is too high (about 56) for them to be classified as such. There are gradations, however, from the less basic to the thoroughly basic types, which finally pass into undoubted basalts. It is highly likely that the Akaroa lavas are of a slightly later date than those from the Lyttelton volcano. They are generally of a more basic character, true basalts forming a large proportion of effusive mass. This evidence is perhaps very unreliable, but it is supported by the fact that the crater-ring of Akaroa is in a much more perfect condition than the Lyttelton ring, denudation not having exerted such a marked influence over its original form. However, this may be accounted for by the more resistent character of the rocks constituting it. In the subsequent section I have represented the Akaroa lavas as being slightly younger than the Lyttelton ones.

The andesitic eruptions from these two centres were succeeded by an outpouring of basalts and andesites from Mount Herbert, and probably from Mount Sinclair. The latter mountain forms the geographical centre of Banks Peninsula, being situated at the junction of the Port Levy, Pigeon Bay, and Little River Valleys, with outlying parts extending nearly to the edge of the crater-ring of Akaroa.

Sir Julius von Haast mentions a fourth centre of eruption at Quail Island, within Lyttelton Harbour; but this may be contemporaneous with that at Mount Herbert, and it is even possible that the Quail Island basalts came from Mount Herbert, and that the connecting rocks have been removed by denudation.

On examining a map of Banks Peninsula it will be seen that the centres of volcanic activity lie approximately on a line running east-south-east and west-north-west. It seems, therefore, a reasonable inference that the eruptions took place at different points of a fissure or line of weakness in the earth's crust running in that direction; that eruptions broke out first at the Lyttelton end of the fissure, and that afterwards the centre of maximum disturbance moved eastward to Akaroa, and then back to Mount Sinclair and Mount Herbert, and possibly to Quail Island.

As the Lyttelton volcano has thrown out rocks belonging to three different periods, and perhaps to four, I think it would be convenient to refer to the rhyolites as the Gebbie's Pass series, to the olivine-andesites as the Mount Pleasant series (named from one of the chief peaks on the northern side of the harbour immediately behind the Town of Lyttelton), and to refer to the lavas which come from Mount Herbert as the Mount Herbert series. All these are quite distinct in age: the Gebbie's Pass series being almost certainly Cretaceous, the Mount Pleasant series being early Tertiary, and the Mount Herbert series middle Tertiary; but the last two are extremely uncertain as regards their age, and may be much more recent. Although stream erosion has exerted a marked influence in forming valleys, yet the form of the crater-ring is fairly perfect, especially as regards Akaroa, so that a more recent date may very well be assigned to the two later series.



DIAGRAMMATIC SECTION OF BANKS PENINSULA, FROM TAI TAPU TO THE COAST NEAR EAST HEAD.

1. Slates and greywackes; Lower Mesozoic(?). 2. Rhyolites, Gebbie's Pass series; Cretaceous. 3. Augite-andesites and basalts, Mount Pleasant series; early Tertiary(?), perhaps later. 4. Basalts and andesites, Mount Herbert series; mid Tertiary(?), perhaps later. 5. Syenite, Onawe Peninsula; early Tertiary(?), perhaps later.

NOTE.—The line of this section is not straight, but altered in direction to show the relative position of the rocks of different age. A good deal of the section is problematical, particularly that portion between Mount Herbert and Akaroa Harbour.

The foregoing section shows the relative position of the different outpourings of volcanic rocks. It will be noted that in it I have classified the lavas from Akaroa as belonging to the Mount Pleasant series; but this classification is merely tentative, and for reasons just stated they should probably be marked as belonging to a later date.

The Mount Pleasant series is penetrated by a remarkable series of dykes, well described by Sir Julius von Haast, who pointed out in the case of Lyttelton that they are oriented in a somewhat striking manner. They all, with few exceptions, converge on a point at the back of Quail Island, no matter in what parts of the crater-ring they are found. The dykes of the Gebbie's Pass series are not so arranged, while there are none visible in the Mount Herbert series. Some of these dykes have been previously described by Hutton*, Ulrich,† Marshall,‡ Filhol,§ Kolenko,‖ and the author.¶ They consist, as far as is known at present, of dolerites, basalts, hornblende, and augite andesites, some containing olivine, trachytoid phonolites, and trachytes, the last being probably the most numerous, although basaltic dykes are also common. Some of the trachytes contain hornblende and others augite, and they are in general of whitish, pale-grey, and sometimes of a greenish colour, and very vesicular. Chemical analysis shows that some contain a high percentage of soda. It is to this class that the rock to be described belongs.

The Soda Amphibole Trachyte.

Its Occurrence.

The rock is found as a massive dyke on the northern side of Cass's Peak, one of the highest points on the west side of the old crater-ring of Lyttelton. The dyke can be traced fully half a mile from near the crest of the ridge, through the Kennedy's Bush reserve, and down one of the valleys towards Lansdowne. At times it is fully 60 ft. wide, but it thins out towards the top of the ridge, and also when followed down the valley. At one spot it was quarried as a building-stone, and several buildings in Christchurch were built of it, notably the present Tourist

* "Eruptive Rocks of New Zealand," Trans. Roy. Soc. N.S.W., 1889.

† "Transactions of the Australasian Association for the Advancement of Science," vol. 4, 1891.

‡ "On a Tridymite Trachyte of Lyttelton," Trans. N.Z. Inst., vol. xxvi (1893).

§ "Mission de l'Ile Campbell," Paris, 1883.

‖ "New Zealand Journal of Science," vol. ii.

¶ "On a Doleritic Dyke at Dyer's Pass," Trans. N.Z. Inst., vol. xxvi (1893).

Office, and it has been used in the construction of others. Blocks of this stone occur in the archway over the entrance to Canterbury College. As a building-stone it is very easy to work, and stands the weather extremely well; but its appearance is somewhat spoiled by the presence of fragments of the country rock, which are irregularly distributed through it.

Macroscopic Appearance.

The rock is of a light greenish-grey colour, with phenocrysts of feldspar visible in a rather porous groundmass. A number of black specks also are to be seen, and these are either the soda amphibole or aggregates of iron-ore derived from it. No other porphyritic crystals are visible. The included andesitic fragments are of all sizes, up to 10 cm. in length.

Specific Gravity.

The specific gravity determined immediately after immersion in water was 2·35; on leaving the rock to soak for twenty-four hours it was 2·48; and determined by a specific-gravity bottle it was 2·57. These figures afford some idea of the vesicular character of the rock.

Chemical Analysis.

A chemical analysis of the rock was made in the chemical laboratory, Canterbury College, by several students, under the direction of Dr. W. P. Evans, who has kindly furnished me with the following result:—

	Per Cent.
SiO_2	70·04
Al_2O_3	15·40
Fe_2O_3 .. .. .. } FeO .. .. .. }	4·65
CaO	Slight trace only.
MgO	0·55
Na_2O	4·35
K_2O	4·65
H_2O	0·57
	100·21

The following points with regard to this result are specially noticeable: The high percentage of SiO_2 (70·04), the low percentages of CaO and MgO, and the moderately high percentage of alkalies for a rock of its character. These peculiarities are explained by the microscopical examination, and will be dealt with more fully subsequently.

Microscopical Examination.

A microscopical examination of the rock shows it to belong to the trachytes, but with characteristics connecting it with the rhyolites. The phenocrysts are apparently all sanidine, clear, fissured, some in Carlsbad twins, their greatest length being about 4 mm. Anorthoclase was specially looked for, in order to explain the fairly high percentage of soda, but no undoubted crystals were detected, although some of the crystals suggested the microscopic twinning of anorthoclase very faintly. In the absence of decided characters I have classified them all as sanidine. No phenocrysts of plagioclase were observed.

The only other porphyritic mineral is the soda amphibole. This mineral occurs in very irregular-shaped individuals of small size, re-entrant angles being extremely common. Pleochroism is very strong, the maximum absorption occurring when the cleavage is parallel to the short diagonal of the nicol. The colours are a deep-blue, greenish-blue, and brownish-yellow. The mineral is somewhat opaque, and only translucent in thin sections. The angle of extinction is therefore somewhat difficult to determine, but it ranges up to about 10°, measured from the cleavage traces in sections where they are parallel. These characters show the mineral to be, in all probability, the soda amphibole arfvedsonite, or a closely related variety. The rock also contains aggregates of iron-ores, which are apparently derived from this amphibole.

Groundmass.

The groundmass is holocrystalline, but the size of the individual crystals varies considerably in different parts of the dyke. It is composed chiefly of rectangular and short lath-shaped crystals of sanidine frequently twinned, with interstitial matter of smaller microlites of sanidine, and sparingly plagioclase; this last is almost certainly albite. The feldspars exhibit at times a rough fluxion structure, especially when the groundmass is somewhat coarse in texture. Small grains of quartz are commonly seen in the groundmass forming part of the interstitial matter between the larger individuals of feldspar. The most brilliant polarisation colours and the index of refraction (Becke's test) show clearly that the mineral is not tridymite—which might have been expected in a trachyte. The high percentage of SiO_2 in the chemical analysis shows that a considerable quantity of free silica must be present, and this must occur in the groundmass, as the clear phenocrysts are apparently all sanidine. The soda amphibole also occurs very plentifully in the groundmass, in the form of irregular flakes. This exhibits the characteristic pleochroism of the larger individuals. In many cases it is moulded on the larger crystals of sanidine in the base, and has evidently separated out at a late period in the consolidation. Small irregular flakes of a greenish augite also occur, but it is very difficult to differentiate them from the blue amphibole, their colour and faint pleochroism being the special criteria for discrimination.

This description of the rock shows that it belongs to the phonolitic variety of trachyte, using that term in its general acceptation—viz., a trachyte which contains sanidine (and anorthoclase), with alkali iron pyroxenes or alkali iron amphiboles.

The microscopical examination thus explains the peculiarities in the chemical analysis. The fairly large percentage of soda is due to the presence in large quantities of the soda amphibole and the green augite. The practical absence of lime shows the absence of all plagioclase feldspars except albite, and, taken in conjunction with the poorness in magnesia and the absence of any other mineral explaining the percentage of iron-oxide, it shows that amphibole is most probably an almost pure soda-iron variety. This may contain a small proportion of magnesia, although the presence of this oxide may be due to the fragments of augite in the groundmass. The high percentage of silica, and its presence in the free state in the groundmass, though rare in trachytes, seems undoubtedly to occur in those of orthophyric character (*vide* Rosenbusch's "Elemente der Gesteinslehre"). The tridymite trachyte dyke from the Lyttelton–Sumner Road described by Marshall also shows a high percentage of free silica; but he came to the conclusion that this was of secondary origin, whereas it appears to me to be a primary constituent in the groundmass of this rock. I include the analysis of the tridymite trachyte made by Marshall for the purposes of comparison, as well as all other analyses which I have come across of the trachytes and related rocks belonging to the Mount Pleasant series.

ANALYSES OF TRACHYTE AND ALLIED DYKES OF THE MOUNT PLEASANT SERIES.

—	A.	B.	C.	D.	E.	F.	G.	H.
SiO_2 ..	58·93	59·87	61·99	61·38	60·69	52·18	71·09	70·04
Al_2O_3 ..	23·95	21·22	13·08	20·60	17·75	20·00	15·45	15·40
Fe_2O_3 ..	5·43	4·42	8·65	2·57	3·83	5·00	1·50	4·65 (for Fe_2O_3 and FeO)
FeO ..	..	1·16	..	..	..	..	0·34	
MnO ..	..	0·14	4·42	1·19	1·21	..	..	..
CaO ..	1·75	2·58	2·21	2·18	1·20	4·92	3·25	Slight trace
MgO ..	0·96	0·91	Trace	0·40	1·43	1·03	0·89	0·55
K_2O ..	4·32	4·06	1·61	..	Traces	2·30	2·35	4·35
Na_2O ..	5·61	5·34	4·22	9·70	13·10	14·57	4·81	4·65
H_2O ..	1·36	..	3·82	1·98	0·79	..	0·07	0·57
Total ..	102·31	99·70	100·00	100·00	100·00	100·00	99·75	100·21

A. Trachytoid phonolite, Lyttelton–Sumner Road; analysed by P. Marshall: Trans. N.Z. Inst., vol. xxvi (1893).

B. Trachytoid phonolite, Heathcote; analysis by T. Butement; quoted by H. F. Ulrich, Trans. Aus. Assoc. Adv. Sci., vol. iii (1891).

C. Vesicular trachyte from agglomerate bed; analysis made in laboratory of the Geological Survey; quoted in Haast's "Geology of Canterbury and Westland."

D. Dyke (side) cut by tunnel, No. 29B, same dyke; analysis made in laboratory of the Geological Survey; quoted in Haast's "Geology of Canterbury and Westland."

E. Dyke (centre) cut by tunnel, No. 29A, same dyke; analysis made in laboratory of the Geological Survey; quoted in Haast's "Geology of Canterbury and Westland."

F. Dyke (centre) cut by tunnel; analysis made in Paris by Dr. H. Filhol; "Mission de l'Ile Campbell."

G. Tridymite-trachyte, Lyttelton–Sumner Road; analysis by P. Marshall; Trans. N.Z. Inst., vol. xxvi (1893).

H. Soda amphibole trachyte, Cass's Peak; analysis made in chemical laboratory, Canterbury College; inserted again for convenience of comparison.

This list includes nearly all the published analyses of trachytic and allied rocks of this series. There seems to be one or two striking features about some of them. Assuming that they are tolerably correct, those marked D, E, F show an abnormal percentage of soda, and also a very small percentage of potash; also A, B, C show an excess of soda over potash. The high percentage of MnO in C is also remarkable; this apparently explains the presence of frequent thin coatings of a black mineral resembling pyrolusite, which occurs on the fracture surfaces of the rock. Analyses A and B undoubtedly show the characters of a trachytoid phonolite, and C, D, E, and F those of a soda trachyte. These last rocks have anorthoclase as a common phenocryst, but the practical absence of potash in the analysis is rather peculiar. The two analyses G and H afford interesting comparisons. The marked agreement of the silica, alumina, magnesia, and the soda are very noteworthy. The only differences appear to be the greater proportion of iron-oxides and the practical absence of lime in H. These peculiarities are explained by the microscopical analysis. There is a fair proportion of plagioclase (andesine) and a very small amount of iron-bearing mineral in the tridymite-trachyte. In his description of the rock Dr. Marshall noted the percentage of magnesia without being able to account for it. On looking over a section of it I found in the groundmass a considerable quantity of greenish-blue pleochroic mineral in very minute fragments, which may be either the soda amphibole or the greenish augite. These would account for the small percentage of magnesia that does occur. This greenish mineral with slight pleochroism is found in other rocks occurring as dykes in this series. In some cases it is undoubtedly an augite of a soda-bearing variety; but in other cases where it has the bluish tinge of varying degrees of intensity it is, in all probability, a soda-iron amphibole.

Perhaps the most interesting occurrence of this mineral is in the syenite of Onawe Peninsula, Akaroa. In his description of this rock Captain Hutton says,* "The hornblende goes up to 0·05 in. in length; when fresh it is greenish and pleochroic, changing from blue-green to yellow-green, the polarisation colours not brilliant." On examining this rock further with the advantage of thinner sections I find the masses of iron-oxides which have in most cases replaced the hornblende show not merely a greenish-blue, but a deep-blue colour, and in other cases I noticed small pieces of hornblende exactly resembling the amphibole of Cass's Peak. This, therefore, seems to me a case of the occurrence of an arfvedsonite syenite. Just as in many dykes of the Mount Pleasant series, this rock is very light in colour, and shows a small proportion of iron-bearing mineral.

The fairly wide occurrence of the rocks of the phonolitic trachyte variety so closely connected with the trachytoid phonolites, as well as the occurrence of arfvedsonite syenite at Akaroa, is of special interest when we note the existence at Dunedin of the magnificent series of alkaline rocks discovered by Ulrich, and well described latterly by Marshall. The occurrence of the rocks previously mentioned in the Banks Peninsula area shows distinctly that the distribution of alkali rocks in New Zealand is wider than at first supposed.

* "The Eruptive Rocks of New Zealand," by Professor F. W. Hutton. Read before the Royal Society of New South Wales, 7th August, 1889.

ART. XV.—*Maori Forest Lore: being some Account of Native Forest Lore and Woodcraft, as also of many Myths, Rites, Customs, and Superstitions connected with the Flora and Fauna of the Tuhoe or Ure-wera District.—Part I.*

By ELSDON BEST.

[*Read before the Auckland Institute, 30th October, 1907.*]

THE forest lore of the Maori people of these isles is but little known to those interested in ethnographical studies—or, at least, the latter have placed but little of such lore on record. Hence these notes are presented in order to conserve some very singular old-time customs and beliefs of the ancient Maori. The paper will be by no means a comprehensive one, inasmuch as it merely treats of a tithe of the forest lore of a single tribe of Natives, the unimportant Tuhoe or Ure-wera clan. Moreover, the old men who held full knowledge of the old customs, myths, and quaint beliefs have now passed away, and much interesting lore has died with them. The items herein given are but fragments, lacking many connecting-links and explanatory notes. The ritual pertaining to all work connected with the forest and its fauna was of a most extensive and pervading character. We can give but the skeleton thereof; the bulk of such matter is lost.

Here follows some account of the forests of Tuhoeland, their sylva, flora, and fauna, as given not by the botanist and ethnographer, but by primitive man. He who evolved the peculiar customs, myths, and superstitions herein described shall tell of them.

MYTHICAL ORIGIN OF TREES AND BIRDS.

The most widely used term employed by the Natives of New Zealand to denote a forest is *ngahere* or *ngaherehere.* In some parts, as among the Aotea tribes, the word *motu* takes its place. In others, the latter term is only applied—as *motu rakau*—to an isolated clump of trees, a grove or small wood. Such a small patch of timber-growth would be called an *uru rakau* by the Matatua tribes.

There is, however, another term used to denote a forest, but which, as a rule, is only employed as a kind of emblematical expression. This is the word *wao,* which is usually connected with the name of the tutelary deity or personification of forests, the great Tane, offspring of the Earth Mother and of Rangi, the Heavens. Thus, forests are termed *te wao nui a Tane* (the great forest of Tane), or *te wao tapu nui a Tane* (the great sacred forest of Tane). A single tree or bird is often spoken of as though it itself was Tane. In speaking of one of the prized timber trees, such as *totara*, a Native would often say, "That is your ancestor, Tane." A canoe made of such trees was often termed *te riu tapu nui o Tane.* It was doubtless this feeling of Tane being incarnated in the forms of trees and birds that induced the Maori to perform some very peculiar rites prior to felling a tree, as also on the opening of the bird-taking season. When engaged in the task of felling some *rimu* trees which overhung my camp, passing Natives would call out to me, "*Kai te raweke koe i to tipuna, i a Tane*" (You are meddling with your ancestor Tane); or, on the fall of a tree, "*E! kua hinga a Tane*" (O! Tane has fallen).

This singular phase of primitive mentality is noted in all Maori myths—viz., the belief in an anthropomorphic origin and personification of all things, such things being looked upon as the descendants of such mythical being, and also as being imbued with a certain amount of his personality. Thus the origin of the gourd-plant (*hue*) in Maori myth is one Putehue, a descendant of Rangi and Papa (Sky and Earth). The saying of Putehue was, "*Ko nga kakano o roto i a au hei utu wai mo aku mokopuna. Ko tetehi o nga kakano he tane, tena e kore ia e whai uri.*" (The seeds within me shall become water-vessels for my descendants. But some of them are male seeds which will not have offspring.) In this ancient myth we note an early proof of Maori recognition of sex in plants.

The following mythical genealogy is of a cosmogonic nature, needing explanation.

Maori Cosmogony: The Cosmogonal Tree in Maori Myth, and the Descent of Tane from the Same, through the Sky and Earth Parents. (From Ngati-Awa of Whakatane.)

Te Pu (root, origin).
Te More (tap root).
Te Weu (rootlets).
Te Aka (creeper, vine).
Te Rea (growth).
Te Wao-nui (great wood).
Te Kune (conception, form).
Te Whe (sound).
Te Kore (chaos, void).
Te Po (darkness, &c.).

Rangi = Papa

Tane-nui-a-rangi   Tangotango   Wai-nui

The above names are said to represent certain beings who existed before man was, and before the sky and earth were formed. Some Native mythologists assert that there were ten beings named Te Pu (Te Pu the First to Te Pu the Tenth), ten named Te More, and so on down to Rangi and Papa, though it is not clear as to whether the ten were contemporaries or otherwise. Others state that Te Pu and Te More were the primal pair, male and female, who begat Te Wen and Te Aka, male and female, and so on down to Rangi and Papa. Yet another version is that each of these beings was of a bisexual nature, and contained within themselves the powers of reproduction. They are not said to have been anthropomorphic, or possessed of any faculties akin to those of the *genus homo.* Rangi, the Sky Parent, and Papa, the Earth Mother, are the first beings to whom are allotted powers of speech, thought, and feeling in Maori myth.

It will be seen that many of the names in the above genealogical allegory pertain to trees and their growth, taking the present-day meaning of the words, which takes the mind back to the cosmogonal or universe tree of Oriental and Aryan mythologies. An explanation of these names given to me by a very old Native agrees with the above bracketed words, save in the case of the first name. He said, "Te Pu is the upper part; Te More is the root; Te Wen represents the rootlets; Te Aka means the *aka;* Te Rea stands for growth, and Te Wao-nui for size attained; Te Kune means form attained; Te Whe stands for *wheke*, the creaking sound of trees heard when wind blows in the forest; Te Kore implies nothingness, non-existence; Te Po is darkness. From Te Po came Rangi; his sister was Papa: these two produced Tane, Tangotango, and Wai-nui. From these sprang all things in the world—people, and plants, trees, stones, fish, animals, birds, reptiles, rats, insects, moths, spiders, mosquitoes, and all other things. From Tane sprang men, trees, and birds. His descendant was Tangaroa-i-te-rupetu, who begat Maui, who begat Te Papatiti-raumaewa, who begat Tiwakawaka, who came to this land (New Zealand) from Mataora in times long past away."

The word *aka*, above, is used to denote long, thin roots, and is also a generic term for climbing-plants. Te Po is a name applied to the underworld, the place to which go the spirits of the dead from this world; but it also is applied to the æons of time before this world came into being—that is, before Rangi and Papa were. For, prior to the forcing-apart of Sky and Earth by their son Tane, light was unknown: darkness obtained everywhere. Beings who existed before the separation are said to have belonged to the Po. Those who came after it are said to have been of the *ao marama*, the world of light.

Other offspring of Rangi and Papa we are not here concerned with, but we will give the position of Tane as preserved by the Tuhoe Tribe, and given by old Tutakangahau :—

"The first-born of Rangi and Papa, who came into being before light was, before man was, and before heaven and earth were separated, were Te Kaukau-nunui, Te Kaukau-roroa, Te Rupe-tu, Te Rupe-pae, Pekepeke, Hanaitu, Te Manu-waero-rua, and Tahiri-matea. The second lot so born of Heaven and Earth were Tane-tuturi, Tane-pepeke, Tane-ueha, Tane-uetika, Tane-mahuta, Tane-mataahi, and Tane-te-po-tiwha. The third lot were Tane-te-wai-ora, Tane-nui-a-rangi, Paia-te-rangi, and Ruaumoko. The human race is descended from Tane-nui-a-rangi and Tane-te-wai-ora. The offspring of Tane-te-po-tiwha were Te Ao-tu, Te Ao-hore, Hine-tuahoanga, and Tangaroa."

Of the many different beings named Tane in the above myth, Tane-te-wai-ora and Tane-te-po-tiwha are often spoken of as being separate and distinct from Tane-nui-a-rangi, but all the others seem to be but different names of Tane-nui-a-rangi. The name of Tane appears to be changed according to the different beings or natural objects which originated with him. As the progenitor of the *genus homo* he is termed Tane-nui-a-rangi, or simply Tane. As the origin of trees and plant-life he is Tane-mahuta. As the origin of birds he is Tane-mataahi. Tane has many other names, as Tane-takoto, Tane-wai-nui, Tane-wai-kokina, Tane-wai-patato, Tane-i-te-kapua, and those given above.

Rangi, the Sky Parent, is known in full as Rangi nui e tu nei (the Great Heavens above), and Papa-tuanuku is the full title of the Earth Mother. This twain were the origin of all things on earth ; they were the primal parents ; nothing existed before them save darkness and the mythical beings that were the denizens of darkness and chaos.

And Rangi and Papa were as one in the beginning, for the sky lay prone upon the earth, and darkness covered the earth. Light was not. It was Tane who forced the heavens upwards and brought light to the world. For the offspring of Rangi and Papa were living in darkness on the breast of the Earth Mother. They desired light and space. Hence Tane thrust the sky upwards with his feet as he lay on the breast of Papa. So it is said that the branches of a tree are the legs of Tane, and the butt or base of the tree is the head of Tane. For such are the thoughts of the Maori.

The many names assigned to Tane is a circumstance that carries the mind to ancient Asiatic cults, and to others far spread toward the setting sun. For in like manner did Merodach, the chief deity of the Babylonian pantheon, bear many names, as also Ea, god of the underworld, of reproduction, of cultivation, and of waters. In India we see the same thing, as of Vritra, who is Ahi the strangler, and Vala, and Pani, who entices the cows of Indra to leave their pastures. Westward to the setting sun and eastward to the dawn one notes similar cases in the mythologies of many peoples.

Rangi also appears under many different names in Maori myth, as Rangi-nui, Rangi-roa, Rangi-potango, &c.

The first act performed by Tane was the forcing-apart of heaven and earth, after which he brought light to the world, by setting the sun, moon, and stars in the breast of Rangi. Having performed these tasks, Tane went in search of the female element. He found the female nature in various forms, but these forms were not human. He found Apunga, by whom he produced shrubs and the smaller birds. He found Mumuhanga, who had the *totara* (a tree). He found Te Pu-whakahara, who became the origin of the trees called *maire* and *puriri.* He found Tu-Kapua, by whom he had the *tawai*, *kahikawaka*, and other trees. He found Ruru-tangi-akau, who bore the *ake* and *kahikatoa* trees. He found Rere-noa, who produced the *rata* and all parasitic and climbing plants. He found Hine-wao-riki, who bore the *kahika* and *matai* trees. He found Mango-nui, who had the *tawa* and *hinau* trees. He found Punga, who became the origin of the *kotukutuku* and *patate* trees, as also of all insects. He found Tutoro-whenua, who bore Haumia (roots of the *rarauhe* fern). He found Hine-tu-maunga, who had Para whenua-mea (origin and personification of flood waters).

Other Natives give Pani-tinaku as being the parent or origin of the sweet potato, Hine-mahanga as the parent of the *tutu* (shrub), Tawake-toro as parent of the *manuka*, Hine-rauamoa as parent of the *kiokio* fern, Huna as origin of the *harakeke* (flax), Tawhara-nui of the *kiekie*, Kakaho of the *toetoe*, and so on.

The sun, moon, and stars were the offspring of Tangotango, while Wai-nui was the origin of all waters. Hence we see that in Maori myth life seems to be shared in common by men, animals, trees, and plants, the heavenly bodies, and water.

The idea of the cosmogonal or universe tree in New Zealand myths seems to bear two aspects—first, that the universe acquired form and grew as does a tree; and again, that the sky was forced upwards, and supported by a tree in the form of Tane, who was the origin, personification, and tutelary deity of trees and forests.

The cosmogonic tree in Maori mythology is a conception of somewhat rudimentary form when we compare it with similar myths in Japan, China, India, Persia, Chaldea, Egypt, and northern Europe, but a study of this conception, as also of many rites, customs, beliefs, &c., conserved in Maori ritual, myth, and folk-lore, tends to a belief that the remote ancestors of the Maori must have for a long period dwelt in a forest country.

Possibly the Indian concept of the universe tree approaches more closely the Maori myth than any other we wot of, wherein Brahma himself is described as the vast overspreading tree of the universe, of which the gods are the branches. In Eastern legend the cosmic tree sometimes appears as the giver of immortality, whereas in Maori legend Tane-te-wai-ora confers that boon by means of the "waters of life." In Arabia the stars were said to be the fruit of the zodiac tree, while the Maori has it that the stars were the ornaments of the house of Tane-te-wai-ora.

The custom of planting a tree at the birth of a child, with the belief in some mystical relationship between them, has obtained in many lands, and has been noted by the late Mr. John White as having been practised by the Maori in former times. The "world pillar," allied to the cosmogonic tree, was also a Maori concept. The "family tree" and "community tree" have not, I believe, been noted in Maori myth, but there is some evidence in favour of a belief in phallic trees. Such a tree is Te Iho o Kataka, a *hinau* tree at O-Haua-te-rangi, Rua-tahuna, a description of which, and the necessary rites in order to cause a woman to conceive, we have already placed on record.

We would hesitate to say that the Maori practised tree-worship, although certain trees were, for various reasons, looked upon as possessing certain supernatural powers, or as being the material representation of wood spirits, or spirits of the land, or as being *tapu* because a chief died near such tree, or it was used as a burial-place, or because the severed umbilical cord of a new-born infant was deposited on such tree. A tree on or in which such umbilical cords were placed, or under which a dying man had been laid, would often be adorned, in modern times, by means of hanging thereon bright-coloured handkerchiefs, strips of cloth, &c., from time to time; but in pre-European days some prized article, as a piece of greenstone, would be placed on the tree, often thrust into a crevice or fissure in the bark.

Now, a traveller who might happen to see such trees so adorned would very probably be of the opinion that the Natives of the district were tree-worshippers—the trees so adorned, as well as *tipua* trees and *uruuru-whenua* trees, being looked upon as gods. But it needs a long residence among a primitive people, a deep interest in primitive cults and kindred studies, and a tireless patience, before we can find out what any primitive people do, or do not, believe. I certainly would not say that the Maori was a tree-worshipper.

Tipua.

The trees termed *tipua* are supposed to be endowed with certain supernatural powers. The term *tipua* is often translated as meaning "demon," and it is applied to anything possessing weird, supernatural power, in Maori belief. There are many trees, stones, &c., in Tuhoeland so gifted, say my Native friends. The small pond called Rongo-te-mauriuri, on the summit of Maunga-pohatu, is a *tipua*. Our term "enchanted," as used in fairy tales, comes near to the meaning of *tipua* in the present case. At the mouth of the Manga-o-hou tributary of the Whakatane River stands a rock known as Te Komata-o-te-rangi, said to have been located there by Tane-atua. Its inherent power is that, should a stranger to the place pass near it, then heavy rain will at once come on, making travelling unpleasant for that stranger.

A rock at Titi-o-kura, known as the Canoe of Taurua-ngarengare, is a *tipua*.

A log of *totara* timber, which is known as Tangi-auraki, lying in the Rangi-taiki River at Nga-huinga, is a *tipua*. It has, or had, the power of preventing eels from travelling any further upstream.

Te Toka a Houmea, a rock situated in a paddock on Section 261 at Whakatane, was a *tipua* until the godless *pakeha* destroyed its magic powers.

When a stranger approaches a *tipua* tree, stone, &c., a heavy fog, or mists, often descend upon the land. A stranger in ascending the enchanted hill Maunga-pohatu is said to be so greeted. The sun is spoken of in old tales as a *tipua*.

Te Kuri-a-Tarawhata is a *tipua* rock in the Whakatane River, near Pu-kareao. Tarawhata was an immigrant from Hawaiki.

Te Puku-o-Kirihika is a stone *tipua* at Pu-kareao, and is gifted with powers of locomotion. If any person moves that stone it will, ere long, return to its former resting-place.

Some of the *tipua* rocks at Wai-kare Moana will, if touched or interfered with, cause the wind to change, or a gale to rise.

Te Tapuwae a Eke-nui (the footprint of Eke-nui), a mark on a rock at Maunga-pohatu, is a *tipua*.

A small *totara* tree growing on a *tawai* tree on the old trail over Huia-rau Range is a *tipua*. It is at a place called Te Pakura, and was an *uruuru whenua*. Marae-roa, a *tawa* tree at Maunga-pohatu, was another such.

There are said to be two *ruru* birds (owls), named Kahu and Kau, which frequent the forest at Te Purenga, Rua-toki. Both of these birds are albinos, and are *tipua*, inasmuch as they give notice of the fruitfulness or otherwise of the approaching season. When a person who has an ancestral right to those lands enters the forest thereof he knows whether or not it will be a plentiful season. If when he commences to set his snares those two white owls appear, that is a sign that it will be a *tau kai*, or fruitful season. If when the first-snared bird is taken and prepared the owls have not appeared, then it is known that a *tau hiroki*, a lean season, is at hand.

The place from which the Wairau district of Wai-kare Moana derived its name was a pond or small lake. This pond was a *tipua*. Around it were many fine trees, much frequented by birds, and on which quantities were snared. Even the *hiwi* (permanently fixed rods on which the poles with set snares are suspended) on those trees were adorned with carving. Once upon a time a chief engaged in bird-snaring at that place told his wife to be very careful to never pass before him when carrying food. Unfortunately she did so on one occasion, with the result that no one has ever been able to find that lakelet since: both it and the prolific trees adjacent thereto have passed from human ken. The term *tipua* is sometimes applied to fairies and other forest- or mountain-dwelling beings supposed to possess strange powers.

Many of the rocks which stand in the entrance to the Whakatane River, inside the bar, are *tipua*. The names of those rocks are Arai-awa, Toka-mauku, Toka-roa, Himoki, Hoaki, and Ira-kewa.

Uruuru Whenua.

The custom known as *uruuru whenua*, or "entering the land," is a peculiar one. Scattered about the tribal lands are certain trees, stones, &c., which are viewed as though they represented the spirits of the land, which must be placated by all persons who pass by such tree or stone for the first time, if not on every occasion. The ceremony is but brief. The wayfarer plucks a branchlet, or frond of fern, or handful of grass, and casts it down at the base of the tree or rock, repeating at the same time a brief charm, such as,—

Tuhituhi o tauhou
Mau e kai te manawa o tauhou
Whakapiri ki tautohito.

This performance is evidently to placate the spirits of the land, and is performed at many of the *tipua* trees, &c., described above. It was absolutely necessary for a person to do this when passing such a place for the first time, or trouble would be his lot. After the first passage it did not matter so much, but still the offering seems to have generally been made. If travellers were overtaken by mists or fog, a person of knowledge among them would pluck up a stalk of fern, strip off the fronds thereof, and stick it in the ground, base uppermost. Splitting the upper part of the stalk as it so stood, he would place therein a clod of earth, reciting a brief charm, which would dispel the fog. Te Rapa a Hine-whati, a *tawai* tree near the Wai-horoi-hika Stream at Wai-kare Moana, is an *uruuru whenua*, as also is Takuahi-tee-ka, a rock in the Whakatane River, at the mouth of the Manga-o-hou Stream. Old Natives tell me that in their youthful days, when this custom was in force, a clear space was always seen round such trees or stones, the vegetation having been plucked by passers-by.

Te Whanautanga o Tuhourangi, a stone near Mount Edgecumbe, is another of these mediums of the land spirits, as also was a stone named Tu-ki-te-wa, situated near the Rua-tahuna Stream.

Another form of the charm repeated is,—

Uruuru o tauhou
Mau e kai te manawa o tauhou.

While in "Nga Moteatea" we find the following :—

Ka u ki mata nuku
Ka u ki mata rangi
Ka u ki tenei whenua
Hei whenua
He kai mau te ate o te tauhou.

The author of "Te Ika a Maui" translates the first two lines of this last effusion in this wise :—

Arrived at slippery point,
Arrived at break of day.

The slipperiness of that point must certainly have been excessive—far too much so for a denizen of the Tuhoean wilderness to attempt to pass.

It is said that a person who had performed the *uruuru whenua* rite would be careful not to look behind him as he continued his way.

In vol. iv. of the "Journal of the Polynesian Society," at page 55, may be found some notes on this same custom as performed in Samoa and far-away Corea. In New Zealand it seems to have been performed at most of the *tipua* objects. Any stranger neglecting this precaution might die or be afflicted by illness if a storm did not arise, or rain ensue, as a consequence of his neglect. These *tipua* were possessed of *wairua* (spirit, soul), according to some of my Native friends.

When the Land Commission was sitting at Wai-mako, near Wai-kare Moana, two Natives visited the *tipua* rock known as Haumapuhia and pulled off some of the water-weeds growing thereon. The demon responded by causing a heavy shower of rain, with high wind. Had the storm not come, then the twain would probably have been attacked by illness—so said the people.

A row of stones known as Hine-porete, situated on a hill near Te Tiringa, was formerly an *uruuru whenua.*

All these objects, it must be remembered, were viewed as representing the spirits of the land, hence they may be termed sacred trees or stones: but the Maori quite recognised the fact that the tree or stone possessed no *mana*, or supernatural power, *per se*. Such powers emanated from the guardian spirits of the forest or land adjacent thereto. The offerings deposited at such places, or at a tree or rock made *tapu* through the severed umbilical cord of a new-born child having been deposited thereon, or because a dying chief had lain hard by—these offerings we say, whether a simple branchlet or a stone, or a piece of prized greenstone, or a handsome piece of cloth, &c., were intended as propitiatory offerings to placate the gods or demons of those parts. It cannot be said with truth that the Maori worshipped such trees, or anything else, for that matter. The bright-coloured handkerchiefs and pieces of cloth placed on sacred trees by these Natives carries one's mind to many a far-off land—to the sacred date-palm at Nejran "hung with fine clothes and women's ornaments"; to the story of Phryxus hanging the Golden Fleece on the boughs of a sacred beech-tree: and to many another tale of days of old. The ancient lore pertaining to the sacred tree has been compiled in a most interesting form by Mrs. I. H. Philpot in her work on "The Sacred Tree."

It may be observed that none of these sacred or *tipua* trees in the Tuhoe district are *karaka* trees, as the *karaka* does not grow in this district. Many such sacred trees have been pointed out to me in the Bay of Plenty district, but in no case were they *karaka*. This will dispose of the theory put forward in vol. xxxvi. (page 12) of the "Transactions of the New Zealand Institute."

In this our discourse on Tane and his realm it may be well to state that Tane represents the male element in nature: hence it was that it was he who sought the female element, and so produced trees, plants, birds, insects, &c., and eventually man. The word *tane* is also employed in the Maori tongue to denote "male" and "husband." The god Tane was essentially a creator.

Trees of a peculiar form of growth, albeit not in any way sacred, are often given names by the Maori. A clump of *totara* trees near Nga-putahi is known as Te Whanau a Mihi (the offspring of Mihi). Another such situated on the Wai-potiki Block is called Te Whanau a Ta-morehu. Trees on which birds were snared each season were also given names, as also many of those which furnished fruits for the Maori larder, as Nga Pukanohi, a *matai* tree at O-kahu, and Ure-takohekohe, a grove of *tutu* at Rua-toki.

Mythical Denizens of the Forest.

Like unto all other forest-dwelling, primitive peoples, the Maori peopled the realm of Tane with divers varieties of mythical beings—fairies, water-demons, and certain subterranean monsters. The last-named were known as *tuoro* and *hore.* These were huge beasts that never appeared above ground, but burrowed through the earth, making great tunnels and caves, and overthrowing huge forest-trees. A cave in the bank of the Whirinaki River at Te Whaiti is said to have been formed by one of these creatures, and is known as Te Ana-tuoro (the Tuoro Cave). Another dwelt in a pond called Otara, situated on the summit of Maunga-pohatu. This monster is said to have formed the valley down which flows the Wai-kare Stream from Maunga-pohatu, the same being a tributary of the Whakatane River.

The mythical monsters termed *taniwha* seem to have been amphibious creatures of a saurian type. Most of them dwelt in lakes or deep holes in rivers and streams, but pursued their prey, the hapless Maori wight, on land. Others, like Te Kuri-nui-a-Meko, at Wai-kare Moana, lived on land, in caves or chasms.

The fairies, or forest elves, are known as *heketoro* and *turehu.* These appear to be synonymous terms, both applied to a mythical people—strange forest people who dwelt on high wooded ranges, as those at Maunga-pohatu, Mapou-riki, Tawhiu-au, &c. They were a very light-coloured people: fair skin they had, as also light, reddish hair. They were wont to be heard singing, talking, and playing on flutes during foggy weather. They were numerous on the forest peak of Turi-o-Haua. These *heketoro* were an extremely *tapu* folk, and should their sleeping-places be trespassed on by Natives, these fairies would at once desert that place and seek new homes. The Maoris say that the *turehu* were in the habit of waylaying and carrying off Native women into the forest in bygone days. A favourite resort of these *turehu* is the bush hill known as Titi-tangi-ao, situated just east of the Whakatane Butter-factory, at Te Hurepo. Indeed, they are apparently still in camp there, inasmuch as some were seen at that place in this year of Our Lord 1907 by a party of Maoris, who forthwith advertised the fact in the *Whakatane*

County Press, together with an invitation to all godless scoffers to go and see for themselves.

Another species of forest-dwelling folk were known as *nanakia*, or are so termed in folk-tales. "Our ancestors called them *nanakia* because they were such a mischievous people. They were a very strange people, who lived in trees in the forest. They built no houses, and knew not the use of clothing or fire. They were unable to kindle fire, and ate all their food in a raw state. They lived principally upon birds, the which they transfixed with their long finger-nails. Once upon a time a Maori woman was captured by these *nanakia*, and lived with them for some time before she escaped to her own people. She taught those strange folk the arts of fire-generation and cooking of food. Friend, I will tell you the story of that woman: In days of old a certain woman dwelt with her husband. One day she went into the forest to procure food. She was seized by a *nanakia*, who carried her off to his home in the woods. Her husband waited in vain for her return, but she returned not: hence he set off to search for her in the woods. He found her basket lying on the ground, and followed the tracks of his wife and her captor until he came to the home of the *nanakia*. It so happened that that creature was absent at the time, engaged in catching birds to serve as food for himself and his captive wife. The husband asked his wife when the bushman would return home. She replied, 'Not for some time yet.' Then he inquired, 'How may I conceal myself?' The woman replied, 'I will manage that.' So she dug a hole at the place where the feathers of the birds caught by the wild woodsman were thrown away when the birds were plucked. She then told her husband to lie down in the pit, whereupon she covered him with feathers. Soon after the concealment the *nanakia* returned home, showing signs of anger and suspicion (*e kune haere ana mai*), and cried out '*Kunekune he tangata kai te kainga*.' The woman remarked, 'No, there is no one here save myself.' Whereupon the *nanakia* became still more angry, while the woman strove to pacify him. At length his anger calmed down. When night came he slept. Then the woman arose and went to fetch her husband. The twain came to the place where the *nanakia* lay. The woman took her place at the feet of the creature, her husband stood by his head. Then they attacked him with axes. They cut off his head, but his arms still fought. They cut off his arms, but his legs still fought. They cut off his legs, and then it was that the *nanakia* perished. Even so that man of old recovered his wife, and the twain returned to their home. Now, while that woman was kept a captive by the *nanakia* she learned one of the songs of that strange folk, which song has been preserved by our people even unto the present day. I think you had better write that song down, that you may know what the songs of those wild folk are like."

The *patu-parehe*, or *patu-paiarehe*, were another mythical folk. They were supposed to enter houses at night and to smite the people sleeping therein nigh unto death. The Maori was apparently not aware of the evil effects of charcoal fires in carefully closed earth-covered huts.

The *tutumaiao* were weird-looking creatures seen on sandy ocean-beaches by travellers. They looked like spirits of human beings, and disappeared as the observer approached.

In Maori myths dealing with ancient times, prior to the colonising of New Zealand by the Polynesians, we often encounter the names of certain fairies, or forest folk, known as Te Tini o te Hakuturi and Te Tini o te Mahoihoi. They appeared to be guardians of the forest, and, in such legends as that of Rata, they carefully guard and uphold the rights of Tane. In several of these old legends a person goes into the forest to fell a canoe, and neglects to perform the necessary rites to take the *tapu* of Tane off the tree, or fells a tree that is the emblem of, or peculiarly sacred to, Tane. Hence, when he returns to his work in the morning he finds that the above-named forest folk have caused his tree to stand upright on its stump once more, and there he finds it growing as sturdily as of yore. The workman encounters the forest folk, and explains his dilemma, whereupon they tell him that he has neglected the necessary rites to placate Tane and take the *tapu* off the tree. After this is done the fairy folk goodnaturedly make the desired canoe themselves and hand it over to the erring woodsman.

In the story of the making of the Matatua canoe, Toroa seeks advice from Hine-tua-hoanga, who tells him to bring to her the first chips of Tane-mahuta—that is, of the tree, for it was over the first chips cut out by the axe that the *ahi purakau* rite was performed. Toroa neglects to do so, hence the fairies re-erect his tree. He returns to Hine for advice, and she sends him to one Tuhoro-punga, who says, "Take the girdle from my waist, and, when you fell your tree again, attach it to the trunk thereof." Toroa does so, and the Hakuturi folk demur not, but make his canoe for him.

"Young man," said an old Native to me, "Let me tell you something you do not know—the story about a certain tree. That tree is the *totara*. All the trees of the forest assembled once upon a time and discussed the matter as to whose legs (limbs) would reach unto their ancestor, Rangi (the sky). The *totara* persisted that his legs would reach to the sky. The *rimu* said No, his were legs that would reach. The *maire* said his;

the *rata* said his; the *tawa* and other trees said the same: each claimed that he alone might reach unto the heavens. So they all spoke. Then the *totara* strove to extend his legs to the sky, but he failed to do so, and was so ashamed that he groaned aloud (*ka hemo te tou o te totara*). There was great applause. When the wood of the *totara* is burned by fire it explodes—a popping sound is heard. That is the sound it made when it failed to reach the sky. The other trees, such as the *matai*, that failed in a like manner, make a similar sound when burned. The *totara* was so ashamed that it retired to the depths of the forest and abode there, where it may still be found, surrounded by trees of other tribes. If, when the wind is blowing hard, a person listens, he will hear a voice calling in the forest—a creaking sound it is. The person listening will think that voice is saying '*Whe! Whe! Whe! Whe!*' but it is not so. It is really saying '*Tou hemo! Tou hemo!*'"

The above is a sample of the more absurd folk-tales of the Maori people pertaining to the forest. Such fables as this are much more puerile than the primitive conception of the cosmogonic tree, or that of the descent of animals and trees, &c., from a common source.

Tree burial was practised to a considerable extent by the Maoris in former times. After exhumation the bones were deposited in hollow trees, or among the masses of *Astelia* growing on the branches.

Having no beasts of burden or draught, the Maori had but two methods of travelling—walking, and travelling by canoe. The primitive tracks which he formed through forest country generally ran along the ridges of hilly country, and sometimes along the beds of streams. Such tracks were very narrow, and were kept open by traffic and by passers-by breaking off any branch which encroached upon the trail. These tracks often bore distinctive names. In hilly country the Natives always had special spots used as resting-places, termed *taumata*. These were situated on a ridge or knoll, usually in a situation from which a good view was obtainable. In the forests of Tuhoeland one often comes upon these little clear spots—albeit but few foot-men are now seen on the trails. In some cases a track might be closed to all traffic for some time by being made *tapu* by a chief. For instance, were a chief to become aware that a chief of a neighbouring district had used some insulting expression towards him, he might *tapu* the track leading to that district, which would cause much inconvenience until it was reopened. That peculiar kind of insult known as a *tapatapa* might cause such an action.

In crossing wide rivers where no canoe was obtainable, or on which to cross goods, the *mokihi* was used. This was a bundle of dry leaves of *raupo*, or the flower-stalks of flax, lashed tightly together. A Native would bestride this primitive craft, and use a stick for a paddle. These rude floats were constructed in the form of a boy's tipcat, being brought to a point at each end.

THE UNSEEN PRESENCE IN FORESTS: PRIMITIVE MAN IN FELLOWSHIP WITH NATURE.

It is a well-known fact that the more primitive races of man are closer in touch with nature than are highly cultured peoples. In like manner they retain more primitive modes of thought and expression. The figurative and metaphorical language, the quaint old-time allegories, of such works as the Bible appeal to the Maori mind more than to ours, and they grasp and understand such language far better than do we. The tree of the forbidden fruit is no real tree to the Maori mind, and he understands full well what Eve's friend, the genial serpent, stands for. For such was the human mind among all peoples in the days when man was young upon the earth. This state of mind is a survival of a still closer fellowship with nature which must have obtained in times long past away. It is a heritage of thought from early man. Such language as we meet with only in old-time works and poetry is the common tongue of the Maori. The Maori is closely in touch with nature, a fact due to their primitive mentality; their leaning toward anthropomorphic personifications; their belief that man, animals, birds, fish, trees, &c., are all descended from a common source; as also to their mode of life—the incessant reliance on, and searching for, the products of forest and stream, wherewith to sustain life.

It is well known that the original tribes of New Zealand were living in the hunting stage of culture prior to the arrival of the historic fleet. They were a non-agricultural people, or at most possessed only one cultivated product—the gourd-plant. They had to rely on forest, stream, and ocean for their food-supply—a neolithic people with the larder of palæolithic man. Hence the forest-dwelling tribes, such as Tuhoe, must have been close observers of nature, and would be liable to place great importance upon all phases of nature, to strenuously uphold the cult of forest deities, to people that forest with divers supernatural beings and objects possessing singular affinities with its various denizens, animate and otherwise. They did more: they believed the land itself, and the forest, to be endowed with a certain personality or vital spirit, as we shall see anon.

But beyond and behind all this, there comes to those who study Maori forest lore the central idea that at some remote period, long prior to the arrival of the race in Polynesia, the ancestors of the Maori must have dwelt in a forest country. Many things tend to the formation of this belief.

As to the unseen presence in forests, the more primitive peoples seem to possess this idea, as also a few—a very few—white men who have lived much alone in the forest and are imbued with a strong love of nature, and perhaps imaginative minds. When such a man enters the portals of the woods and wanders companionless in their darkling depths, he is possessed of a curious feeling that he is not alone—that some presence, unseen of mortal eye, fills the solitudes: curious because he is tempted to wander on and explore the dusky recesses of the forest, with a feeling that there is something hidden from his ken—perhaps the woodland presence he feels may be seen ere long. The mental state of our wanderer is one of receptiveness of the effect of nature, and of expectancy. The haunting presence of the forest causes primitive man to evolve myths of fairies, wood-elves, and divers creatures of the ogre type. To cultured man, freed from the more primitive superstitious feelings, it brings a feeling of pleasure, of wondering contentment. But always the receptive mind, the love of nature, the imaginative temperament, must be there.

Then, again, there are strange sounds, of unknown origin, breaking upon the ear. Weird sounds are these, more especially as heard at night in forest-depths. But you must not erect a tent and camp therein. Your bed shall be a *take rakau*, that you may look upwards and see the great branches of the Children of Tane far above you, with maybe a glimpse of some well-known orb, Venus or Jupiter, or ruddy Antares, through leaf-bound spaces. And, at such a time, when your camp-fire has died down, and the solitude has filled your soul, you will greet the gleaming Cross, or the Kakau, or Maui's Fish, as an old and welcome friend that ties you to the world of life, where men are.

"When you hear in forest-depths sounds like rustlings—a rustling and cracking—that is what we term a *parangeki*. Those sounds are caused by human spirits, spirits of the dead. The singing of the *heketoro* (fairies) is quite a different thing."

The forest and forest life has ever had an important effect on man. A people settling in a forest country must destroy that forest or it will conquer them. The forest is conservative, repressive, making not for culture or advancement. None of the higher types of civilisation of antiquity originated in forest lands. Primitive man remains primitive in sylvan solitudes. Some day a civilised tribe, from open lands, happens along, and hews down that forest. Then the Children of Tane, human and arboreal. alike disappear, and the place knows them never again.

There is much of silence in the heart of the forest. The voices of the feathered Children of Tane are not often heard. The harsh cry of the *kaka* occasionally grates upon the ear, even in the dead of night: but for bird-life you must seek the stream-sides, the clearings and edges of the forest. Those birds that frequent the deep solitudes are, as a rule, not a noisy company. In the small clearings of the forest, probably overgrown with light second growth of *mako*, *puahou*, *wharangi*, &c., you will note, on sunny days, the hum of innumerable insects. At times you hear strange sounds that you cannot explain; at others the crash of a fallen tree or branch, more especially in wet weather, for continued rain will cause more destruction in the forest than does the wind.

Should a tree be heard to fall in the forest on a calm night, such an occurrence is termed a *takiari*. It is an evil omen. If several trees are so heard to fall on windless nights, then some serious disaster will overtake the people ere long.

There is yet another sound that you will hear by day and night, which is one as of people talking. These sounds seem exactly like the voices of persons talking at some distance. In the days of my youth, when camped alone in the bush, I sometimes went in search of those persons. I no longer do so, but they are old friends. In the early seventies an old soldier was lost in the bush between Opotiki and Poverty Bay for a week. He was at length found and brought down to a station at Waikohu. He informed me that he often heard those forest voices talking during his week's wanderings, and used to descend into the gullies to find those people. But he was lightheaded from hunger and exposure. Maybe all dwellers in forest solitudes are a bit lightheaded. *Quien sabe!*

The forest solitudes will fill some who sojourn therein with a great loneliness and misery, but to other minds may bring a great contentment and even much calm happiness.

The Sylva and Flora of Tuhoeland.

We will now give a list, albeit an incomplete one, of those of the Children of Tane-mahuta that are found in the Tuhoe district—or, rather, such of them as we know the Native names of. For there are many plants the Maori names of which have not been obtained, as also some of which the botanical names are not yet to hand.

Aka. A generic name for climbing-plants and long, thin roots.
Aka-kopu-kereru. *Clematis*, sp.
Aka-tea. *Metrosideros albiflora.*

Aka-kura.
Aka-poananga. *Clematis*, sp. (? *C. indivisa.*)
Aka-ngakau-kiore. *Clematis parviflora.*
Aka-kahia. ? *Passiflora tetrandra.*
Aka-kiore.
Ake. *Dodonæa viscosa.*
Akeake.
Akiraho. A small tree.
Angiangi. A moss.
Awanga. A variety of *Phormium tenax.*
Aoanga. A variety of *Phormium tenax.*
Hakeka; syn., keka, hakeke. *Hirneola polytricha.*
Hangaroa. A plant.
Hangehange. *Geniostoma ligustrifolium.*
Harakeke. *Phormium tenax.*
Harore. A generic term for fungi.
Hawai. A variety of harore.
Heketara; syn., kotara and taraheke.
Heruheru. *Todea hymenophylloides* and *T. superba.*
Hinau. *Elæocarpus dentatus.*
Hinau-puka. *Elæocarpus Hookerianus.*
Hohoeka; syn., horoeka, kokoeka. See "Horoeka."
Homangoroe. *Panax Edgerleyi* (mature form).
Horoeka. *Pseudopanax crassifolium.*
Horopito.
Houhi. *Hoheria populnea.*
Houhi-ongaonga.
Houhou; syn., puahou, parapara. *Panax arboreum.*
Huariki.
Hue-o-Raukatauri. *Ourisia macrophylla.*
Huhi. A variety of *Phormium tenax.*
Ikaroa. A variety of gourd (hue).
Ipurangi. A variety of harore.
Irirangi. *Hymenophyllum demissum.*
Iwi-tuna. *Lycopodium Billardieri.*
Kahakaha. *Astelia* (? *nervosa*).
Kahia. *Passiflora tetrandra.*
Kahikatea. *Podocarpus dacrydioides.*
Kahikawaka. *Libocedrus Doniana.*
Kai. Young tree of *Podocarpus spicatus.*
Kaikomako. *Pennantia corymbosa.*
Kai-weta. *Carpodetus serratus.*
Kaiwhiria. *Hedycarya arborea.*
Kakareao. *Rhipogonum scandens.*
Kaponga. *Cyathea dealbata*, &c.
Karaka. *Corynocarpus lævigatus.*
Karamuramu. *Coprosma robusta.*
Karetu. *Hierochloe redolens.*
Kareturetu. A grass.
Kauere. *Vitex lucens.*
Kawakawa. *Piper excelsum.*
Keka; syn., hakeka, hakeke. *Hirneola polytricha.*
Keketuwai. A water-plant.
Kiekie. *Freycinetia Banksii.*
Kiokio. *Lomaria procera.*
Kiwikiwi. *Lomaria fluviatilis.*
Koareare. *Panax Edgerleyi* (young state).

Kohe. *Dysoxylum spectabile.*
Kohukohu. *Hypnum clandestinum.*
Kohuwai. A water-plant.
Kokaha. *Astelia*, sp.
Kokakoware. A variety of gourd.
Kokoeka; syn., horoeka and hohoeka.
Kokomuka. *Veronica*, various sp.
Kokomuka-taranga. *Veronica*, sp.
Kokomuka-tu-tara-whare. *Veronica*, sp.
Kopakopa. *Trichomanes reniforme.*
Kopakopa. *Plantago major.*
Kopukupuku. *Ranunculus hirtus.*
Kopuru. A moss.
Korokoro-whetu.
Koromiko. *Veronica salicifolia.* Also a generic term for *Veronica.*
Korukoru. A species of *Loranthus.*
Kotara. A tree; probably an *Olearia.*
Kotukutuku. *Fuchsia excorticata.*
Kowhai. *Sophora tetraptera.*
Kowhai. *Geum urbanum.*
Kowharawhara. *Astelia*, sp.
Kukuraho.
Kumarahou. *Angelica rosæfolia.*
Kutakuta. *Eleocharis sphacelata.*
Kuwawa. *Eleocharis sphacelata.*
Mahitihiti. A plant.
Mahoe. *Melicytus ramiflorus.*
Maiheru. A species of harore.
Maikaika. *Microtis porrifolia.*
Maire. *Olea*, sp.
Makaka; syn., raranhe.
Mako. *Aristotelia racemosa.*
Mamaku. *Cyathea medullaris.*
Maanga-a-huripapa. *Libertia ixioides.*
Manehau. A species of harore.
Mangeao. *Litsæa calicaris.*
Manono; syn., raurekau. *Coprosma grandifolia.*
Manoao. *Dacrydium Colensoi.*
Manuka. *Leptospermum scoparium* and *L. ericoides.*
Manuka-roa. A variety of hue (gourd-plant).
Mapau. *Myrsine Urvillei.*
Mapere.
Maru.
Maruru. *Ranunculus hirtus.*
Matai. *Podocarpus spicatus.*
Matata. *Pteris incisa.*
Matau. *Uncinia ferruginea.*
Matau-ririki. *Uncinia leptostachya.*
Matia. The common blue pansy (introduced).
Matoetoe. A plant.
Matukutuku. A plant.
Matua-mauku. *Hymenophyllum dilatatum.*
Mauku. *Asplenium bulbiferum.*
Maukuuku; syn., perei. *Gastrodia Cunninghamii.*
Maurea. A coarse tussock-grass.
Mauri. *Astelia*, sp.
Mawhai.

Mawe. *Galium umbrosum.*
Mekemeke. A species of harore.
Ngaio. *Myoporum lætum.*
Ngaio. A variety of *Phormium tenax.*
Ngakau-kiore. See "Ake."
Namunamu. *Geranium molle.*
Neinei. *Dracophyllum latifolium.*
Nikau. *Rhopalostylis sapida.*
Niniao. *Helichrysum glomeratum.*
Ngohungohu. *Cyathodes acerosa.*
Ngohungohu. *Leucopogon fasciculatus.*
Ngutu-kaka. An epiphyte.
Ngutu-nui. A variety of *Phormium tenax.*
Ongaonga. *Urtica ferox.*
Oue. A variety of *Phormium tenax.*
Paea. An introduced plant, perhaps *Brassica oleracea.*
Paewhenua. The common dock (introduced).
Pahau-kakapo. *Dawsonia superba.*
Pakau-roharoha. *Polypodium pennigerum.*
Panakenake. *Pratia angulata.*
Panako ; syn., petako. *Lomaria Patersonii.*
Paopao. *Eleocharis sphacelata.*
Paopao-kutukutu. A plant.
Papa-hueke. A liverwort, a species of *Marchantia.*
Papa-koura. *Epilobium microphyllum.*
Papauma. *Griselinia littoralis.*
Paraharaha. *Polypodium Billardieri.*
Parani. *Lagenophora petiolata.*
Parapara ; syn., puahou, houhou. *Panax arboreum.*
Pari-taniwha. A variety of *Phormium tenax.*
Patate. *Schefflera digitata.*
Pa-totara. *Leucopogon Fraseri.*
Patu-tiketike. *Coprosma lucida.*
Peka-a-waka. *Earina mucronata.*
Pepepe. *Dianella intermedia.*
Perei. *Gastrodia Cunninghamii.*
Peretako. *Lomaria Patersonii.*
Peretao. *Lomaria Patersonii.*
Petako. *Lomaria Patersonii.*
Petako-rau-riki. A fern.
Petako-paraharaha. A fern.
Petipeti. *Lomaria discolor.*
Piki-arero. *Clematis indivisa.*
Pinakitere. *Pratia angulata.*
Pipiko. *Aspidium Richardi.*
Pipiro. *Coprosma fœtidissima.*
Piripiri. *Hymenophyllum demissum.*
Piripiri. *Acæna sanguisorbæ.*
Pirita ; syn., kakareao. *Rhipogonum scandens.*
Poananga. Flowers of piki-arero.
Poa-taniwha. *Melicope simplex.*
Pohue. *Convolvulus,* sp., white- and pink-flowered.
Poniu. Some edible introduced plant.
Poporo. *Solanum aviculare.*
Porerarua. A plant.
Pororua. A plant.
Puahou. *Panax arboreum.*

Puakaito. *Celmisia spectabilis.*
Puapua-a-autahi ; syn., mekemeke. A species of harore.
Puha (puwha). A generic term for many plants used for food, as greens.
Puha-tiotio. A plant.
Puhou ; syn., tutu. *Coriaria ruscifolia.*
Puka. *Griselinia lucida.*
Pukatea. *Gnaphalium luteo-album.*
Pukatea. *Laurelia novæ-zealandiæ.*
Pungitangita. Scotch thistle (introduced).
Punui. *Dicksonia fibrosa.*
Punui. *Todea superba.*
Puriri ; syn., kauere. *Vitex lucens.*
Puwatawata. *Enargea marginata.*
Ramarama. Erroneously applied to *Olearia.* sp.
Raorao. A plant.
Rarauhe. *Pteris aquilina.*
Rata. *Metrosideros robusta.*
Rataroa. A variety of *Phormium tenax.*
Raukatauri. *Asplenium flaccidum.*
Raumoa. A plant.
Raupeka. *Earina suaveolens.*
Raupeti. A *Solanum.*
Raupo. *Typha angustifolia.*
Raurekau. *Coprosma grandifolia.*
Rauriki. A plant.
Rauroroa. A plant.
Rau-tawhiri. *Pittosporum tenuifolium.*
Rearea. Introduced. ? *Brassica oleracea.*
Rengarenga. A plant.
Repehinapapa. *Arthropodium candidum.*
Rereti. *Lomaria lanceolata.*
Rerewai. *Potamogeton Cheesemanii.*
Rewarewa. *Knightia excelsa.* Flowers termed "rewa."
Rimu. *Dacrydium cupressinum.*
Rimurimu. A generic term for mosses.
Rohutu.
Ruatapu. A variety of *Phormium tenax.*
Taihinu ; syn., tauhinu. *Cassinia fulvida.*
Takahakaha.
Takahikahi ; syn., taranui. ? A sedge or coarse grass.
Tamatea.
Taneawai. A variety of *Phormium tenax.*
Tanekaha. *Phyllocladus trichomanoides.*
Tanguru. *Olearia furfuracea.*
Tanguru-rake.
Tapairu. *Senecio Kirkii.*
Tapia. *Tupeia antarctica.*
Taramea ; syn., takahikahi. *Aciphylla Colensoi* (spear-grass).
Taraheke ; syn., heketara and kotara.
Tarata. *Pittosporum eugenioides.*
Tarewarewa. A plant, either a parasite or epiphyte.
Taro-para. Probably *Marattia fraxinea.*
Tataramoa. A generic term for brambles and thorny shrubs. The introduced sweetbriar is so named. Also *Rubus australis.*
Tataramoa-turuhunga. *Rubus australis.*
Tauira-kohe. A shrub.

Tawa. *Beilschmiedia tawa.*
Tawai. *Fagus*, sp.
Tawaka. A species of *Agaricus.*
Tawari. *Ixerba brexioides.* Flowers termed "whakou."
Tawhewheo. *Quintinia serrata.*
Tawhero. *Weinmannia racemosa.*
Tawiniwini. *Gaultheria antipoda.*
Tawhiwhi.
Teterewhete. A species of moss, genus *Polytrichum.*
Ti. A generic term for *Cordyline*, and applied specially to *Cordyline australis.*
Ti-kapu. *Cordyline Banksii.*
Ti-para. ? *Cordyline terminalis.*
Ti-tawhiti. *Cordyline*, sp.
Ti-toi, or Toi. *Cordyline indivisa.*
Ti-kumu.
Tikitehetehe. A species of harore.
Tipitaha. A species of harore.
Tirawa; syn., wheki. *Dicksonia squarrosa.*
Titoki. *Alectryon excelsum.*
Toatoa; syn., tanekaha.
Toetoe. A generic term for many sedges, &c.
Toi. *Cordyline indivisa.*
Toi. A species of fungus (a Taupo word).
Toheraoa. A plant.
Tohetaka. The introduced dandelion.
Toro. *Persoonia toru.*
Toromiro. *Podocarpus ferrugineus.*
Torakenake. A variety of pohue (*Convolvulus*).
Toropapa. *Alseuosmia quercifolia.*
Toropapa-pukahu. A moss.
Totara. *Podocarpus totara.*
Tota-rimu. A small plant.
Totoroene. *Parsonsia capsularis*, and *P. rosea.*
Tu-huhi. *Eugenia maire* (an unsatisfactory name).
Tumatakuru. *Aciphylla squarrosa.*
Tumingi.
Tuokura. *Dicksonia lanata.*
Tururu-mauku. Young plants of *Asplenium bulbiferum.*
Tutae-manu. A variety of *Phormium tenax.*
Tutoke. *Aspidium Richardi.*
Tutukiwi. *Pterostylis Banksii.*
Tutumako.
Tututupo. A fungus, genus *Clavaria.*
Upoko-tangata.
Upoko-taupo. A variety of hue (gourd).
Waeakura. *Gleichenia Cunninghamii.*
Wae-kahu. *Lycopodium*, sp.
Waewae-atua. A species of harore.
Wairua. *Fumaria hygrometrica.*
Wairuru. A species of harore.
Waiu-atua; syn., waiu-o-kahukura.
Whakahau-matua. A variety of hue (gourd-plant).
Waoriki. *Ranunculus rivularis.*
Wharangi. *Melicope ternata.*
Wharariki. A variety of *Phormium tenax.*
Whare-hinu. A variety of hue (gourd-plant).

Whare-kaka.
Wheki. *Dicksonia squarrosa.*
Wheki. A plant.
Whereki. The large introduced strawberry.
Wi. A generic term for several coarse grasses, &c.
Whiri-o-raukatauri. *Lycopodium Billardieri.*
Whiri-o-raukatauri. *Asplenium flaccidum.*
Wiwi. Several species of rushes (*Juncus*).

The above are the items of the sylva and flora of the Tuhoe district of which the Native names have been obtained. There are many others, principally small plants, &c., which we do not here enumerate, as this paper is one dealing with Maori lore, not with that of the scientific botanist.

"The *aka* (climbing-plants) which cling to trees—these are the things with which Tangaroa is captured. Hence they are used as a means to slay Tangaroa." So sayeth the Maori, meaning that eel-pots are constructed of stems of climbing-plants, and of thin roots.

The *aka kopu kereru* is the small green-flowered *Clematis.*

The *aka-tea* has a very light-coloured bark, and is extremely durable, hence it is much used for lashing palisades, fences, &c.

The *poananga* makes a brave show in some parts of the Rua-tahuna district when in flower. The masses of white blossoms are seen on the tops of lofty trees, though more numerous among second-growth timber at deserted cultivations.

The *ngakau kiore* is more generally found in scrub and fern country, where its small yellowish-green flowers are not very conspicuous.

The sap of the *aka-kura* is applied by the Natives to the eyes in cases of inflammation.

The *kahia*, with its orange-coloured fruit and handsome foliage, is here frequently seen. The stem of this climber was formerly much used as a firestick by travelling parties. It was cut green and allowed to become quite dry. One end being set fire to, it was carried in the hand, and would smoulder like punk.

The *ake* is not often seen in Tuhoeland. The most reliable war weapons were fashioned from this timber. A grove of *ake* trees near Te Onepu, on the Whirinaki River, is known as Te Hokowhitu a Ngai-Tawha.

The *awanga*, or *aoanga*, is a variegated variety of *Phormium tenax.*

The *hakeka*, *hakeke*, or *keka* is the fungus of commerce. It grows principally upon dead logs and stumps of *karaka*, *pukatea*, *tawa*, *mahoe*, and *kaiwhiria*, and not upon the living trees. It appears to reach a matured state about two years after the trees have been felled. After that time the quantity on such timber seems to decrease.

The *hangaroa* appears to be a grass, the culms of which were used in making belts or girdles for women, as also anklets, pieces of flax-fibre being drawn through the hollow stems in order to strengthen them. The fruit of the *papa-koura* is also known as *hangaroa*. Children string these berries on pieces of fibre in order to form necklaces and bracelets, as they also use the berries of the sweetbriar.

The sap of the *hangehange* bark is used as a cure for a skin complaint known as *hawaniwani*.

Harakeke is the generic term for *Phormium tenax*, each variety having its distinctive name.

Harore is a generic term for many species of fungus, &c., each having its own distinctive name. The *tipitaha* appears to be the mushroom, while the *maiheru*, which grows on open country, is probably the same as the *tiki tahora*. The *puapua-a-autahi*, one of the edible species, is somewhat poisonous, and has to be cooked for a long time in a steam-oven in order to render it innocuous.

Leaves of the *heketara* were used in former times wherewith to give an agreeable scent to oil (a toilet article). The crushed leaves, together with the *kopuru* moss, also seem to have been employed without any agent, to impart a pleasing odour to clothing. If the *heketara* is seen to blossom abundantly it is said to be a token of a fine summer to follow.

The hard frond-stems of the *heruheru* fern are said to have been utilised as teeth for hair-combs in past times. *Todea superba* is also known as *heruheru*.

The bark of the *hinau* and *hinau-puka* were used in dyeing fibre black for being woven into garments. The meal of the berries of the *hinau* was an important item of the Tuhoean food-supply in former items. These berries have a sort of emblematical name—viz., the *Whatu o Pontini*—perhaps only used in song and aphorism. A gum which exudes from the *hinau* tree is dissolved in the liquid used for preparing the black pigment for tattooing purposes. It is said to prevent the tattoo-marks from fading. A *hinau* tree from which the gum exudes without the tree being cut or wounded is said to provide the best bark for dyeing purposes. This bark produces the mordant for dyeing, the fibre being afterwards immersed in a black mud.

The leaves of the *horopito* were used by women when weaning a child, crushed leaves of the same, or of the *kiwakiwa* fern (syn., *kiwikiwi*), being rubbed on the breasts in order to give them a bitter taste. The berries of the *horopito* are termed *matou* by the Arawa Tribe. The sap is used to cure skin-diseases.

The *houhi*, known in some districts as *houi*, *houhere*, and *whauwhi*, is a very common tree in Tuhoeland. That variety bearing a white flower is a charming sight during a season when such blossoms are abundant. The deciduous variety is much the larger specimen of these "ribbonwoods," as they are often termed by settlers (being also known popularly as "lacebark" and "thousand-jacket"). This tree may be seen nearly 2 ft. in diameter and sometimes as much as 50 ft. in height. It has a very insignificant. non-conspicuous flower. The Tuhoe Natives call it *houhi-ongaonga*, because they have a belief that it is a mature form of the *ongaonga* (*Urtica ferox*), saying that the latter eventually develops a single stem which grows into the large deciduous *houhi*—a very singular theory. This tree is certainly deciduous in the Tuhoe district, not partially so. The bark of this tree is extremely thick. Its leaves are eaten by the pigeon. The inner part of the bark was sometimes eaten by refugees or others in an extreme stage of hunger. This tree is probably *Plagianthus betulinus*, though Cheeseman's Manual does not mention its deciduous habit, but it speaks of *Gaya Lyalli* as being partially so. Mr. Rutland speaks of *Plagianthus betulinus* and *P. divaricatus* as being evergreen or deciduous according to the lsituation in which they grow. (See Trans. N.Z. Inst., vol. xxi, p. 110.) These deciduous trees are seen growing by the sides of streams, or a little wayup hillsides, in Tuhoeland, to an altitude of at least 2,000 ft.

The *puahou* or *houhou* tree, known also as *parapara*, is very common in this district. It grows readily in places where the forest has been destroyed. Places thickly overgrown with this tree are often alluded to as *tau-parapara*. The old Maori name of the site of the Hawera Township, in Taranaki, was Tau-patate, the latter word (*patate*) being the native name of *Schefflera digitata*. The bark of the *puahou* is nibbled off and eaten by horses, and they seem to be remarkably fond of it. It may possibly possess some saline property. The *kaka* parrot also nibbles off this bark, but finally rejects it, having apparently derived some benefit therefrom. Rats eat off the bark of the small trees, and also the stems of the leaves. The term *tahumate* seems to be applied to the first *puahou* that blossoms during a season. There is some singular myth about this tree being the offspring of Rehua, the latter being the name of the star Antares, as also of one of the old-time Maori gods, though possibly the star is the visible form of the god.

Rehua = Puanga.

Poanana. Tahumate. Puahou.

My informant says, "These were the first-born children of Rehua. Their mother was Puanga (the star Rigel in Orion). These children were born in the moon (month) *Mahuru*, the fourth month of the Maori year. Observe that the *puahou* blossoms in winter. It was Ruaumoko that caused them to be born when the earth was shaken. After those children were born, then the many others were born. Puahou was born in August, according to your European method of month-names. The duty of those first-born of Rehua is to indicate the approach of the warmth of summer. Puahou was the most important of the children of Rehua. Those children are suckling during the month indicated." The explanation of the above quaint myth is in this wise: Rehua is spoken of in Maori myth as being the origin of the *koko* bird (syn., *tui*), the *inanga* (a small fish), and the trio above given. Poanana seems to be for *poananga*, the large-flowered white *Clematis*. These three first-born of Rehua and Puanga (Antares and Rigel) show by means of their blossoming the coming of the warmth of spring. Ruaumoko, the slumbering subterranean monster of Maori myth, is said to cause the changes of season by turning over and causing an earthquake, which has the effect of turning the warmth, or cold, of mother earth uppermost, according to the time of year. This act, in producing warmth towards the close of winter, causes trees to blossom, and the above are among the first to do so, and hence are spoken of as the first-born. After these, then other children are born—that is to say, other trees blossom.

The *komangoroa* tree is the matured or tree form of the *koareare* shrub, according to the Tuhoe Natives. The former name is applied to it after the form of its leaves is changed. They have certainly pointed out to me some which were in a sort of transition stage, bearing both forms of leaves, the handsome star-shaped leaf of the *koareare* (*Panax Edgerleyi*) and the plain, dark, glossy leaf of the *komangoroa*. But Williams's Dictionary gives *kaumangoroa* as *Panax simplex*. However, judging by the descriptions given in Cheeseman's "New Zealand Flora," both the Tuhoean names apply to *P. Edgerleyi*.

The *kahikatea* was a most useful tree to the Maori in former times, on account of the great quantity of bird-food furnished by its berries. This fruit also served as an article of food to bushmen. Persons ascended the trees and collected the berries of the *kahikatea*, *rimu*, and *matai*, which were placed in a basket. When full, the basket was lowered to the ground by means of a cord, there emptied by an assistant, and drawn up again to be refilled. These berries were washed in order to get rid of any leaves, &c., and eaten without being cooked in any way.

When a *kahikatea* tree decayed, the *mapara*, or hard resinous heart-wood, was eagerly sought for, and was used for several purposes. Implements and weapons were fashioned therefrom, the wood being exceedingly hard, durable, and difficult to break, hence it carried a fine point. The smaller pieces of *mapara* were used for making torches for night fishing and travelling, a number of such pieces being tied together for this purpose. Also, the finest pigment for tattooing was made from the soot obtained from this wood when burned in a confined space. Thus this child of Tane and Hine-wao-riki was highly esteemed by the neolithic Maori. The white sap-wood of the tree was not prized, on account of it lacking durability. Canoes were occasionally made of *kahikatea*, but were much inferior to those made of *totara*.

The *kai*,* or young tree of *Podocarpus spicatus*, is useful to the Maori on account of its thin, pliable, and tough branches, which are used for making eel-pots. I have seen a Native driven off with much tongue-lashing for taking these *kai* branchlets from the lands of another tribe than his own.

The *kaikomako* tree is met with in Maori myth, for this was the principal tree into which fire, or the seeds of fire, fled when the memorable contest raged between Maui, the demi-god, and Mahuika, the goddess of fire. Hence it is the best wood from which to fashion *kauahi*, or fire-sticks, by which to obtain fire by friction. This tree is personified in one Hine-kaikomako. She is the fire-concealer and fire-conserver of mythology. She was taken to wife by Ira, the fire-seeker. I once related this myth to a little Maori girl, stating that Hine is seen now merely in the form of a tree, not endowed with the powers of speech and locomotion. The child remarked, "*Kua whakaaroha ahau ki a Hine-kaikomako*" (I deeply sympathize with Hine-kaikomako). The child mind grasped and accepted the myth.

The *kaponga* is *Cyathea dealbata*, but the word is sometimes used in a generic sense to include several or all species of arborescent ferns. The name *ponga* is not used by the Tuhoe Natives. The *kaponga* is found in all parts of the Tuhoe district. The hard, black fibres found in the soft interior of the stem are termed *katote*. The *mamaku* is not found at Rua-tahuna and other inland places, but is seen in great numbers near the coast, at Rua-toki, Te Wai-mana, and elsewhere. In fact, one often sees dense groves of very fine specimens on the hillsides or in gullies. The soft interior of the upper part of the trunk of this species (*Cyathea medullaris*) was largely used in former days as an article of food, more especially before the introduction

* Also termed *kakai*.

of the sweet potato. It was cooked in a steam-oven for about forty-eight hours, the hard outside part of the trunk having first been hewn off. This and other species of fern-trees are remarkable for the great variety of the epiphytes which they bear, ranging from the most minute plants (ferns, mosses, &c.) to forest-trees such as the *puahou* and *tawhero*. The two latter are very frequently met with under such conditions, sending roots down the stem of the fern-tree to the ground. Some specimens of *wheki* and *kaponga* seem to have their stems enclosed within a network of such roots. The harder stems of the *mamaku* support a large number of smaller epiphytes, as ferns and *Astelia*. Many of the *puahou* (*Panax arboreum*) so growing are very handsome specimens of their kind, but yield in picturesqueness to a very fine specimen growing on the top of the dead stump of a forest-tree, some 20 ft. in height, and which stands in open ground at Mingi-nui.

The *wheki* (*Dicksonia squarrosa*) is very common in some parts, and is much used in the construction of rude huts by the Natives. In this species one often sees the young plants of the same growing on the stems of the mature specimens, though they do not seem to attain any size under such conditions, or to develop into branches. Trunks of the *wheki* cut and laid on the surface of the ground often put forth new fronds and flourish for some time. This species is termed *ti-rawa* by the Ngati-Awa Tribe, and a hut the walls of which are formed by such trunks is known as a *whare tirawa*. It is much used in the construction of cooking-sheds. The *tuokura* (*Dicksonia lanata*) is found on the high ranges.

The *punui* (*Dicksonia fibrosa*) is very common in the high-lying districts of Tuhoeland. With its thick stem and short rigid fronds it cannot be termed a handsome species. Some of the trunks are of great size. The Natives hew off wide slabs of the fibrous matter and utilise them in the building of food-stores. This material is durable, and is a bar to rats, which do not seem able to gnaw through it.

The *karaka* tree concerns us little, as it never obtained in Tuhoeland, except a few planted in former times on the northern frontier, as at Rua-toki. Natives say that seeds of the *karaka* were brought to the Bay of Plenty district in the "Nukutere" canoe.

The *karamuramu* is remarkable for having entered largely into the sacerdotal rites of the Maori in former days, a wand of this small tree being used by priests in various ways, and rude girdles or aprons made of its leafy branchlets worn by them when the sacredness of their duties prevented them retaining any of their clothing.

The *karetu*, a grass having a sweet scent, more particularly when dry, was much used by girls to make waist-belts with, as many as twenty plaited strands being used to form a belt. The midrib (*tuaka*) was taken out of each leaf before being used, in order to make the leaf more pliable and prevent a breakage.

The *kareturetu* is a grass the botanical name of which I have not obtained.

The *kauere*, or *puriri* tree, is not found in the interior, but only near the coast.

The *kawakawa* is not found at the higher altitudes, but is fairly common nearer the coast, as in the lower part of the Whakatane Valley. The same may be said of the *pukatea*, *nikau*, *kiekie*, *kohe*, *mangeao*, and divers plants.

The *kiekie* was a useful plant to the Tuhoean bushmen, inasmuch as their forest lands did not produce flax (*Phormium tenax*). Belts, sleeping-mats, and rough capes were made from its leaves, which contain a durable fibre. These capes were made from the fibre after the leaves had been subjected to a retting process. Mats and belts were made of narrow strips of the leaves bleached to a pleasing whiteness. The *kiekie* is not found at Rua-tahuna, but only in the lower parts of the valleys, nearer the coast. There is said to be one only plant of *kiekie* at Maunga-pohatu, which is known as Te Kiekie a Rangi-wai-tatao, the same Rangi having brought the plant from the coast lands. That plant is but seldom seen by man, and only by those whose days in the land are numbered. Should you chance to see it, then it is high time to hurry home and put your earthly affairs in order. Tarry not on your way, the gods are calling you. But should your end not be near, then you will not see that ill-omened plant, pass you never so close to it.

The *harakeke* (*Phormium tenax*) and the *kiekie* (*Freycinetia Banksii*) became separated in the dawn of time, according to Maori myth. The *kiekie* followed and clung to its ancestor Tane, hence you see it clinging to the forest-trees. But the *harakeke* went to its ancestor Wai-nui (origin and personification of water), and even so you now see it growing in swamps and by streams. The *raupo* also went to its grandmother Wai-nui, to be nurtured by her. The fruit and sweet flower-bracts of the *kiekie* are eaten by Natives.

The *kiokio* fern, like the poor, is ever with us, being very common. Cliffs and steep sidelings bearing no large trees are almost invariably covered with a dense growth of this *kiokio*, or *Lomaria procera*, as you *pakeha* folk term it. Hence the expression *pari kiokio* (*kiokio* cliff or bluff) is a common one. This fern is said to have originated with one Pari-kiokio, who was born of the Wai-nui above mentioned. Another of Wai-nui's offspring was Te Hinatore, a term applied to any phosphorescent substance.

The *koareare* flourishes on the high-lying ranges, and has a remarkably handsome appearance, the leaves thereof being very attractive to the eye, as also very aromatic. These leaves were used as a scent in former times, and chaplets were made of the green leaves, by the maids of Tuhoe. The mature form of this tree is known as *homangoroa*.

The *kohe* tree, termed *kohekohe* in some districts, is found only in the lower country, near the coast. Its berries are eaten by the *koko* bird; hence the expression, "*He koko kai kohe.*" The *kohe* is very easy chopping, and cuts well with a crosscut saw, but it takes the conceit out of your steam-gauge when you put a circular saw into a *kohe* log.

The *kareturetu* is a bush-growing plant, resembling the *karetu* in appearance.

The *kokaha* is an *Astelia*. The name is applied by the Tuhoe Natives to the short-leaved terrestrial variety found growing in forests, but not to the narrow-leaved *mauri*, which grows on logs and the lower part of tree-trunks, nor yet to the *kowharawhara*, which grows also on trees, but usually on the branches and upper parts of the trunk. One authority states that the *kokaha* is known as *takahakaha* when in flower, or perhaps the latter term is applied to the flower. The *tuaka* or midrib of the leaf of the *kokaha* is used in hat-making, while its red-juiced berries were formerly sought for by girls and women as a face-paint, the cheeks being coloured therewith. The fruit of the *kowharawhara* is eaten. Leaves of *Astelia* are used to wrap round eels when cooked by the *kopekope* process. The *kokaha* is probably *Astelia trinervia*. Another species, found growing in swamps, is probably *A. nervosa*.

The *koromiko* or *kokomuka* is plentiful throughout the district, by streams, in old clearings, or wherever it can get a chance to grow. The species termed *kokomuka-taranga* is but seldom seen in groves here. The *kokomuka-tu-tara-whare* is also presumably a *Veronica*, and derives its Native name from the fact that it often is seen growing on or against the earth-covered sleeping-huts of the Natives. Hence the name of this species has been adopted as a title for "stick-at-home" persons, and is crystallized in a favourite proverbial saying, "*Na wai te kokomuka tu-tara-whare i kiia kia haere?*" (Who said that the "house-wall-standing" veronica should travel?) This saying is said to have originated with one Rua-te-pupuke, an ancestor of very remote times. Some other ancient asked Rua to go afishing, when he made the above remark, meaning that he was too old for exertion, and had grown to the house-wall like the *kokomuka*.

Another form of the above saying is, "*E kore au e haere, he kokomuka tu tara whare.*" "*He koromiko te rakau i tunua ai te moa*" (The *koromiko* is the wood with which the *moa* was cooked) is another saying applied to this tree. A tribe of the original Polynesian people of the Bay of Plenty district was named Te Tini o te Kokomuka-tu-tara-whare.

The fragrant moss called *kopuru* was used as a scent in former times by the belles and beaux of the Children of the Mist. The *kopuru* is sometimes a *tohu mate*, or token of coming misfortune. If a number of persons are near it and its fragrance is detected by only one of such persons, then some trouble will soon follow. Probably a person of importance will die ere long.

The red-flowered *Loranthus* known as *pirinoa* is termed *korukoru* when in flower, or the flower is so styled. It grows as a parasite on the *tawai* trees around Wai-kare Moana. Mr. Field gives *rorerore* as the Native name of a red-flowering *Loranthus* in the Taupo district, while Mr. J. B. Lee obtained the Native name of *amaru* for a similar plant.

The *kotara* is a tree only found on the high range at Maungapohatu in this district. It has a serrated leaf, hence its Native name. In former times its fragrant leaves were employed by Natives as an agent wherewith to import a desired scent to toilet-oils, neck-sachets, &c., hence young specimens were sometimes transplanted into the village cultivation-grounds.

The *kotukutuku*, or *Fuchsia*, is a very common tree on the high-lying lands of the Tuhoe district, but not so very numerous in the lower parts of the main valleys. This tree was of no great economic value to the Natives. The fruit is eaten by children, and also furnishes a food for birds. The edible berries of this tree are called *hona* by the Tuhoe Natives. The flowers are termed *takawa*. The *kotukutuku* and *houhi-ongaonga* (or *houhi puruhi*) are the principal deciduous trees of Tuhoeland. The *ongaonga* (*Urtica ferox*) and *tapia* (*Tupeia antarctica*) are also here deciduous, and the *kowhai* is often very nearly so, retaining scarcely any leaves in winter.

The *kowhai* does not obtain to any great extent in the Tuhoe district. The bark is used by the Natives in the form of an infusion as a medicine for internal pains. The flowering of this tree is said to mark the last frost of the season, which is known as the *kowhai* frost. In some parts the *kowhai* flood or rains is also upheld as inevitable. The plant *Geum urbanum* is also termed *kowhai*.

The *kukuraho* is a swamp-plant having hard black knobs on its roots, which are known as the *raho* of Tuna.* This Tuna is

* These roots were eaten formerly, the outside part peeled off first.

an *alias* of Puhi, the eel-god of Maori myth. It has been borne in upon me that this same Puhi was originally a snake-god in some distant land, at an early period in Maori history—say, about the time when Tangaroa was a land deity, as I am informed he used to be.

The *kutakuta*, said to be also known as *paopao* and *kuwawa*, was formerly used in the manufacture of aprons and mourning-fillets, as we have recorded elsewhere.

The small tuberous roots of the *maikaika* are eaten by Native children, either raw or roasted.

Both white and black *maire* are found in the Rua-tahuna district. The black or narrow-leaved *maire* is sometimes seen of a great size. This wood was used in former days for the manufacture of implements, such as *ko* (a planting-spade or dibble) and spades (*rapa maire*); also certain weapons, as the *wahaika*, which was fashioned from the roots of the tree.

The *maire*, sayeth the Tuhoean bushman, is one of the trees of which we recognise the two sexes. The female tree is termed *maire-rau-riki*, and the male is *maire-rau-nui*. The *maire* tree is the offspring of Te Pu-whakahara and Hine-pipi. The former was a son of Tane, and appears to be a star-name, or connected in some way with a star. An old saying applied to the hard-wooded maire is, "*E kore e ngawhere, he maire tu wao, ma te toki e tua*"; meaning, "It will not break (or work) easily, it is a forest-standing *maire*, the axe alone can fell it." This saying is also applied to persons. This timber is a favourite fuel for use in meeting-houses, as it gives out but little smoke and a good light; but if seeds are kept in a house in which *maire* is used as fuel, then such seeds will not germinate when planted. In former times, when forest-birds were numerous, the *kereru* (pigeon) and the *koko* (or *tui*) were wont to frequent in great numbers the *maire-rau-nui* trees to feed on the berries thereof, when great numbers would be snared, although they did not fatten on that diet. The *koko* also feeds on the berries of the other *maire* (*maire roro*), but the *kereru* never does so.

The *mahitihiti* (*mahiti* = to spring, leap) is so named because its seeds are distributed in the same manner as are those of furze (whin).

The *manono* or *raurekau* tree is common on the high-lying lands of Rua-tahuna. Its range is apparently about equal to that of the *papauma*, possibly somewhat more extended. The *manono* tree, or *Coprosma grandifolia*, is also known as *raurekau*, but I am informed that the latter name really applies to the leaves only, while the trunk, or tree, is *manono*, and the fruit is termed *kueo*. The *koko* bird feeds upon the berries, while the leaf is used by fowlers as a *pepe* or call leaf, with which they imitate the cry of that bird, and so attract it to snare or *pae* (perch). In the summer-time a filmy white substance is seen on the leaves of this tree, which may be detached. It was formerly used by women as an ornament, manufactured into a kind of apron, and seemingly also as a *pohoi*, a bunch of the material being suspended from the ear. This thin white film is termed *kahu raurekau*. A yellow dye was sometimes prepared from the scraped or pulverised bark of the *manono* by means of the stoneboiling process. The fibre to be dyed was then boiled in the liquid. This dye, however, was but little used. The crushed bark is also applied to wounds, cuts, or bruises by the Natives. The inner bark was squeezed or pressed in order to express the sap, which was used in cases of skin-disease. The bark has a bitter, pungent taste. It is inadvisable to handle this wood without cleansing the hands afterwards. Mr. Strauchon informs me that if tobacco be rubbed in the hands at such a time, and smoked, the result is a painful affection of the throat and palate. A note on this bark, by Mr. W. Skey,* does not contain anything remarkable.

The *manoao* shrub is but seldom seen within the realm of Tuhoe, it being a denizen of the plains. Nor is its absence to be lamented, for a more dismal-looking thing we know not. Natives say that if a branch of this shrub is broken by any person rain will soon follow.

Of the *manuka* we have both the red *manuka* and white *manuka*, as they are often termed by settlers. The former is, I take it, *Leptospermum scoparium*, and the latter *L. ericoides*. Both are termed *manuka* by the local Natives. The timber of both is termed durable, but is not really so when exposed to wet. *Manuka* fence-posts of *L. ericoides* have a life of but three years in this district. The timber lasts longer as rails. The wood of white *manuka* was formerly used by Natives for manufacturing into weapons and agricultural implements. The long fighting-spears were made of this timber. The bark of this species is much used by the Maoris for roofing their huts, as it is pliable and can be stripped off the tree in long pieces. Hence these trees were valued in former times, and woe betide the person who presumed to take bark from trees on land to which he had no right. The outer bark is stripped off without causing any injury to the tree. The fragrant leaves of *L. ericoides* were formerly used wherewith to scent toilet-oil. Some Natives hold the erroneous belief that this latter is the male tree and the red *manuka* the female tree, possibly on account of the conspicuous and abundant flowers and capsules of the latter. A

* Trans. N.Z. Inst., vol. ii, p. 152.

decoction of the bark of white *manuka* is used by Natives where-with to cure diarrhœa.

Mapere is the Native name of a species of *toetoe* which grows in the bush. It has a dark-green leaf and black "plumes."

The *maru* is a swamp-grass, or sedge.

The *matai* was one of the most important trees of the forest to the neolithic Maori, for it was included in a group of trees termed *rakau rangatira* (important trees), as opposed to the smaller or less useful species, which are known as *rakau ware*, or common trees. If you remark to a Native that his hair is becoming grey, he will reply that moss grows only on *rakau rangatira*—alluding to the long grey moss that is often seen on different species of *Podocarpus*. Grey hair is also alluded to as the *tarutaru o Tura*, or weeds of Tura. Young trees of *matai* are known as *kai* and *kakai* among Tuhoe, and as *mai* among some other tribes. "*Ko te wahie tena i taona ai a Tupurupuru*" (That is the fuel by means of which the body of Tupurupuru was cooked) is a saying connected with this tree. Tupurupuru was an ancestor of the East Coast Natives, who lived and was slain at Poverty Bay. Natives recognise the difference in appearance of timber, &c., that exists among *matai* trees, as also differences in the "flesh," as do our bushmen. They believe that the variety which has a dry, light inner wood, and splits easily, is the female tree. The wood of the *matai* was used for drums (*pahu*) and some other articles, as it is said to possess good sounding-qualities.

The common blue pansy, introduced by the early missionaries, was named *matia* by Tuhoe, after the name of the Native who brought the first plant to Rua-tahuna.

The *matukutuku* is probably a *Lycopodium*.

The *mauku* fern (*Asplenium bulbiferum*) is the most common fern in the Tuhoean forests. The young undeveloped fronds, termed *pikopiko*, form an article of food; while coarse mats of a very temporary nature were plaited from its leaves and used as a covering at night by refugees or persons camping out. Hence the tribal aphorism, "*Rua-tahuna kakahu mauku*" (Rua-tahuna of the *mauku* clothing). The young plants often seen adhering in great numbers to the leaves are termed *tururu mauku*, which was taken as a tribal name by one division of the original inhabitants of the Bay of Plenty district. Fronds of this fern seem to have been used in certain rites connected with the felling of trees, and the making of a new canoe, in days of yore.

Maukuuku is a secondary name of the *perei* (*Gastrodia Cunninghamii*), and is a sort of term of courtesy for that plant, the tuberous roots of which are eaten by the Natives. If when searching for the plant you happen to mention its ordinary name (*perei*), then you will not find a single specimen. It apparently conceals itself when its name is mentioned. Hence, at such a time it is always termed *maukuuku*. This plant did not originally spring from the earth, but was formed by the gods; hence, presumably, it has a certain amount of *tapu* pertaining to it. The roots are dug up in the winter months. A similar superstition to the above seems to obtain in parts of Europe anent the mandrake-plant, and in Tahiti concerning arrowroot and other plants, products, &c.

The *maurea*, a coarse tussock-grass of a reddish-brown colour, was formerly sought after for the making of belts for women. It is common in the Runanga district. An old proverbial saying, "*He maurea kia whiria*," preserves the name.

The *namunamu* (*Geranium molle*) is said by some botanists to be an introduced plant. The Natives steep the leaves in hot water and apply them to open wounds. It is said by them to be antiseptic. The water in which leaves of this plant, of the *piripiri*, and some others has been boiled is used in the same way. In cases of bruises it is used as an embrocation.

The *neinei* (? *Dracophyllum latifolium*) is found at high altitudes in Tuhoeland. In ascending the ranges of the interior one often passes through a belt of 200 or 300 yards in width, sometimes less, wherein this tree is common, while above and below such belt not a specimen is seen. Its plume-like bunches of leaves make this tree a handsome and conspicuous object. Straight stems of the same are sought after for the making of walking-sticks. It is often termed "spiderwood" by settlers and bushmen, on account of the web-like pattern seen when a stem is cut transversely. The Natives hold the green stick over a fire, and when heated it is beaten with a stick, so that the bark may be detached without injuring the fluted appearance of the wood beneath. In former times a kind of flute was made from the *neinei*, the pith being removed in the process. I have not, so far, seen the *neinei* near the coast.

The *nikau* is found only in the northern part of the Tuhoe district, in the bush of the Rua-toki and Wai-mana districts. The young, undeveloped leaves are eaten, and the leaves are used in thatching huts.

The *ngutu kaka* is an epiphytal plant found growing upon the *tawai* tree. It takes root in clumps of *Astelia*, and sends its roots downwards toward the ground.

The *ongaonga* (*Urtica ferox*) is not common in the Tuhoe district, but is occasionally seen, usually near streams. The larger stems were peeled and the inside portion eaten in former times. It is said to have a sweet taste.

The *paea*, an introduced plant, is said to have been named after the European from whom it was first obtained. A Poverty Bay tradition states that Captain Cook was so named by the Natives of that place, on account of his calling out the word "Fire" when ordering his men to fire upon the Natives. The Maori pronunciation of the word is *paea*. Or it may have been named after Tupaea.

Some very fine *pahau-kakapo* moss (*Dawsonia superba*) is found in the interior, especially in the Parahaki district. The general name for mosses is *rimurimu*. *Angiangi* and *kohukohu* seem to be names both of which are applied to *Hypnum clandestinus*. The *angiangi*, a very soft species, is used as a sort of bandage or covering for parts of the body affected by disease, &c., and by women as a diaper. It is also used by fowlers to cover a *pewa*, or bird-snare, in order to give it the appearance of a growing branch. Colenso says of the *angiangi*, "A long, loose, pendulous, filamentous, white lichen (*Usnea barbata*)"—which is assuredly not the moss above mentioned. Moss was formerly used as a sort of sock when wearing sandals in crossing high, snow-clad hills, it being stuffed in round the foot.

The *papauma* (*Griselinia littoralis*) flourishes in the Ruatahuna district. The berries are known as *huariki*, and are eaten by the *koko* bird, which is said to get very fat on such food. *Kawariki* is said to be another name of the *papauma*. Cuttings take root readily.

The berries of the *pa-totara* are eaten by children.

The *pepepe* is so called because the leaves thereof are used as bird-calls (*pepe*) by fowlers.

The large-flowered white *Clematis* has two names applied to it: the flowers are termed *poananga*, while the stem or plant is *piki-arero*. It is *Clematis indivisa*. The species bearing small greenish flowers is called *aka kopu kereru*. The *ngakau-kiore* is *Clematis parviflora*. *C. indivisa* is sometimes termed *aka poananga*. The *poananga*, *whakou* (flowers of the *tawari* tree), and *kahika* (*rata* blossom) are said by Natives to produce the finest honey. Leaves of the *piki-arero*, as also those of the *horopito*, were used by women to wean a child from suckling, being crushed and rubbed on the breasts (see "*Kiwikiwi*"). The sap of the *horopito* was used in cases of skin-disease.

Young fronds of the *paraharaha* and *rereti* ferns are eaten by Natives, being cooked as greens.

Popore: This name is applied to *Solanum aviculare*. It is said to be so termed before it bears fruit, but is called *kaoho*, or *kahoho*, after it has once borne fruit. Apparently fruiting specimens are known by this latter name.

The leaves of the *pohue*, *tohetaka*, *kohukohu* (a kind of chick-weed), *panakenake*, *pororua*, *raupeti*, and *poniu* were cooked and eaten as greens.

The *puakaito* has been observed only on the high range at Maunga-pohatu in this district.

A sort of jelly was made from the ripe berries of the *puhou*, or *tutu*, in former times. This jelly was a much appreciated food-item, but the process of making it was tedious, as the fruit had to be carefully strained, in order that all the poisonous seeds might be retained by the strainer. The latter consisted of a closely woven basket, lined with plumes of the *toetoe-kakaho*. The seeds are termed *huarua*. It is said by local Natives that if a person breaks off young branches, stems, of the *tutu* that such act will cause a downfall of rain ere long.

Natives formerly made cartridge-holders of the tough wood of the *puka* (*Griselinia lucida*).

An *Olearia* usually termed *akeake* by Natives is termed *ramarama* by the Tuhoe Natives. The latter name is applied by most tribes to *Myrtus bullata*. The wood of this Tuhoean *ramarama* was formerly used for making certain toys, as tops, and *kororohu*, because it was thought to make more sound than most other woods.

The starchy rhizomes of the *rarauhe* were an important item in the food-supply of the Natives in pre-European days, but are seldom used now. The young fronds of the *rarauhe* are termed *mokehu*, while *haumia* is a sort of emblematical term for the roots or rhizomes thereof. Haumia was one of the offspring of Rangi and Papa (Heaven and Earth), and is personified, as it were, in the fern-root. Haumia retired to the bosom of the Earth Mother in order to provide sustenance for the human offspring of Rangi and Papa. The enemies of Haumia are represented by the Maori people (because they ate largely of fern-root). The children (offspring) of the *mokehu* are the mosquito and sandfly. These two assail man. Sandflies are a dauntless folk. It matters not how many thousands be slain, they reck not of that, but still attack man. Nothing but fire can stop them. The saying of the warlike sandfly is, "What matter if I be slain, so long as I draw forth the blood of the Maori people of the world" (*Hai aha ahau te mate ai, i nga toto o te iwi Maori o te ao ka pakaru kai waho*). The *rarauhe* is also known as *takaka* and *makaka*.

The *rata* is a prominent feature in the higher forest ranges. This huge tree was held in much esteem in former times, because it was much resorted to by birds seeking the honey contained in its flowers. Most of these trees had special names, such as Te Tohu a te Ropu, a *rata* tree at O-haua, which is said to be always the first to bloom of such trees in that vicinity. The flowers of the *rata* are termed *kahika* and *te kanohi o Tawhaki*. In the old-time legend of Tawhaki and his ascent to the heavens it is stated that after his encounter with Tama-i-waho the hapless Tawhaki fell from the heavens and perished at the place where the sky hangs down. When the people of this lower world awoke next morn, behold! the *rata*, the *pohutukawa*, the *kowhai* trees were all red, reddened by the blood (*toto*) of Tawhaki. Even so the blood of Tawhaki and the *kura* (red-feather ornaments) of his *taiaha* (a weapon) are seen in the blossoms of those trees. The above does not quite explain why the *rata* flowers are termed the *kanohi* (face or eye) of Tawhaki. Possibly he became red in the face through ascending to such great altitudes. A decoction of the bark of the *rata*, boiled for some time, is used by Natives to apply to wounds. As elsewhere, most of the *rata* trees of this district commenced life far sundered from mother earth, but at some places—*e.g.*, near Taumata-miere—many terrestrial specimens are seen. A *rata* at Heipipi began its sinful career high up on the branches of a *matai*, about 4 ft. in diameter. Finding that the latter tree was hollow, the *rata* sent a questing root-stem down the hollow centre of the *matai*, which reached the ground and found much nourishment therein, even that it grew to such dimensions as to rend asunder the great trunk of the *matai*, which rent is about 8 in. in width, and has killed the tree. The root-stem gained access to the hollow centre of the supporting tree through a knot-hole. The *ngutara*, or so-called vegetable caterpillar, is found under many of these *rata* trees. These creatures were formerly collected by the Natives and burned, the residue of black ash being used to make a pigment for tattooing purposes. The term *kahika*, applied to the blossoms of the *rata*, seems to be used in the same manner as is the name *whakou* (flowers of the *tawari* tree), and some others—viz., the name appears to be applied to the whole tree while it is in flower, but no longer. Apparently the Maori is not happy unless he can bring superstitious ideas to bear on every subject. Hence, when procuring the bark of the *rata* for medicinal purposes, he will only do so at early morn, and no person of the hamlet may partake of food, or smoke a pipe, until the medicine is prepared, otherwise it will lose all its efficiency. Probably this custom arose through the still-room artist being afraid of losing his breakfast. The honey of the *rata* blossom is known as *wai kaihua*. It is eagerly sought by the *kaka* birds, and when these birds are seen on the *rata* trees it is known that the *rarangi tahi* season has arrived, so the bird-snares are laid aside, and the long, pliant spears get to work. As the wise woodsman sayeth, "*Ka kai te kaka i te* *wai kaihua, ka kiia he rarangi tahi.*" Another old saying is, "*Kei whawhati noa mai te rau o te rata,*" which Sir George Grey translates as, "Do not fly into a passion (get red in the face) for no cause, like the wind scattering the *rata* blossom." Colenso gives it as meaning, "Don't pluck and fling about to no purpose the blossoms of the *rata*"; hence, "Don't become ashamed when your lying is detected." The *rata* trees of terrestrial origin I have seen only on high ranges in this district, while those of epiphytic origin are seen on sidelings and lower ground. The former furnish the more solid trunk to the splitter or sawyer, save in cases when the latter develops but a single aerial root.

The names *raukatauri* and *whiri-o-raukata-uri* seem to be applied to several species of *Lycopodium.*

The inner part of the roots (*karito*) of the *raupo* were formerly eaten, and a kind of bread was made from its seeds (*tahuna, tahune, hune*).

The *rau-tawhiri* is said to have been so named because branches thereof were used as *tawhiri*—green branchlets carried in the hand and waved during the ceremonies of receiving and welcoming visitors. It is known among some tribes as *kowhiwhi,* and is often termed "silverleaf" by settlers.

The *rerewai,* an aquatic plant, is seen in ponds and other placid waters. Its leaves have a very pretty effect as seen floating on the surface of such waters.

The *kohuwai* is apparently a kind of aquatic moss, while *retoreto* seems to be the name of the duckweed.

The *rewarewa* tree is very common in some parts of Tuhoe-land. Its flowers are termed *rewa* (*He rewarewa te tinana, he rewa nga pua*).

The *rimu* tree is also of common occurrence, much more so than the *rewarewa* in the higher-lying districts.

The *taihinu* is seen only in river-beds in the lower parts of their courses.

The *tamatea* is found in swampy places in open country, and is used as thatch for huts.

The *tanguru* grows among fern and scrub, often on steep, rocky hillsides. Its aromatic leaves (? young leaves) were gathered by the exquisites of Maoriland, as also were those of the *kotara, ko-areare,* &c.

The *tangaru-rake* is said to be a species found growing on the summits of high ranges, where scrub alone prevails.

The *tapairu* (*Senecio Kirkii*) is found on the ranges of the interior, growing as an epiphyte, and also in a terrestrial form. The white blossoms of the former are very conspicuous in the forest.

The *tapia*, a true parasite, is very common throughout the district, and is deciduous, losing all its leaves, at least in the Rua-tahuna district. It is found growing on the *puahou* tree (*Panax arboreum*), but rarely on any other. In only one instance have I seen it growing on any other species, and that was a *kai-weta* tree (*Carpodetus serratus*). The berries are eaten by Native children.

The *tarata* tree shows some very fine specimens in the interior, its fine foliage being a beautiful sight in the early summer. In former times the Natives obtained an aromatic gum from this tree by means of wounding the trunk. It was used to scent satchets with.

The *taro-para* I have not seen, as it is found only up the Wai-o-eka River in this district, but from descriptions given by Natives I judge it to be the *para-tawhiti* of the north (*Marattia fraxinea*). Its large rhizomes are eaten by the Natives.

The *tawa* is very common throughout the Tuhoe district, and was a most useful tree to the Maori in former times. From its trunk he fashioned slender bird-spears (*maiere* and *tao-roa*) of great length, while its wood is an excellent fuel. Its fruit, termed *pokere*, furnished a kernel that was one of the principal food-items of these Tuhoean bushmen. These kernels were steamed in a *hapi* (steam earth-oven) for two days and then dried, when they would keep for years. When placed in the steam-oven they were covered and surrounded with leaves and fronds of *karamuramu*, *hangehange*, *petako*, *paraharaha*, and *rau-tawhiri*. These leaves imparted a brownish colour to the kernels that was considered desirable. When required for food these dried kernels were stoneboiled and pounded. The kernels were sometimes roasted before a fire, and, when heated, exploded with a popping sound; hence *ahi tawa*, a fire at which *tawa* kernels are roasted, is a term sometimes employed to express noisiness. Of a noisy child it is said, "*Ko te ahi tawa hai whakarite*" (It resembles a *tawa* fire). The *tawa* tree is sometimes termed *tawa rau tangi*, from the rustling sound made by its leaves in a breeze. A *tawa mapua* is a *tawa* tree that bears abundance of fruit. This fruit is a favourite food of the pigeon. The straight-grained white timber of the *tawa* tree is described by the terms *ngako* and *kaupuka*. European bushmen divide the *tawa* into two varieties, termed by them "white" *tawa* and "black" *tawa*. The former has a very white, easy-splitting, soft wood, excellent chopping for the bushman, and is a splendid fuel timber. These trees do not seem to grow so large as the black variety, but are more plentiful, and often very straight in the grain. The Natives made their bird-spears of this kind. The black *tawa* has a darker-coloured timber, is much harder.

and does not split so well as the white. It is much inferior as firewood, and the heart is often quite black. This black heart-wood is very tough. Sir George Grey has placed on record two old-time sayings connected with this tree: "*He tawa para, he whati noa*" (The brash, decayed wood of the *tawa* breaks easily). This is applied to a person timid in battle, &c. "*Ka mahi te tawa uho*" (Now is seen the strength of the heart-wood of the *tawa*)—said of an energetic fighter, &c.

The *tawai* tree is plentiful in the high-lying districts, as Rua-tahuna, more especially on the high ranges. Some of these trees are of great size, and the heart-wood thereof is very durable. At these high altitudes the *tawai* supports a great many epiphytical plants, for the humidity of the air is most marked. The principal benefit derived by the Maori from this tree was the fact that the beech mast provided food for the native rat, great numbers of which were trapped in former times. The bark was used in dyeing fibres for weaving purposes; while the *puku tawai*, a kind of fungoid growth on the trunk, was used as punk in fire-generating, and as a fire-stick. The *puku tawa*, a similar growth on the *tawa* tree, was considered useless for this purpose.

The *tawaka*, a species of *Agaricus* found growing on dead logs or stumps of the *tawa*, *houhi*, and *mahoe* trees, was eaten by the Natives. It is said that when a person has eaten of this food it is not well that he should go into the cultivations of the hamlet, among the gourd-plants, or the fruit of those plants will decay prematurely; or, should that person go afishing, he will not take a single fish.

The flowers of the *tawari* tree are termed *whakou*, which blossoms make a brave show in some seasons. In like manner the *hinau* and some other trees differ much as to the quantity of flowers produced in different seasons.

The *tawhero* is found in all parts of the Tuhoe district, and may be said to be the most common tree thereof. Its bark is sometimes used in the dyeing of fibre for making cloaks, &c. Handles for the large stone adzes were made from branches of *tawhero*.

The two species of *Gaultheria* (*G. antipoda* and *G. oppositifolia*) found here seem to be both termed *tawiniwini* by the Natives. Colenso gives *koropuku* as a name for a variety of *G. antipoda*.

The name *ti* is used as a generic term for *Cordyline*. The following species are found in the Tuhoe district: 1, *ti* (*Cordyline australis*); 2, *ti-kapu* (*C. Banksii*); 3, *toi* (*Cordyline indivisa*); 4, *ti-para* (? *C. terminalis*). *C. pumilio* I know not in this district, while the *ti-tawhiti* is doubtful. The latter is said to be distinct from the *ti-para*, and was in former times a prized article of food. It does not appear to have grown, or been cultivated, in this district, or at least not in the interior, but the name is known to the old men. The following remark was made by a local Native before the Land Commission: "*He ti tawhiti te o i mate ai te tahi tangata o Rotorua, na reira i tapaia taua ingoa ki tetahi wahine o konei*" (A *ti-tawhiti* was the last food partaken of by a certain dying person at Rotorua, hence that name was given to a woman of this place).

The common species of *Cordyline* (*C. australis*), the "cabbage-tree" of the settlers, is known as *ti* to the Natives, though *ti* is also a generic term for all the species. *C. australis* is known as *kouka*, or *ti-kouka*, among some tribes; others, again, term it *whanake*. The leaves of this species are said to contain a bitter sap which is absent in leaves of the *toi*. Leaves of the latter are said to have been sometimes steamed and the fleshy part eaten. The tap-root and upper part of the trunk of the *ti* were eaten. After having been steamed for about forty-eight hours it was chewed and the fibrous matter rejected. The roots contain sugar and farinaceous matter. The leaves of *C. australis* contain a strong fibre, which is much more durable than that of *Phormium tenax*, hence it was much used in the manufacture of snares and other articles exposed to the weather. Rough shoulder-capes were also made from these leaves. The *ti* are much frequented by pigeons in the season, and it was a valuable tree to the old-time Maori.

The *ti-kapu* seems to be known in other districts as *ti-parae* and *ti-ngahere*, while Williams's Maori Dictionary gives *hauora* as another name for it. The word *parae* is generally used by the Maoris to denote open country, but the Tuhoe Tribe apply the term to bush country, which is somewhat confusing to a new-comer. The *ti-kapu* is generally found about the edge of a forest, or on high ridges and steep places where small timber prevails. Myriads of these plants sprang into life on the Tau-mata-miere Range when the bridle-track was made and the trees felled a width of a chain. On the high ranges of the interior the *toi* springs up on such cleared lines, though not in such great numbers. Of the *ti-kapu*, the young undeveloped leaves (*rito*) alone were eaten.

The *toi*, or *ti-toi*, is known to some tribes as *ti-mataku-tai* (ocean-fearing *Cordyline*), which same is an excellent name for it, as it does not flourish near the coast. The *kauru*, or upper part of the trunk of the *toi*, was sometimes eaten prepared as was that of the *ti*, but it does not seem to have been much appreciated. The outside of the *kauru* was cut off before being steamed in the earth-oven; the tap-root was also eaten; while the young leaves were used as a vegetable, as we use greens. The fibre contained in the leaves is exceedingly strong, and such leaves have a peculiar elasticity when subjected to a strain lengthwise. This species is sometimes termed the "mountain-palm," and is a very handsome object as seen growing on the high ranges, the leaves being 7 in. and 8 in. in width. The midrib (*tuaka*) of these leaves is of a red colour, and was used in making waist-belts, while from the coarse fibre rough rain-capes are made. These capes are very much more durable than those made of flax (*Phormium*), and were almost the only clothing used by the Tuhoe Tribe in former tribes.

The *ti-para* I believe to be *C. terminalis.* But very few plants now exist in the district, nor does it appear that it ever grew here in a wild state, but only as a cultivated plant. It was formerly grown by the Natives because it was much esteemed as an article of food, the whole plant being edible. The outside of this species was not removed when placed in the steam-oven. It was the best-eating of all the species of *Cordyline* here known. When the stem of this species has attained a height of about 3 ft. or 4 ft. the Natives bend it down until the upper part touches the ground, and cover that part with earth. It takes root where it is so covered, and then the bent trunk between the two roots is cut out, cooked, and eaten. When the young plant grows up it is treated in a similar manner. A small sucker planted in my camp garden two years ago is now 2 ft. in height, and has about a hundred leaves, which are 1½ in. wide in the middle. This species seems to be known as *ti-pore* among some tribes, while Williams gives *mahonge* as the name of a variety of *ti-para.* The following old saying was given by a member of the Atiawa Tribe: "*E kore e riro, he ti tamore no Rarotonga*" (A chief possessing courage, energy, &c., was said to be able to withstand a gale like the branchless *Cordyline* of Rarotonga. Enemies would not conquer him, any more than the wind could overthrow a branchless *ti*). In his collection of Maori proverbs Sir George Grey gives "*Ehara i te ti e wana ake*" (When man dies he dies completely; no suckers or shoots spring from his decaying body, as they do from the stump of a *ti*).

The *ti-kumu*, a plant found only on the summit of Maunga-pohatu in this district, appears to be similar to the "leather-plant" of the south—a *Celmisia.* It is mentioned in, I think, Dieffenbach's "New Zealand" as being found on Mount Egmont. He gives it the same name as that used by Tuhoe; while in Parkinson's Journal it appears as *teegcomme*—evidently as near as an Englander could get to it. Some tribes seem to have utilised the *ti-kumu* leaf in the making of rude capes, &c.*

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* Trans. N.Z. Inst., vol. xxix, p. 175; also vol. i, p. 15, of Essay No. 1.

The *titoki*, *rimu*, *hinau*, and *tawa* trees do not produce fruit every year, according to my Native informants, but only when they like (*kia puta tana hiahia*), then they fruit (*katahi ka hua*). A *rimu* tree may go several years without producing fruit. From the seeds of the *titoki* the Maoris formerly expressed an oil which was used for toilet purposes. A strong bag was woven of strips of flax-leaves, being about 6 in. in diameter and 3 ft. in length. This bag was termed a *ngehingehi*, or *kopa whakawiri titoki*. The seeds were placed in it, and the mouth of the bag tied up. The bag was then pounded with a club, so as to crush the seeds. At either end stood a man, who held an end of the bag firmly, and, by turning in opposite direction, sufficient pressure was obtained to express the oil contained in the berries, or at least a portion of it. One authority states that hot stones were placed among the crushed seeds to increase the flow of oil. This oil was placed in gourds, and scented by means of placing therein certain aromatic leaves, &c., as those of the *heketara*, *koareare*, *manuka*, and the *kopuru* moss. We have representations of a similar instrument used by the ancient Egyptians, who, however, obtained increased purchase by winding the confining cord round the long bag in a spiral manner, attaching one end to one side of a square wooden frame, and passing the other end through a hole in the beam on the other side of the frame. This end was then secured to a wooden bar, which gave a great power to the twisting process. Colenso gives a saying I have never heard—"*Ko nga rangatira a te tau titoki*"—applied to a person of low birth who obtains some of this toilet-oil in the season when the *titoki* tree bears plenty of fruit. That man is a chief only in the *titoki* season. The Tuhoe people have a saying, "*Apa he peka titoki*" * (When a man dies, his branches—children—live after him, unlike branches of the *titoki*, which die for ever). This rendering may be correct, but it conflicts with several other sayings, as, "*Apa he peka a kai*" (Food products grow again when planted, but man when buried appears no more).

Toi, a species of fungus, is not, I think, a Tuhoe word. It is applied to a kind of toadstool that grows in deserted huts, &c. *Toi whenua* is a term used by Te Atiawa—the people of a place, the permanent or original inhabitants.

The introduced dandelion (*tohetaka*) has a very firm grip on New Zealand. Its leaves are sometimes eaten by Natives, cooked as greens. "*Kai te moe tonu te tohetaka*" (The dandelion still sleeps) is said of a late sleeper. That plant does not open its flowers until the day is well aired.

* In full, "*He peka tangata, apa he peka titoki.*"

The *toromiro* tree, known as *miro* in many other districts, is not a very common tree in this district, but is much prized by the Natives on account of the amount of food provided by it for the pigeon, which becomes extremely fat when feeding on its berries. Hence every tree of this species is well known by the sub-tribe on whose land it stands, and most of such trees are known by distinct names, as also are any trees of other species—*kahikatea*, *matai*, *rata*, &c.—that were much resorted to by birds, and were for that reason favourite snaring-trees. The Natives profess to know the male and female trees of *toromiro*, stating that the female trees alone bear fruit, while others, which produce flowers only and never fruit, are said to be male trees. The bark of the *toromiro* is used medicinally by the Natives: albeit these *wai rakau* medicines, as they term them, are quite a modern usage.

The *toetoe-kakaho* is used here, as in other districts, in the construction of huts—the leaves as thatch occasionally, the flower-stalks for lining the roof. Natives recognise two varieties of *toetoe-kakaho*—one, known as *kakaho-matariki*, produces the best reeds (culms) for house-lining; the other, termed *kakaho-puha*, has larger and somewhat crooked or bent culms, deemed inferior for the above purpose. Hence the following saying: "*Ka whakarerea te puha, ka whai ki te matariki*" (The *puha* is rejected, the *matariki* sought after)—a saying that is made use of in speaking of persons, or, in fact, almost anything. The term *rake kakaho* is applied to a plant of this species which produces a large number of straight culms of the better kind for house-lining, walls and roof; or, rather, it applies to the bunch or collection of culms, not to the whole plant. "*Te rake kakaho a Tunono*" (the culm-clump of Tunono) is a Ngati-Awa saying. It was first used to describe the sons of one Tunono. These men were all tall, and all had grey hair, hence they were likened to a *rake kakaho*. The following saying is a well-known one: "*He ta kakaho, e kitea ana te oioi i te hau; he ta ngakau, e kore e kitea*" (The crookedness of a culm is seen when the wind blows; the crookedness of the [human] mind is not seen). The leaves of *toetoe-kakaho* do not appear to be looked upon as making very good thatch, but are used for huts. The rush (*wiwi*) seems more durable.

The *upoko-tangata*, sometimes called *toetoe-whatu-manu*, was formerly used in the making of kites (*manu*), the triangular stems being used for that purpose. Two varieties are recognised by Natives.

The *toro-papa* is evidently so named from its curious growth. It not only spreads underground, throwing up several stems, but also such branches as come into contact with the earth take root.

The *totara* is sometimes termed *Te Riu o Tane*, because most canoes were fashioned from that timber. This was, in former times, the most prized tree of the forest, the foremost of *rakau rangatira*. Its timber was the best for canoes and house-building and other purposes. The bark was used for covering houses, and vessels for containing water and preserved foods were made of it. Vessels made for the former purpose were termed *patua*, and were often used for stoneboiling, as also were *kumete*, a wooden trough. The bark vessels, made to contain preserved birds, rats, &c., were called *papa*. Temporary *patua*, used to hold water, were sometimes made from bark of the *mako* and *houhou* trees, but these would only be serviceable for one day. The Tuhoe Natives claim that they recognise the male and female trees of *totara*. They call the male (*toa*) tree *karaka*, and the female (*uwha*) tree *kotukutuku*. The terms *kouwha* and *karawa* are also used to denote the female sex of trees. The outer bark of the *karaka* or male *totara* tree is termed *tuanui*; the inner bark is called *kiri* (the common name for bark or skin). The *tuanui* bark is thick, and peels off in long strips. It is the only kind valued. The *kotukutuku*, or female *totara*, has no *tuanui* bark, but only a thin bark resembling that of the native *Fuschia* (*kotukutuku*) tree, hence the latter name has been applied to the female *totara*. One informant tells me that in ancient times all the *totara* folk lived together, but that after the contest already described in this veracious chronicle some of them fled to cliffs and rugged lands, there to dwell. Also, that the *matai* wood that pops when burned comes from a male tree; that which does not act so is of a female tree. And who am I that I should doubt these things?

The thick-barked *manuka* is also termed the male tree by Natives. This is our "white" *manuka*. The scientific botanist may tell the simple autochthones that they are wrong. I decline to do so, lest I lose my reputation for trusting, childlike faith.

The bushmen of Tuhoe say, "Only the female trees bear fruit (*Ko nga rakau kouwha anake e hua ana*). That produced by the male trees is termed *hae* (pollen). It is like dust, and is blown and carried by the wind. It is not a real *hua* (fruit), but a form of *pua* (blossom or seed). It is produced by male trees of *toromiro*, *kahika*, *matai*, &c. All trees are divided into male and female sexes; we recognise the male and female sexes of the *totara*, *matai*, *kahika*, *kotara*, and some other trees."

In vol. i of the "Transactions of the New Zealand Institute," page 13 of special essays, is an interesting account of how the Maoris lightened the labours of future canoe-makers by stripping off a piece of bark and a portion of the wood from comparatively young *totara*.

I have obtained no satisfactory name locally for *Eugenia maire.* One Native gave *puka* as the name thereof, but the statement is unsupported, and I have little faith in it. Another gave *tu-huhi*, which is very unsatisfactory, and might be applied to any swamp-growing tree. Such tree or plant names as the latter, and *tu-repo*, *tu-tahuna*, *tu-tawai*, *tu-pari*, *piripiri*, *piri-pari*, *piri-noa*, &c., are objects of my deepest scorn. They appear to be employed by Natives who do not know the proper names of such plants, &c. It is quite easy to call a plant that grows on cliffs a "cliff-grower," but that is not necessarily the proper name of it. In the north the Natives call the above tree *maire-tawhake*, and Mr. J. B. Lee obtained *whakoukou* as a name for it, while Dr. Hector gives *whawhakou.*

A kind of sandal or galligaskin was made from the *tumatakuru* (*Aciphylla squarrosa*) plant by the Tuhoe Natives in former times. Several kinds of sandals or buskins were made and used in winter-time, when crossing the high ranges of the interior, which were often snow-covered. Tuhoe have traditions of several parties of travellers which were snowed up on those ranges and perished miserably in past times. When Hape-nui, some generations ago, started to cross the Huia-rau Range, then deeply covered with snow, the folk of Rua-tahuna tried to dissuade him from the attempt. But Hape declined to stay, saying, "*He riri awatea.*" Even so he perished. Paerau, of Rua-tahuna, crossed the same range at a time when the summit at Te Whakairinga was very deeply covered with snow. He marked the depth of snow by cutting a notch in a tree, which mark was pointed out to travellers for many years after.

The *toheraoa* plant is said to be so called because if a portion of the seed-head gets into food it will choke a person. Deaths have so occurred.

The *tuokura* (*Dicksonia lanata*) appears to be known as *tuakura* among other tribes. When Te Kahu-o-te-rangi, of the Wai-roa district, East Coast, visited Ngati-Apa, of Galatea, he took as a wife one Taratara of the latter people. Their nuptial couch was composed of fronds of *tuokura.* When Te Kahu returned home he left his new wife behind, saying, "*Ki te whanau to tamaiti he tane, tapaina ki te kahu o te rangi. Ki te whanau he wahine, tapaina ki te rake o tuokura*" (If your child be born a male, name it after the hawk of the heavens [his own name]: if born a female, then name it after the *rake o tuokura*). The term *rake* is applied to high exposed range-tops where few large trees are seen, but only scrub and very hardy plants and ferns, such as the *tuokura.*

The name *waiu-atua* is applied to several species in different districts, for which see Cheeseman's "New Zealand Flora," page 1110. Ngati-Awa know that name, and also *waiu-o-Kahukura* (the milk of Kahukura). They give the following origin of the name: Just before Pou-rangahua, of Kiri-kino, Turanga district, went to Hawaiki he seems to have visited Whakatane, where he appears to have taken to wife one Kanioro, sister of Hoaki and Taukata, who brought the knowledge of the *kumara* to the Hapu-oneone people of Kakaho-roa, as Whakatane was then called. It was proposed to despatch a vessel to Hawaiki in order to obtain seed *kumara* (sweet potatoes). Pou said, "Do not sail until I return here. I am going home to see my child Kahukura, at Kiri-kino. I have noticed that when the sun rises he puts out his tongue in that direction, so I think that away toward the place where the sun rises is some desirable food *hei whakawaiu mo taku tamaiti* (to cause the child's mother to give abundance of milk). When Pou returned to Kakaho-roa he found that the Ara-tawhao had sailed without him, so he obtained the *tawau* (milky juice) of the plant since known as *waiu-atua* and *waiu-o-Kahukura*. It is probably *Euphorbia glauca*.

The *waoriki* plant (*Ranunculus rivularis*) is found in some swamps of the district. It is poisonous to stock. It may be seen in swamps about Galatea, as also is the white moss *Sphagnum cymbifolium*. The leaves of the *wharangi* are also poisonous to stock, and the honey obtained from its flowers is extremely hurtful to the *genus homo*.

The stems of the *tonakenake*, a small variety of *pohue*, were used in the manufacture of eel-pots.

A coastal variety of *Asplenium flaccidum* is found on the Rurima rocks, off Matata.

A few notes lately obtained: Several Natives inform me that the *kokomuka-taranga* and *kokomuka-tu-tara-whare* are one and the same. Mr. Cheeseman gives the former name for *Veronica parviflora* (leaves 1 in. to 2½ in. long), whereas the Tuhoean *kokomuka-taranga* has leaves 4½ in. long. The tough stems of the *iwi-tuna* (*Lycopodium Billardieri*) were formerly used to put round the neck for suspending ornaments of stone, &c., thereto. The white *maire* is here termed *maire-roro*. The black *maire* is *Olea Cunninghamii*. One Native gave *maheruheru* as the name of *Gleichenia circinata*, but it seems doubtful, inasmuch as other Natives do not recognise the name. Several Natives state that *kotara*, *heketara*, and *taraheke* are all names of one tree. Cheeseman gives *heketara* as *Olearia Cunninghamii*. I have been told that *tororire* is a tree-name, but have not learned as to which tree it is applied. The ends of the fronds of the *kiwikiwi* fern are chewed as a cure for ulceration or soreness of the mouth or tongue.

The general term for the bark of trees in this district is *kiri*, which is also used to denote skin; hence, when bark is meant, the phrase *kiri rakau* (tree-skin, or bark) is employed. Other words for bark in various districts are *peha*, *hiako*, *tapeha*, and *tangai*. Tuhoe use the word *torokiri* for bark or the outside of a tree. They employ this word to denote outside slabs from a sawpit or mill, which are of sap-wood with bark on.

The term *iho* is used for the middle of a tree, the centre of the heart-wood. *Taikura* is the reddish heart-wood between the *iho* and the sap. *Taitea* is the sap-wood. The first term (*iho*) is used to denote the very heart, or kernel, of anything, even of a speech. *Taikura* implies a red or reddish-brown colour, as seen in the heart-wood of many trees. *Taitea* denotes whiteness, as of sap-wood, &c.

An old proverbial expression says, "*Ruia taitea, kia tu ko taikaka anake*" (Reject the sap-wood and leave only the heart-wood). Here the word *taikaka* is used for heart-wood—perhaps a northern word. Sir George Grey gives the following words for the timber of the *totara*: *Iho* or *uho*, the heart; next the *kaka*, or hard part; then the *rangiura*, or reddest part; then the *taitea* or sap, which soon decays. The above proverb means, Discard the useless or worthless, retain that which is valuable—a saying often quoted by the Maori. A somewhat similar saying is, "*He rakau tawhito, e mau ana te taitea i waho ra, e tu te kohiwi*" (In an old tree the outside is sap-wood, but it encloses hard, durable heart-wood). (See "*Kohiwi*," *post*.)

The Maoris are acquainted with the movement of sap in trees, hence they cut off the tops of certain species of *Cordyline*, intended for food, before the sap rises in the spring.

The top of a tree is termed *kapuhi* or *matamata*—*i.e.*, the very highest part, the top of the head. The head of a tree is *kauru* or *kouru*. The branches are termed *peka* or *manga*, but a very large main branch or division of a tree is called *ruha*. A dry, dead branch is *puanga*. The word *kawekaweka* is employed to denote extreme length in branches. The trunk of a tree is termed the *tinana*. The base of the trunk is the *take*. A stump is *tumutumu* or *kotumu*. *Take* is also applied to the root. *Pu* and *putake* are applied to the base or root of anything—of a tree, or an argument, or action—its secondary meaning being "reason, cause." Roots are termed *paiaka* and *pakiaka*. Small rootlets or fibres are called *weu*, *weru*, and *piakaaka*. An old saying of these bird-snaring, tree-climbing bushmen is, "*He toa piki rakau, he kai na te pakiaka*" (The fearless tree-climber becomes food for a root. Some day he will fall from a tree on to the roots thereof, and so perish).

The term *wana* is usually applied to a shoot or bud, but among Tuhoe it is used to denote a young tree, a seedling (*he wana karaka*); while *mahuri* and *kahuri* denote a sapling—*i.e.*, of a larger growth than a *wana*. *Huri* is used for "seed," as seed potatoes, seed *taro*, &c. *Pua* means "seed"—apparently small seeds only—but is sometimes used for "flower." *Puawai* is also applied to flowers. A large seed, as those of the gourd and pumpkin, or a kernel, as those of the *tawa*, *titoki*, &c., are termed *kakano*.* Kernels are also termed *iho*. Fruit, berries, are styled *hua*, which is also used for egg and the roe of a fish: *hua manu*, a bird's egg, or "bird-fruit"—an expressive term.

As we have already seen, the flowers of a tree sometimes bear a special name, distinct from that of the tree that bears them. The blossoms of the *rewarewa* tree are termed *rewa*, those of the *tawari* are known as *whakou*, &c.

In his work, "Evolution of the Idea of God," Grant Allen states that primitive man, the genial savage, would not possess the faculty of perception to the extent of perceiving that plants spring from seeds. I would much like to meet that primitive man. He would be a curiosity, and very primitive withal. For those are just the things that the savage does notice—the operations of nature. Were he not so to do he would not be a primitive man for long, nor any other kind of man, for that matter.

The pollen of trees is termed *hae*; that of some plants, as *rarauhe*, is *nehu* or *puehu*. The rains of January, which cause the pollen of trees to disappear, are termed *hikuwai*.

The Natives deem the abundant flowering of certain trees as a sign of a fruitful season. The fourth month of the Maori year, which year begins about the middle of June, is marked by the flowering of the *puahou*, or the appearance of its berries; the fifth month, by the flowering of the *kowhai*; the sixth month, by the *rewa* blossom; the seventh month, by the blooming of the *kahika*; and the eighth month, by the flowering of the *tawhiwhi*. Thus it will be seen that the flowering of trees served as time-markers to the Maori. Thus, when intending to burn off a patch of *rarauhe* fern, in order to prevent the growth of scrub, and to render the edible rhizomes a desirable white colour, the Natives would do so when the *hinau* and *whakou* blossoms appeared. If they waited until the *rata* and *korukoru* blossoms came the fern-roots would be brown, and the edible matter of inferior quality. Also, the *kekerewai*, an edible beetle (?), appears on the *manuka* when that tree blossoms, and was then sought for. It is not seen in the winter. The flowering of certain trees, the dying of leaves of *raupo*, &c., the

* *Kakano* is also used to denote the grain of timber.

fall of the leaves of the *kotukutuku*, were signs of certain birds being in good condition—it was time to commence snaring the same. There are a great number of such *tohu* (signs, tokens) well known to that keen student of nature the Maori. He may be a bit primitive, but he knows the functions of seeds and the varied manifestations of Dame Nature in the *wao tapu nui a Tane.*

The Maori has two names for leaves—*rau* and *wha.* The first is applied to all short or comparatively short leaves, however broad, while the long leaves, such as those of *raupo* and flax (*Phormium*), are termed *wha.* I have also heard the latter term applied to leaves of the *toi* (*Cordyline indivisa*), *kiekie*, *mauri*, &c. *Wha taro* or *whawha taro* is the leaf-stalk of the *taro.* Some Natives maintain that while a *wha raupo* implies the whole leaf, a flax-leaf, owing to its different form, contains two *wha*—*i.e.*, that each half of the leaf is a *wha.* This is possibly correct. Sir George Grey, in his "Whakapepeha," gives a Maori proverbial saying, "*He wha tawhara ki uta, he kiko tamure ki tai*," and translates *wha tawhara* as the "broad fruit of the *tawhara*." *Tawhara* are the flower-bracts of the *kiekie*, which are eaten by Natives.

Young shoots of the *rarauhe* fern are termed *mokehu.* The word *kotau* is employed to denote young shoots, as those of *tutu*, *pirita*, &c., and those of *rarauhe* before they appear above ground. The word *pitau* has a similar meaning, but is more often applied to young curled unexpanded fronds of tree-ferns. The word *koata* is used for the unexpanded fronds of tree-ferns before they reach the *kotau* stage of growth, also to those of the *nikau*, and many other trees, &c., of similar growth. One also hears *koata* applied to young shoots, as those of the *tutu*. *Pihi* is the general term for shoots of plants; and the horns of cattle, goats, &c., are also termed *pihi* usually, but in the Waikato district are called *maire.* The term *rito* seems to be equivalent to *koata*, and is applied to the young unexpanded leaves or heart of a plant. The word *komata* means young shoots of plants and trees. The old dead leaves of certain acrogenous plants—*toi* (*Cordyline indivisa*), and *ti* (*C. australis*), and others, as also those of flax (*Phormium*)—which dry leaves hang down in masses for years ere they become separated from the trunk—that is, in sheltered situations—are termed *koka* and *kuka.* The former term, says one authority, is applied to those leaves just turning a brownish colour—the first symptom of decay; while the leaves of previous years, which are quite dry, are called *kuka.* The *kuka* of *C. indivisa* are used in the making of rough rain-capes, as loosely hanging outside pieces to turn the rain. These two terms apply only to such leaves as are termed *wha*, and not to leaves called *rau*. The Natives say that the latter class of leaves are killed by summer weather, which turns them brown (*kua tu pakaka*), but that *wha* die in a different manner, and hang long on the plant or trunk after becoming dry. The word *tuakoka* is employed to describe a poverty-stricken place or person—"*Ou mahi a te kainga tuakoka, kaore he kaka, he aha!*"

The leaves of the gourd-plant (*hue*), pumpkin, &c., bear different names. The first two leaves put forth are termed *rau kakano*, or "seed leaves." When a third leaf appears, it is said "*kua rau tara te hue.*" The fourth leaf is called *putaihinu* (*putauhinu* among some tribes). When the first runner (*kawai* or *waero*) appears, it is styled *uma* (*kua uma te hue*). This shoot soon falls and commences to run (*toro*).

The expression *whatu toto* is applied to the red-coloured sound heart-wood of the *totara* and *matai* trees. This timber takes a long time to dry out and become light when split. The term *komako* is applied to the lighter-coloured *totara* wood that soon becomes light and dry. *Aritahi* means straight-grained timber, easily split. That peculiar state of *totara* timber known to bushmen as "dozy"—*i.e.*, pitted with small holes—is here called *tatarapo* and *kakapo*, but on the west coast is termed *kaikaka*. This condition is oft noted in *totara* growing on stony ground, and it impairs the value of the timber. Apparently it is a state of incipient decay. *Makohe* is another word meaning straight-grained, easy splitting, of timber. This state is expressed as "good rift" by American lumbermen—the timber rives well.

My late friend Te Puia Nuku, who was one of the Tuhoe contingent that marched to Whirinaki in the early fifties in order to save Ngati-Manawa from being wiped out by Ngati-Maru, under Taraia, told me that during the hostile speeches then made the latter chief said to the Tuhoe warriors, "*Ahakoa he iti te matakahi, ka pakaru i a au te totara*" (Though the wedge be a small one, yet will the *totara* be riven by me)—meaning that though Tuhoe were numerous and versed in warfare, yet he was a match for them. Wepiha, of Ngati-Awa, promptly replied, "*Ae! Me he makohe; tena, mehemea he pu peka kai roto, e kore e pakaru i a koe*" (Yes! If it be good rift; but if it contains blind knots, then it will never be split by you). He meant that Ngati-Maru might defeat ordinary fighters, but that so many famed warriors were present that they could not hope for a victory. A *pu peka* is the hard, in-locked wood which composes the internal base of a tree-branch —that part of it that extends from the heart of a tree outwards to the bark, but supports or shows no external limb: it has decayed or been broken off. A *puku whenewhene* is a "blind knot" that does not extend out to the outside of a tree, but is sometimes marked by a *puku* or excrescence on the outside, over which the bark is intact. These "blind knots," or branches in embryo, seem to be also termed *pu kanohi*. *Toropuku* is a term apparently applied to an incipient knot inside a tree, and perhaps sometimes to the heart-wood. The light-weight brittle inner wood of a tree is termed *puwhawha* and *puanga* among Tuhoe. *Puaka* seems to be applied to a *rimu* tree among the Arawa Tribe. "*He rakau puwhawha*" is a term sometimes applied to an old man, presumably because he has become dried up, light, and withered. With this may be compared the famous saying of Pou-whare-kura, wife of Kahu-ngunu: "*Tu ana he rakau puwhawha, haere ana he rakau wharemoa.*"

The decayed heart-wood of the *matai* tree (*i.e.*, natural decay, not as affected by grubs) is termed *popo-a-whaitiri*. The word *waipawa* is used to denote the dry brash wood of the *tawa* tree when quite dead, dry, and light. It then breaks easily, or flies well off the axe. "*Kua waipawatia te rakau na,*" and "*Te waipawa pai!*" are common expressions. Clear timber—*i.e.*, good, sound, solid, straight-grained timber, free from shakes, decay, ring-shakes, blind knots, or other defects—is called *ngako*, an expression often applied to the wood of the white *tawa*. *Mapua* describes a tree bearing abundantly of fruit: *He tawa mapua*. *Poike* seems to have a similar meaning: *Poike ana te hua o te rakau.*

The term *puarere* implies "run to seed." The words *koiki*, *kohiwi*, and *paiore* denote hard, sound, dry heart-wood, from which all sap-wood has decayed: *He koiki matai*. The expression *kohiwi* is also applied to a person who is mentally inert, absent-minded, or listless, who has no heart for action. Should the human medium of a god be deserted by such spirit, then it would be said, "*E noho kohiwi noa iho ana te tangata*" (Nothing but his *kohiwi* remains; his knowledge—hence also his power and prestige—has departed; only the earthly body is left). *Koero* and *hiwi* have a somewhat similar meaning to that of *koiki*, but more applied to anything that has become dry, attenuated, old in appearance, as a dry weather-beaten branch. Another way in which the term *kohiwi* is employed—viz.: "The Iho o Kapuru is the name of a cave. The *iho* (severed portion of umbilical cord) of Kapuru was deposited there. *He totara tona kohiwitanga.*" My informant seemed to mean that a *totara* tree which stands at that place is all that remains of the *iho*, or that represents it.

As observed, the Tuhoe Tribe apply the term *parae* to forest lands, while *pakihi* is open land on which nothing taller than grass, sedges, or rushes grow. Treeless country on which fern or scrub grows is called *mania*. *Nuku maraha* denotes open country, and the term seems to convey a sense of flatness —open lands over which one can see for a considerable distance.

High-lying forest lands, such as the high ranges of Huiarau, &c., where beeches and *tawhero* are the principal trees, and where snow lies in winter, are termed *hunua* by the Tuhoe Tribe, while the forests of the lower country, which may also be very hilly, are known as *uruora*. It is so named on account of there being much bird-food in these forests at a lower altitude, the trees being *kahika*, *toromiro*, *rimu*, *maire*, *rata*, &c., which do not grow on tops of high ranges. Any forest or portion of a forest that produces a great quantity of berries, seeds, &c., on which birds feed and fatten is termed a *whenua pua*, or fruitful land; sometimes simply *pua*: "*He pua tera whenua a Te Wera-iti*," or "*He hunua a Te Peke, engari a konei, he pua tenei.*" The expression *toiora* seems to apply to *hunua* lands. As my informant put it: "*Ka tau ki te whenua tawai, pipiro, tuokura, ko o te rake ko ona rakau. Me tau ki reira taua toiora.*" (It applies to *tawai*, *pipiro*, and *tuokura* lands, the trees of sterile lands. Let the term *toiora* be applied there.) The term *rake* is applied to the poor high-lying lands, such as the upper slopes and summits of high ranges, whereon but a thin layer of soil covers the rock. The word *pukahu* is used to denote the fibrous, spongy mass of rootlets, moss, &c., that covers the ground in *tawai* forests on the summits of ranges. Poor, sterile surface-matter on soil is known as *akeake*. *Tatahou* is virgin soil, while soil exhausted by cultivation is termed *patohe*.

Scrub or brush is known as *tawhao*, *ururua*, *heuheu*, and *moheuheu*, but the last two words seem to be applied more especially to the growth of scrub and fern over tracks: *Kua heuheu katoa te huarahi* (The track is all overgrown). *Kua apiapi te huarahi* has a similar meaning, the word *apiapi* meaning "filled up, closely occupied." *Arawheu* is an expression denoting the summer months when paths are much overgrown, as the word itself implies. Travellers would gradually clear away such obstructions by breaking off encroaching branches. In traversing old-time trails of neolithic man, we sometimes see young trees which have been tied with an open single knot by travellers, in order that such might be cut and converted into walking-staffs when grown to a desirable size. Such tough woods as young *hinau* were so treated.

A second growth of timber, such as grows up in a forest-clearing, or cultivation-ground, and which usually consists of such small trees as *mako*, *kotukutuku*, *koromiko*, and *puahou*, is known as *waipapa* and *waiheuheu*. "*Kua waipapa te wae-*

renga" (The clearing has become covered with second-growth timber).

Driftwood is called *tawhaowhao.* *Uru rakau* and *motu rakau* imply a clump of trees, a small wood. *Purei* means a tuft, as as of rushes, &c.; while *pureirei* is applied to the stump and roots of a tree torn up by the roots. A single log or tree lying across a track would be termed a *taita,* but a mass of fallen trees, or of drift timber in a river-bed, is called *taiha*: "*Kua taihatia te huarahi i te rakau.*"

Tree-climbing.

The Maoris were, and are, adepts at tree-climbing, for much of their food was obtained from trees, which were ascended in order to set snares for birds, or for spearing the same, and also when in search of various berries. For both these purposes the Natives climbed to the top branches of lofty forest-trees, and clambered out on the branches in order to reach the outer branchlets. There are three methods of tree-climbing employed by the Maori—viz., the *piki,* the *tapeke,* and the *rou* methods. To *piki* a tree is simply to climb it by means of hand-holds—*i.e.*, holding on to branches, &c. In the *tapeke* method the climber "swarms" up the tree, clasping the trunk with his hands, and also gripping it with his legs. In such cases as where the trunk is too large to ascend in this manner, two loops of cord, or some climbing-plant, are employed. The feet are confined in one such cord, and the other is grasped in each hand. After drawing his feet, with their confining cord, upwards, the climber slips the hand-loop up the further side of the tree. If the bark be rough, then the hand-cord is jerked upwards, so as to clear any obstruction. The *rou* method is employed in cases where the two former plans are not suitable, and in cases where the tree is ascended often, as a tree on which birds are taken by fowlers. It is a permanent ladder, or is so as long as the poles and lashings remain sound. The *rou* consists of saplings placed upright against the trunk of a tree, and retained there by means of lashings passed round the tree, such lashings being the stems of climbing-plants. Two such poles are placed parallel to each other, like the sides of a ladder, the rungs or foothold being twisted creepers of a tough nature, such as *aka tea.*

The Maori measured the girth of trees with the extended arms, the process being termed *whananga* by the Tuhoe Tribe. Each stretch of the two arms is called a *pae.** If the fingers do not meet in so clasping a tree, or if, after measuring off two or more *pae,* the fingers do not reach the starting-point, then the

* *Pae* is also used as a verb.

portion over is termed *hamama* (literally, "open, vacant"). "*Pae hia to rakau?*" (How many *pae* is your tree?) "*Pae rua*" (Two *pae*); or, "*Pae toru hamama*" (Three *pae* and a space over).

Tree-felling.

In felling bush in order to make a garden or cultivation-ground, three different methods are employed—viz., the *autara*, *whakapapa*, and *hapai tu*. The first-named (*autara* or *kairangi*) consists in cutting down all small stuff and in lopping off all branches of larger trees, leaving their trunks (with the bases of branches) standing. When dry the felled bush is burned off and crops planted. The *whakapapa* method consists of felling all trees, save perhaps a few very large ones, then burning off, &c., as before. In some districts, where frosts prevail, potatoes are planted just before the bush is felled. These potatoes grow, protected from the frosts by the felled timber. When the timber dries in the spring it is burned off. The potato-plants are, of course, also burned, but grow up again more vigorously than ever, the soil being enriched by the ashes. By this method potatoes are planted as early as July, thus insuring an early crop. This method is termed *whakapara*.

In lopping off branches in the *autara* method every branch must be so cut. If only those on one side of the tree are so cut off it is unlucky—*he aitua, he pouaru* (an evil omen)—a widow or widower; the workman will soon lose his wife, or will himself die. Stone axes were employed for such work.

The *hapai tu* mode is again different, for every tree is felled, and all logs, branches, rubbish, &c., removed from the ground—except perhaps some large logs—leaving the ground ready to be turned up for the crop. Observing a patch of bush where no big trees stood, I inquired the reason. The answer was, "*He hapai tu pea na nehera*" (Maybe it is a *hapai tu* of olden days).

The usual term for tree-felling in this district is *tope rakau*, but a better term is *tua rakau*. *Waere* = to clear by cutting down trees; hence *waerenga*, a clearing. *Para* = to cut down bush, &c.; to clear.

Stone Axes.

The felling of a tree of large size, as when making a canoe, obtaining timber for a large house, &c., was a serious undertaking to the neolithic Maori. It was accomplished by means of fire and stone axes. The process was an exceedingly tedious one. The *toki*, or stone axes, might be better described as adzes, inasmuch as they were helved as is an adze—or, rather, the relative positions of head and helve were similar, for in no case were handles inserted in the head, but the head was lashed on to the helve. The most prized stone was the *pounamu*, or greenstone, of which, however, the Tuhoe Tribe do not appear to have become possessed to any great extent, hence it was used by them principally for war-weapons and small axes, not for large *toki*. Small adzes (*toki*) were used for fine work, as in finishing off a canoe, &c. A small greenstone adze of this type in my possession is $2\frac{1}{8}$ in. long, the cutting-face is $1\frac{5}{8}$ in., while the *reke* or poll is but $\frac{7}{8}$ in. The thickest part—*i.e.*, the *uma*, or swell—is $\frac{3}{8}$ in. The greenstone *toki* and weapons or chisels were much more highly valued than those made of other kinds of stone. The other stones used for such implements were *kara, uri, onewa*, and *kohurau*. The first two are black, the third is dark-grey, while the last-named I am not acquainted with.

The different kinds, sizes, &c., of these adzes were known each by its own special name :—

Toki ngao pae.—A large, heavy axe for heavy roughing-out work.

Toki ngao tu.—A medium-sized axe (adze) for shaping beams, canoes, &c.

Toki ngao matariki.—A small finishing-adze.

Toki whakarau.—Seems to be the same as the *ngao matariki*. (See "*whakarau*," below.)

Toki pou tangata ; toki hohou pu ; toki whawhao pu.—These names are applied to small greenstone *toki*, helved as adzes, sometimes used for fine wood-working, but often merely carried by chiefs as a token of chieftainship ; carried in belt, or in hand when making a speech. Sometimes used to despatch a stricken foe in fighting.

Poki.—Concerning the *poki* I have no notes save two supplied by Mr. S. Percy Smith, who says, "The *poki* was a big stone axe, sometimes 18 in. long, lashed on in line with handle, not at right angles as an adze. I think that *poki* is a Ngai-Tahu word, but am not sure. The old-fashioned European axes were termed *poke*. The *poki* was used as a huge chisel, but without the use of a hammer."

Toki titaha.—My Tuhoe notes say, "The old-fashioned, long-bladed, steel axes obtained from European traders in early days. No longer seen." Williams's Dictionary says "*Toki titaha*, or *toki whakapae* : the common felling-axe." Tregear, in "The Maori Race," applies these two names to the big stone *poki* above described, which does not agree with Williams's or my own notes.

Poke.—The American-pattern steel axe. Not applied to any stone axe.

Paneke.—A steel hatchet. The term not applied to any stone tool.

Patiti.—An iron or steel hatchet.

Williams's Dictionary also gives *panekeneke* as a small iron tool, a hatchet. *Patiti kupa* is said to be the European squaring-axe, but *kupa* sounds suspiciously like "cooper."

Small *toki* were carried in the belt, but with large ones the handle was thrust down under the shoulder-cape, thus resting on the back of the carrier, being supported by the head of the axe resting on the collar of the cape. Handles for these stone axes—or, rather, adzes—were made of the branch of a tree, the *tawhero* and *matai* being favourite woods for the purpose. A small branch was selected for the handle; a secondary branch and a piece of the main branch from which it sprang was cut off and left adhering to the handle. The whole was then reduced in size, and properly shaped, being made smooth by means of hard rubbing on the rough outside of a *kaponga*, or tree-fern. Its shape was then like a human leg from the knee downwards, including the foot, the stone *toki* being lashed on to the sole of the foot.

The name of the above adze-like implement is *toki*, which name was also applied to metal axes obtained from early European voyagers and traders. European adzes are termed *kapu* and *kapukapu*, so called from their shape. The blades of our carpenters' planes were formerly much sought after for the purpose of using as adzes, being lashed on to handles like unto the one described above. The term *tarai* signifies to adze down or hew a timber with a *kapu* or *toki*. *Tarei* is a variant form of the above expression. To use a small implement, as a *paneke*, to shape a timber is described by the term *tukou*.

Regarding the term *whakarau* used above, it appears to signify the finishing-off process in timber-hewing, the smoothening of the surface with a small *toki*. When a workman is finishing off a canoe it may be asked, "How is So-and-so's canoe?" The reply will be "*E! Kua oti, kua whakarau te toki*" (O! It is almost finished, the adze is just doing the *whakarau*). It is then known that the *waimanu* (hollowing-out) work is done, and that the surface is being finished off. When the workman commences to *whakarau* a canoe-hull he casts a small stone into the hold thereof, in order to preserve his knowledge of the art of timber-working, that it may not be lost—*Kia mau tonu tana maramara, ara kia mau tona mohiotanga, kia kore e ngaro.*

In making stone axes and other implements the Tuhoe people seem to have obtained the stone from outside sources, the rocks within their tribal boundaries being principally a shattered slate, and in some parts sandstone, limestone, and volcanic tuff. Stone was obtained from the Wai-kato district, and also from the Wai-paoa River, inland of Poverty Bay. Pieces of stone were first chipped (*toto*) into something like the desired form, and then reduced, made smooth, and brought to an edge by means of rubbing on sandstone—a very lengthy process. The Maori did not use a handstone as we use a hone or whetstone for sharpening purposes: he laid the grindstone on the ground and rubbed the implement on it. Two kinds of sandstone were used by the Tuhoe people as grinders—one, known as *totara*, is a fine-grained stone of a reddish colour; the other, termed *tunaeke*, is a coarser-grained, greenish-coloured stone. In some places, where a surface of suitable sandstone was exposed, implements were taken to it, and the rubbing done there. At the Mimiha Creek, near Matata, is such a rock, in which are many grooves formed in days gone by by the neolithic Maori. Tuhoe obtained the *tunaeke* sandstone from a small stream near Kakanui, at Rua-tahuna.

Many of the stone adzes of the Maori were given special names, and many are famous in song and legend, such as Te Awhiorangi, Te Manokuha, Te Rakuraku-o-Tawhaki, and Hui-te-rangiora.

Certain charms were repeated over the stone *toki* used in felling and working timber, as in canoe-making, hewing out timbers for an important house, &c. Here is a specimen of such charms:—

Toki uri, toki uri, toki amoamo
Ake hoki au i taku toki nei
Kia rahirahi to kiki
Kia rahirahi to kaka
Nohea te toki nei e manihi
Nohea te toki nei e manaha
Te manaha nui a Tane
Ka whakarongo nui ake
Nui ake, nui marire
Koia ra tutara wiwini
Koia ra tutara wawana
Nohea i toki ai ?
No runga i toki ai
Oi !
Taku toki nei he riponga, he awhenga
Homai taku toki
Tu mai te toki
Haumi—e !
Taiki—e !

The following is said to have been a song, of the nature of a charm, which was sung in connection with, or as referring to, the *Whatu o Poutini* (apparently a term for *pounamu*, or greenstone):—

Kaore ra, e hine !
He putanga ki te tonga
Nou anake ra te putanga
Ko Whakahewa i te rangi
Nana i kimi ko Poutini, ko Wharaua
Ko te wai ra i tere ai te toki
Ka kitea i reira, e tuhi ana, e rapa ana
I raro i te whatu kura o Tangaroa
Ko whatu uira ra tena
Ko whatu rarama ra tena
Ka hewa e Rua tumata kurukuru
Tumata ka rewa
Homai, whakapiritia ki a Hine-tua-hoanga
Hai oro i te toki
He pua totara kauorohia
He pua totara kauorohia
Kauorohia te ati tipua
Kauorohia te ati tawhito
Hai whakakoi ra, e hine !
I te mata o te toki
Hai tuatua i te wao a Tane
I te tuatua i te wao a Tane
I te maramara o Tukehu
I te tama iara na Mumuhanga
Hai ara mo taua
Kia whiti ai taua
Ki rawahi o te awa
E hine !

The word *kauoro* is a form of *oro*, "to grind by rubbing on a stone." A grindstone is *hoanga*. Mumuhanga was, as we have seen, the origin of the *totara* tree, while Tukehu is said to be a daughter of hers, and the emblem or personification of the *totara*.

In felling trees, should a tree fall backwards (not the way it was intended to fell it), that circumstance was deemed an unlucky omen. If the tree hangs on the stump—*i.e.*, the butt thereof remains on the stump and does not fall to earth—that is also unlucky, and is termed a *hongi*.

When a man was employed in felling a tree he would expectorate into the *tuaumu* (scarf, kerf) in order to prevent his arms from becoming weary.

He kupu i mahue: Remarks omitted. When about to engage in felling and hewing timber for a house, canoe, fort, &c., the *karakia* or charm was repeated over the stone tools in order that they might do the work effectively, and that no mishap occur to such work, to the timbers, or workers thereat. There was a certain amount of *tapu* pertaining to the destruction or utilising of the Children of Tane (trees), or at least of the more important species thereof. When so working, all chips must be left where the work is done, and not burned or taken away. To do either of these things was deemed unlucky—the work would never be finished; some untoward incident would prevent its completion: so sayeth the Maori.

There are different methods of adzing timber. In finishing off slabs for a house a sort of pattern was often adzed on, marked by the "bite" of the tool as it took the timber at each blow. These different modes are known as *toro*, *heretua*, *miri*, *ao marama*, and *whakahekeheke*.

In felling a tree the Maori proceeded in the same way as we do—that is, by first cutting a front scarf on the side towards which the tree was supposed to fall, and then cutting a back scarf on the opposite side. A scarf was termed *umu*, *imu*, *tuaumu*, *tuaimu*, and *tarawaha*, the last-mentioned being a Ngati-Raukawa word. The front scarf I know not any special term for, but the back scarf (skärf) was called the *imu whakahinga*—*i.e.*, the *imu* which causes the tree to fall. To continue a scarf right round the trunk of the tree was looked upon as the work of an ignorant workman, as it is with us. Such a scarf was termed an *umu potaka* or *more potaka*. In felling a big-based tree, a stage, termed *whata* or *whatarangi*, was erected, on which the tree-fellers stood to work. In beginning the work, the large, heavy stone axe described above under the name of *poki* was employed. Being fastened on in line with the handle (by means of lashings of *aka*, the poll of the axe being butted against the base of a scarf in end of handle), this weapon was really used as a chisel. The handle was long, and held by several men, who grasped this shaft firmly, and at a given signal thrust it forward with all their strength, bringing the huge stone chisel into contact with the wood with considerable force. The process may be described as "bashing" rather than cutting as do metal axes. Personally I would prefer to use a Michigan double bit. Having "bashed" out a groove or channel of some depth for a desired distance round the trunk, the process was repeated higher up the trunk, the two grooves being horizontal and parallel, and some distance apart, in order to allow room for carrying the scarf in, and also to give sufficient space to kindle a fire therein. Having formed these two channels, the next thing was to split out the block of timber between them. This was chipped out in pieces by the same battering process with the *poki*, and in some cases hardwood wedges were employed. In the latter case a perpendicular groove would be formed by punching with a *poki*, in which slot the point of a wedge would be inserted, the wedge being driven in by means of a heavy wooden beetle or maul (*ta*).

Having carried the scarf in for some little distance by this process, a fire was then kindled in the scarf, and kept burning for some time. When the inner part had at last become charred (and it takes a long time, as I well do know, having tried it) the fire was raked out and the charred surface of the wood chipped with stone *toki*. This done, the fire was again kindled, and the process was repeated, charring with fire and chipping off, for day after day until the front scarf was considered deep enough. The back scarf was taken out in a similar manner, the work being continued, of course, until the tree fell. Certain charms repeated were believed to be of great assistance in this labour.

A member of the Ngati-Raukawa Tribe, Tamati Ranapiri, of O-hau, informed me that the *tarawaha* (scarf) was cut out on that side of the tree facing the wind. Presumably this would be the back scarf, so that the work would be assisted by the wind. His words were, "*Ka tuwhera te tarawaha ki te mata o te hau.*" He used the word *karo* to describe the chipping-out process. Ngati-Awa use the term *patoto* to indicate the "bashing" process with the heavy stone axes.

No level cut could be made in the trunk with an ordinary adze like *toki*, but it was often used for chipping off the charred inner surface (*konga* or *panga ahi*) after the fire was raked out, and for chipping off splinters on the face of the scarf.

On an islet in the Wai-kare-iti Lake stands a *totara* tree which some old neolith started in to fell in days gone by, but only cut in the front scarf about 5 in. or 6 in. From the top to the bottom of the scarf is about 30 in. space. The two grooves had been made and the timber between split out. The marks of the stone tools are plainly seen on the heart-wood, but at the edges the sap-wood and bark have grown over the wound.

Old Pio, of Ngati-Awa, had his little say on this subject: "*Te putake o te waka. Ko Tane te rakau, e tu nei i te ngaherehere. Ka tirohia, pae rua ranei, pae toru ranei. Ka mea te iwi Maori me tua hei waka. Ka hui te iwi ki te tua. Te toki, he toki kohatu. Te rua o nga toki, he ahi. Ka ki te tangata—me noho tonu i te taha o te ahi, i te take o te rakau, i tetehi taha o te rakau, i te imu whakahinga. Ka patoto te toki kohatu, ka ka te ahi ki te wahi e patotia ana e te toki kohatu, ka hinga, ka tareia, ka oti, ka whai waka.*" (The origin of the canoe. The tree standing in the forest is Tane. It is examined, and may be two *pae* [fathoms] or three [in circumference]. The Maori people propose to fell it and make a canoe. The people assemble to fell it. The axe [used] is a stone axe. Another axe [used] is fire. A person says, "Remain by the side of the fire at the base of the tree, on one side of it, at the *imu whakahinga.*" The stone axe dashes against the trunk. Fire is kindled at the place beaten by the stone axe. At length the tree falls, it is shaped, and finished, [the people become] canoe-possessed, &c., &c.).

The following account of the rites pertaining to tree-felling was given by Tutakangahau, of Maunga-pohatu, a direct descendant of the Children of the Mist, and our last old warlock and man of knowledge among Tuhoe :—

"These remarks concern certain works performed by the hands of man. A person desires to make a clearing in the forest, or to fell a tree for a canoe, or for house timbers, or for some other purpose. In the early morn he goes to the forest. He makes a certain contrivance, the semblance of an axe. He takes a small branch, and fastens to one end thereof a leaf (a leaf to represent blade of axe is secured to end of a stick). He then prepares for his task, girding himself by donning a belt, at the same time repeating—

Kai te hiahia (*a wishing*)
Kai te koronga (*a desiring*)
Kai a Tane (*for Tane*).

He then grasps his toy axe, and strikes the trunk of the tree that he desires to fell with the leaf—although, of course (as Tu quaintly puts it), no chips will fly with such an axe. Then he recites the following charm :—

He ao pukapuka
He ao mahamaha
He toki henahena
He toki ta wahie
Ka pa ki tua
Ka pa ki waho
Ka pa ki a Tane.

He then takes up the real axe and strikes therewith the tree. When the first chip flies off he ceases to chop, picks up the chip and carries it away, leaving his companion to continue the chopping at the tree. The man goes off with his wooden chip into the forest. At length he stops, and listens. If he hears the sound of the axe beating on the tree-trunk he again goes on, then stops again to listen. When he can no longer hear the sound of the axe he halts and kindles a fire, which is known as the *ahi tumuwhenua* (*tumuwhenua* fire). This fire is kindled by the friction process. When the fire burns up he places the chip in it and repeats the following *karakia* (charm, spell, invocation) :—

Hika ra taku ahi
E tumutumu whenua
E aneane whenua
E raro timu, e raro take
E Hawaiki
Ka hika ki te ibi o Tane
Ka hika ki te mana o Tane
Noho mai i tua na
E tapu ana Tane
E maota ko te rangi o Hawaiki—e.

This is the *tumutumu-whenua* fire (or rite). The chip is burned in this fire. This rite and chip are for the gods. The man now returns to his companion; the chopping continues, until many chips are collected, when another fire is kindled by friction near the base of the tree. This is the *ahi purakau* (*purakau* fire). The chips are burned in that fire. Food is cooked. This is to take the *tapu* off, that the proceedings may be freed from *tapu*. This rite is to (placate) Tane. The other, the *tumutumu whenua* was to the gods. Now the officiating person recites a *karakia* (incantation, &c.). This is the *karakia* of the *ahi purakau* :—

Hika ra taku ahi, e Tane
Hika ra taku ahi, e Tane
He ahi purakau, e Tane
Ka hika i te ihi o Tane
Ka hika i te mana o Tane
Ka hika i te marutuna o Tane
Ka hika i te maruwehi o Tane
Ka hika i te pukapuka o Tane
Ka hika i te mahamaha o Tane.
Ka kai koe, e Tane
Ka kai hoki au, e Tane
Ka mama nga pukenga
Ka mama nga wananga
Ka mama hoki ahau
Tenei tauira.

This rite takes the *tapu* off Tane (*i.e.*, off trees, the offspring of Tane), to prevent him punishing the tree-fellers—to prevent the axe being broken, or the workmen being cut by an axe. The closing lines mean that offerings (placatory ?) are made to the *pukenga* and *wananga*. When the food (ritual or sacerdotal feast) is cooked, then the *taumaha* rite is performed. The officiating priest takes a small portion of the food, and repeats over it the charm termed a *taumaha*, as you Europeans say a prayer before a meal. This not only completes the lifting of the *tapu* from the food, the work and workmen, but is also a *pou* (it strengthens or supports the workmen), and it wards off evil influences and sickness from the workers, and prevents them from becoming unduly wearied. It makes them intelligent and clear-minded at their work, and pertains to Tane. Here is the *taumaha* :—

Tenei te pou ka eke
Te pou kai a koe
Ko te pou o tenei mahi
Tiaho i roto
Wananga i roto
Korero i roto
Tena te umu
Te umu ka eke
Ko te umu o tenei whaihanga
Ka ma taku hau tu
Ka ma taku hau mahi

Ka ma moe tu
Ka ma moe rere
Ka ma moe te whakaarahia
Whakaarahia i te ata hapara
Ka ma tatua mau wawe
I te ata hapara
Ka ma nga pukenga
Ka ma nga wananga
Ka ma hoki matau
Enei tauira.

By this rite the priest has now taken off the *tapu* pertaining to the proceedings and the food. The people can now eat of the food and continue their labours."

Such is old Tu's account of these tree-felling rites, the best description I have collected. The *taumaha* was recited over the foods at all ritual feasts. Another form may be seen at page 96, vol. xxxv, of the Transactions. All religious rites were performed early in the morning, before the people partook of food, or after sunset. When about to perform any rite, the officiating priest divested himself of all his clothing, and secured a girdle round his waist. This girdle often consisted of nothing more than a few green branchlets of *karamuramu* (a *Coprosma*). The true meaning of the above ceremonies and invocations was to placate Tane (the origin and tutelary deity of forests, trees, and birds) and the gods of the Maori pantheon, that they might not resent the felling of the tree or trees, and hence punish the fellers thereof for their sacrilegious act in slaying the offspring of Tane. The first sacred fire and rite are for the gods (*atua*), the second for Tane.

Another note, from Pio, of Awa, is brief and unsatisfactory :—

"Another remark : Persons go to the forest to fell a tree for a canoe. The first thing done is to kindle the *ahi purakau.* When it burns up, a chip, a piece of bark, is put on the fire, as also some *mauku* (a fern—*Asplenium bulbiferum*). The fire is kindled at the base of the tree. Then the *karakia* is recited :—

Ana ra te ahi
Ki te take o te rakau
Te maramara o Tane
Ka pokaia koa
Te riu tapu nui o Tane
Ka tapahia koa
Te kauru tapu nui o Tane
Whiwhia mai, rawea mai
Rei kura, rei ora
Torohei.*

Then the tree is felled. There will be two scarfs cut in that tree, the *imu tua* and the *imu whakahinga.*"

* Evidently incomplete.—E. B.

A reference to the above rites may be found in "Nga Moteatea," page 105. For the expression "*Tane tumuwhenua*," see Trans. N.Z. Inst., vol. xxx, page 52. A Ngati-Awa note in my note-book says that when a canoe was dubbed out in the forest, fronds of the *mauku* fern were fastened thereon, though the meaning of the act is not explained. In vol. 3 (page 4) of White's "Ancient History of the Maori" a similar custom is mentioned. This occurs in the well-known legend of Rata felling the forest-tree, which the forest elves re-erect on its stump, because their consent to the felling thereof has not been obtained. The forest folk said to Rata, "It is for us to consent to you cutting the throat of your ancestor, Tane-mahuta, and felling him. When you have felled your tree, then fetch some *paretao* (a forest fern) and cover the butt (or stump) of your tree, and then set to at hewing the trunk." These forest elves were the Tini o Te Hakuturi. These folk were wont to punish persons who did not placate the gods and spirits of the forest, as also Tane, in that manner. They chanted a charm that caused the tree to stand up on its stump again, and the chips to return to their original position.

Hauling Trees.

When engaged in dragging heavy logs from the forest, such as the ridge-pole of a large house, or a canoe, the hauling-track was carefully selected and cleared. Skids were laid down, over which the heavy timber was hauled. The *puahou* (or *parapara*) furnished these skids, it being used because of the slippery nature of the surface of the wood when the bark is removed. Long forest-creeper stems were attached to the timber or canoe, and used as drag-ropes. Such hauling-work was never done without the use of hauling-songs (*tau to*), of which there were many. These consisted of brief lines sung by a fugleman, and a chorus, generally consisting of but one or two words, to each line. The chorus was given, in deep tones, by the haulers, who all hauled at the drag-ropes as they shouted. People would collect from many hamlets for such a task, which was conducted as a working-bee (*tuao*). Women accompanied such parties to carry and cook food; in fact, it was a picnic for the whole subtribe or family group.

He Tau to Waka (A Canoe-hauling Song).

(The italicised words repeated by haulers as a chorus and signal for united action in hauling.)

Ka piki te iwi
Ka kake te iwi
Pikipiki, kakekake!
Ki te rangi nui au e moko (? a Ue-moko)
Pouri
Pouri!

Potango
Potango !
Hakere ra—i, mau ra—i
He tieke, he tieke Tangaroa !
Tu mai te toki
Haumi—e !
Te hiwi, te maunga e tu mai nei
E tupa
Hoi eke !
E tupa
Hoi eke !
Tupato
Hoi eke !
Homai te tu
Kauaia !
Homai te maro
Kauaia !
Kia hurua
Kauaia !
Kia awhea
Kauaia !
Ki te takapu (? takupu)
Kauaia !
Ki te takere
Kauaia !
No te hanga
Kauaia !
No Tane
Kauaia !
Titi—e
Tata—e !
Kei te puke iti kei tatahi
Niore, naiore !
I pati kau te wai o te ure
Turuki !
Turuki
Turuki !
Paneke
Paneke !
Mau ai te tieke
Tena koia !
Tane rauihi
Tane mama !
Tane hikitia
Tane hapainga !
Tane toimaha ki te rangi
Tane puha, tane mama !
Tane hik'tia ki te uru
E ki te rangi !
Ka tapu te waka nei
Tukutuku *rawa te waka nei !*
Nga whenua te waka nei
Ko te whenua te waka nei !
Aotearoa te waka nei
Ko kahukura, ko waiho tere !
Turuki, turuki
Paneke, paneke awa !

Should any error be made in the rendering of these hauling-songs, it is looked upon as an unlucky omen.

There were certain rites performed at the launching of a new canoe, and at the opening of a new house, at which religious ceremonies a human sacrifice sometimes took place.

The idea of the indwelling spirit of the tree, as also those of tree gods or forest deities, are far spread o'er the earth. In Burmah, Siam, and other eastern lands this belief appears to have been universal and strong. Presumably the belief in tree spirits and such small deer would merge into that of a god of vegetation as a people advanced in culture. The Maori looked upon Tane as the origin of all trees and plants, but also believed in divers breeds of forest elves, &c., and held that the ancestral gods would punish persons who interfered with any forest products, tree, or bird-life, unless he performed rites of placation or propitiation. In fact, a system of placatory rites and invocations was the very essence of Maori religion.

"*Takoto kau ana te whanau o Tane*" (The offspring of Tane lie low) is a saying heard when a tree has been felled, or a piece of forest-ground cleared.

In turning over a heavy log the Natives used wooden hand-spikes and levers, also a contrivance termed a *poipoi*. A hole was made in one end of the log (so as not to spoil the timber in the middle of the log), and one end of a long pole inserted in this hole. A long rope was fastened to the upper end of the pole, and a number of men "tailed on" to this line. By means of this crude windlass arrangement a considerable leverage was gained. Old Tutaka, my informant, was not quite sure, however, that this contrivance was known to them in pre-*pakeha* days. It may have been adapted from our "Spanish windlass."

Splitting Logs.

The tools used by the Maori in splitting timber for house timbers, &c., were extremely primitive, and consisted of wooden wedges and a wooden club for a maul. This maul or beetle was termed a *ta*, and was simply a heavy club of *maire* wood, a very hard and close-grained timber. The roots were preferred, as being less liable to split.

"*Mehemea ko te ta o Manunui-taraki*" (It reminds one of the maul of Manunui-taraki). This Manunui was an ancestor who used a remarkably heavy maul with ease; hence the above saying is often heard when a man performs some noteworthy feat of strength, as in lifting weights.

A splitting-wedge is called *matakahi*, while a wedge used for tightening, as in helving a European axe, was termed a *matia*.

The splitting-wedges were of different sizes. Small entering-wedges (*hai toro i te ara*) were known as *pipi*, while large bursting-wedges were called *kaunuku*. An old Maori saying is this—"*Ko te pipi te tuatahi, ko te kaunuku te tuarua*" (The *pipi* is first used, then the *kaunuku*)—which may be applied to many situations. Bad-splitting timber, with inlocked grain, is described by the terms *puti* and *humengemenge*, and straight-grained good-splitting timber as *makohe*. The term *tahatonga* is also applied to timber difficult to split, because it is said to be a peculiarity of *tahatonga* trees—that is to say, of trees exposed to the south winds. Some Natives state that the bark of trees is thickest on the north side, the side facing the sun.

A proverbial expression of former times: "*He kino tangata, e kore e taea; he kino rakau ka taea*" (Human faults cannot be overcome, but timber faults may be). This alludes to inferior, bad-splitting, faulty timber.

Having no metal tools, the working of timber was an excessively arduous task to the Maori, and much timber was wasted in dubbing down logs or large balks to the desired size, for slabs, &c.

When a long-continued rain occurs in spring or summer, the expression *whakahapu kakano* (seed-conceiver) is applied to it. "It is raining," remarks some one. "Nothing but the trees blossoming and producing seeds (or pollen)," says a person of knowledge, "for such is the effect of rain during the fourth to the eighth months (of the Maori year): it causes male trees to blossom."

The expression *taru kahika* (*ta* = causative prefix, hence *taru kahika* = *whakaru kahika*) is applied to a light rain in summer-time, or to cloudy, damp weather after rain, with a sea-breeze, or showery weather. Such is said to cause the *rata* to blossom, and to loosen and distribute the pollen of the *kahika* and other trees. A person says, "It is raining; we will get wet." "Not at all," remarks another, "it is only a *taru kahika*."

In Maoriland the year began in winter. Its commencement was marked by the appearance of the Pleiades (*Matariki*) on the eastern horizon just before dawn, which occurs about the middle of June. If the stars of *Matariki* are indistinctly seen—do not stand out distinctly—that is said to be a sign of a cold, unprolific season to follow. But if these stars stand out distinctly, then a warm, fruitful season follows. The four seasons are—*takurua*, winter; *te koanga*, spring (digging or planting season); *raumati*, summer; *ngahuru*, autumn.

The following expressions are used to denote various kinds of seasons :—

Tau mahana.—A warm season; prolific.

Tau horahora; tau hua; tau ruru; tau kai.—A prolific season; food products plentiful.

Tau matao.—A cold, unprolific season.

Tau tukuroa.—Slow growth of crops; late fruiting of trees, &c.

Tau tane.

Tau wahine.—Denotes quick growth, abundant foliage, good crops.

Tau niho roa.—A season during which birds and rats eat all kinds of food. Rats bold at eating crops.

Tau maro.—A backward season; poor growth of crops, &c.

If the *riroriro* bird builds its roofed nest with the entrance thereto facing the north, the prevailing winds of the coming season will be from the south. When the forest-trees commence flowering, or the fruit forms, on the lower branches first, and so proceeds upwards, a *tau mahana*, or prolific season, follows; there will be no late frosts. But if such blossoming, &c., begins on the uppermost branches, and so on downwards, then a *tau matao* ensues.

Inasmuch as our forest-lore notes are scarce half-completed, we will here cease our labours for a space, leaving the balance for the days that lie before. *E rau rangi pea ka kitea.*

Art. XVI.—*Additions to the New Zealand Molluscan Fauna.*

By W. H. Webster, B.A., Waiuku.

[*Read before the Auckland Institute, 12th December, 1907.*]

Plates XX and XXI.

Acanthochites (Loboplax) mariae, n. sp. Plate XX, figs. 1–11.

Shell elongated, elevated, dorsal angle about 110. Colour greenish-grey, minutely freckled with dark. Latero-pleural areas crowded with flattened granules, strap-shaped or oval, as in *A. zelandicus*, all the valves being bordered with irregular, raised, white, pebble-like granules of the same type as those in *A. violaceus*, with which this species also agrees in having 5 prominent lobes on the anterior valve, the ribs being of white raised elongated granules, the ribs of all valves similarly marked; another characteristic feature is the presence of three almond-shaped white granules just within the posterior edge of each median valve. Dorsal areas wedge-shaped, the edges being serrated, sculptured with cuneiform lyrulae. The posterior valve has the tegmentum longer than the breadth, the hooked mucro being slightly post-median; the area behind it is concave, white, composed of oblong granules, bordered on either side by others of longer form, but the same colour. Anterior valve with 5 slits corresponding to the ribs; median valves with 1 slit; posterior with many slits, the denticles being mostly bifid. In the type these denticles are perpendicular, and not visible from above; in other specimens they extend outwards, and may be seen beyond the tegmentum; in such specimens the mucro is not so prominent, the white area narrower, and composed of long granules like those bordering the oblong granules of the type, these latter being altogether absent, as also are the raised white borders of the valves. It may be that these specimens have not attained their full development, as none of them approach the type in size. Interior blue-green, white towards the edges. Girdle grey-green, leathery, a minute pore at each suture, 4 on anterior valve. The dotted lines on figs. 5 and 7 show the limit of the white granular patch. Figs. 6 and 7 represent the posterior valve of a second specimen.

Length of dried specimen, 35 mm.; width, 18 mm.

Hab.—Orua Bay, Manukau Harbour; on rocks at low tide.

Type in my collection.

The type is unique; seven of the less-developed specimens were found. The apparent hybridism is striking, especially as I have never found *A. violaceus* on the west coast, though a very small form of *A. zelandicus* is fairly common. Professor Pilsbry remarks (Man., vol. xv, p. 17) that another species of *Acanthochites* will probably be found. I have not given the dentition, as it is of little value in determining the position of species or genera of the *Placophora*.

Named after my wife, who is an enthusiastic collector.

Tornatina oruaensis, n. sp. Plate XX, figs. 12–15.

Shell cylindrical, white, of $3\frac{1}{2}$ whorls, slightly concave in the crown, above the centre of which projects the smooth protoconch, tilted at an angle of somewhat less than 90°. Sculpture: Faint growth-lines, prominent posteriorly, following the curve of the outer lip, the surface scored with fine wavy spiral furrows. Suture deep. Type I: Crown hollow, the tilted apex visible above it. Outer lip longer than the shell, advancing in the centre and rounded anteriorly; columella arcuate, with a thin but distinct labial pad and a very strong fold, which is thickened anteriorly. Type II: Apex subscalar; aperture shorter than the shell; columella with a much slighter fold than the last.

These shells (about 50), obtained by dredging, show many variations of apex between these types; the protoconch is never sunk below the crown, as in *Cylichna*. In the Manual no similar shell appears.

Height, 3 mm.; breadth, 1·25 mm.

Hab.—Orua Bay, Manukau Harbour; in 3 fathoms.

Types in my collection.

Trochus carmesinus, n. sp. Plate XX, figs. 16–18.

Shell broadly conical, with $4\frac{1}{2}$ slightly triangulate whorls and flattened base. Colour pale-pink, speckled and marbled with bright crimson. Sculpture: The entire shell finely spirally striated, about 21 on body-whorl and the same on base; a smooth band round periphery. Protoconch very small, of $1\frac{1}{2}$ whorls. Suture distinct, not deep. Aperture quadrate. Columella very sloping, with a large denticle near its junction with the body. Umbilicus: A pervious funnel, in which the spiral is faintly visible. Animal and operculum unknown.

Height: Major diameter, 8 mm.; minor diameter, 6·25 mm.

Type in my collection.

One beach specimen from Russell has been in my possession for some years. Confirmation has now arrived in the form of two specimens from Cape Palliser, found in shell sand.

Trochus oppressus, Hutton, is dark-green in its normal condition, and has a band of sharp radiate wrinkles beneath the sutures, the plain band round the periphery alone being polished. It is possible that this is the shell referred to by Suter (P.M.S., vol. ii, pt. 6, p. 261) as having been reported by T. W. Kirk from Wellington.

Thaumatodon iredalia, n. sp. Plate XXI, figs. 19–22.

Whorls 4, last descending. Colour horny, irregularly blotched with dark-brown. Protoconch $1\frac{1}{4}$ whorls, striated. Sculpture: Body-whorl with growth-lines, spiral striations, and 13 strong ribs, which slope backwards from the suture, and extend, sloping forwards, into the umbilicus, which is pervious, and occupies $\frac{1}{4}$ of the major diameter. Aperture advancing slightly above. The body has 1 simple lamella within the aperture; it is hardly visible until the shell is revolved so as to see well into the opening (fig. 21).

Major diameter, 3·25 mm.; minor diameter, 3 mm.; height, 1·5 mm.

Hab.—Two specimens, both dead, but in perfect condition, from Ashley Gorge, Canterbury. (Bush since burnt.)

Type to be presented to the Christchurch Museum.

Sent to me by Mr. T. Iredale, a painstaking and enthusiastic conchologist, who seems to be doing good service in the difficult branch comprising our marine minutiæ.

I have much pleasure in calling this pretty shell after the discoverer.

Thaumatodon mira, n. sp. Plate XXI, fig. 23.

Whorls 4, the last descending more than that of *Th. tau.* Colour horny, banded with chestnut. Protoconch $1\frac{1}{4}$ whorls, finely malleated. Sculpture: Body-whorl with 40 varicosely angled sinuous ribs, also growth-lines and fine spiral striations. Umbilicus pervious, occupying $\frac{1}{3}$ of the major diameter. Aperture advancing slightly above. The apex is more deeply sunk than that of *Th. tau*, the crown being quite hollow. The body has a lamella within the aperture, not easily recognised as bifid in the position in which the shell is drawn (fig. 23), but its character is clearly seen by revolving the shell slightly: In the illustration the lower flange is seen somewhat sideways, the upper flange appearing edgeways above it; the latter is more prominent than the former. A second short lamella is seen on the outer lip near the columella. Some specimens have a callous white patch inside the aperture on the periphery, thus almost linking them with *Th. tau*, which usually, however, has a third lamella without a white patch. The exterior of the shell bears no resemblance to *Th. tau*.

Major diameter, 3 mm.; minor diameter, 2·75 mm.; height, 1·5 mm.

Hab.—Waiuku: not common.

Type in my collection.

In vol. xxxvii of these Transactions I mentioned that specimens of *Th. varicosa* found in this neighbourhood had 2 lamellæ in the aperture instead of 1, as recorded by Suter *fide* Mr. E. A. Smith. A closer examination reveals the division of the body lamella into 2 flanges, which seems to remove this shell from *Th. varicosa*: it is still further separated by the fact that Pfeiffer describes *Th. varicosa* as moderately umbilicated and *Th. tau* as widely so, while my new shell is more widely umbilicated than *Th. tau*. The latter is one of our commonest shells, and is very variable in the number of ribs; but their character is constant. These shells also vary in height. I have one specimen almost the same height as *Charopa egesta*, which it greatly resembles in outline.

Kellia bifurca, n. sp. Plate XXI, figs. 24–29.

Shell somewhat quadrate, pale-grey; at first glance somewhat resembling *K. parva* in sculpture, but a closer examination reveals the linear markings, which, though irregular, have one general direction. The concentric growth-lines are very marked, dividing the entire shell into bands, in each of which the sculpture varies somewhat. Prodisoconch and first $\frac{1}{3}$ of the shell white, translucent, and devoid of sculpture; it follows that all young shells are likewise colourless when alive and white when dead. Umbones directed forwards, pointed, shining. Hinge: a large posterior resilium, but no visible external ligament, and no lunule; 1 cardinal tooth in each valve, sometimes accompanied by a small point under the umbo in the right valve and a clumsy thickening of the margin in the left valve, as at fig. 29; an anterior and a posterior lateral in each valve; in some specimens a second posterior in each valve. Pallial line entire. The shell is characterized by two clumsy internal patches of varying shape in different specimens, extending downwards and outwards from behind the hinge; in young shells these are milky, and may be seen through the shell, reminding one of the description of *Thyasira albigena*, Hedley; in mature shells these patches spread and thicken clumsily in such a manner as to seriously diminish the capacity of the shell.

Height, 3·25 mm.; breadth, 4 mm.; depth from valve to valve, 2 mm.

Hab.—Orua Bay, Manukau Harbour; plentiful in 3 fathoms.

Type in my collection.

Rissoina coulthardi, n. sp. Plate XXI, figs. 30–32.

Shell imperforate, milk-white, loosely coiled, especially the last whorl, the aperture and its posterior callosity occupying exactly one-half the entire length of the shell. Protoconch minute, shining, colourless. Whorls 5, somewhat flat, extremely glossy, the body-whorl with a few longitudinal markings of pale-brown; in some specimens these stripes are transparent. Suture shallow. Base of one specimen (not the type) with 4 spiral lines. Aperture pear-shaped; a heavy callous at the juncture with the body, and a partly concealed arch in the angle. Columella nearly upright, with a wrinkled twist on the outside of the pillar. Animal and operculum unknown.

Height, 3 mm.; width, $1\frac{1}{2}$ mm.

Hab.—Orua Bay, Manukau Harbour; fifty specimens in 3 fathoms.

Type in my collection.

Mr. Suter, who has seen this shell, says that it resembles his *R. parvilirata*.

Named after the well-known family of Coulthard, in Orua Bay, a member of which kindly assisted me in my dredging.

EXPLANATION OF PLATES XX AND XXI.

PLATE XX.

Figs. 1–4.	*Acanthochites mariae*, n. sp.;	valves 1, 2, 4, 8.
Fig. 5.	,, ,,	valve 8, profile.
Figs. 6, 7.	,, ,,	valve 8, another specimen.
Figs. 9–11.	,, ,,	interior of valves 1, 4, 8.
Figs. 12–14.	*Tornatina oruaensis*, n. sp.	
Fig. 15.	,, ,,	another specimen.
Figs. 16–18.	*Trochus carmesinus*, n. sp.	

PLATE XXI.

Figs. 19–22.	*Thaumatodon iredalia*, n. sp.	
Fig. 23.	,, *mira*, n. sp.	
Figs. 24, 25.	*Kellia bifurca*, n. sp.;	right valve.
Figs. 26, 27.	,, ,,	left valve.
Fig. 28.	,, ,,	sculpture.
Fig. 29.	,, ,,	hinge of another specimen.
Figs. 30–32.	*Rissoina coulthardi*, n. sp.	

ART. XVII.—*The Bipolar Theory.*

By H. FARQUHAR.

Communicated by Professor H. B. Kirk.

[*Read before the Wellington Philosophical Society, 2nd October*, 1907.]

SINCE my paper on the evidence for the bipolar theory in the littoral marine fauna of New Zealand* was written I have gathered a few more scraps, which may be taken as supplementary.

Mr. F. Chapman, Palæontologist to the National Museum, Melbourne, who described the *Foraminifera* recently dredged up from 110 fathoms off the Great Barrier Island, says, "Another interesting feature of the present assemblage of *Foraminifera* is the presence of a large number of forms which have hitherto been found in dredgings from other, widely removed, areas, generally in the Northern Hemisphere; and particularly from the colder waters of the Temperate Zone."†

Three species of marine *Bryozoa* besides those given in my former paper appear to be common to New Zealand and the North Atlantic—namely, *Cellaria fistulosa*, Europe and New Zealand; *Plumatella princeps*, identical with or closely allied

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* Trans. N.Z. Inst., vol. xxxix, p. 131.

† Trans. N.Z. Inst., vol. xxxviii, p. 77.

to the European form; and *Ætea recta*, Arctic and Europe, closely related to *Æ. anguina*.

The nudibranch mollusc *Goniodoris castanea* occurs in New Zealand and Britain. The genus *Homoiodoris* has only two known species—one (*H. neozelanicus*) occurs in New Zealand, and the other in Japan.

The enteropneust *Dolichoglossus otagoensis*, Benham, has a grooved proboscis, "which is only known in one other species (*D. sulcatus*, Spengel) from Japan; and the polynoid *Physalidonotus squamosus* (*Lepidonotus giganteus*, Kirk) represents peculiarities, indicated by its generic name, that have hitherto only been noted in two Japanese polynoids, recently described by Moore as *Lepidonotus branchiferus* and *L. chitoniformis*, but which probably should be included in Ehler's new genus just mentioned." (Benham.)

A sea-star from Japan closely allied to our common littoral form *Asterias calamaria* has been described by Doederlein under the name *A. calamaria*, var. *japonica*.* The New Zealand species occurs also on the east coast of Australia and in Mauritius.

Although there is but little evidence for bipolarity in our land fauna, the fresh-water fauna contains many bipolar forms. *Retropinna richardsoni* is the southern representative of the smelt of northern Europe and America.

Of the 130 species of *Infusoria* given in the "Index Faunæ," no less than eighty-four are said to be identical with European forms. I cannot say that these identifications are correct, but Maskell, who was a good observer, and had a great deal of experience in the determination of microscopic forms (*Desmideæ*, *Coccidæ*, and *Aleurodidæ*), told me shortly before his death that, on account of doubts expressed by a European naturalist, he had reviewed his identifications, and had concluded that our species could not be separated from those of Europe.

Of the forty-two species of *Rotifera* recorded from New Zealand, thirty-four are European.

The fresh-water sponge *Spongilla lacustris* occurs in our streams and lakes, and also the common European hydra (*H. viridis*), and a species of *Cordylophora*, which, if not identical, is nearly related to *C. lacustris*.

"The fresh-water shell *Latia*, which is living in New Zealand, is fossil in North America. It is closely related to *Gundlachia*, which inhabits Tasmania and North America . . . . The fresh-water spider *Cambridgea* is almost identical with *Argyroneta* of Europe." (Hutton.)

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* Zool. Anz., xxv, p. 332.

A number of New Zealand plants, especially those of the mountains, have representative forms in Europe and America. The tutu (*Coriaria*) may be taken as an example. "Our common tutu (*Coriaria ruscifolia*) occurs equally commonly on the Chilian Andes; the smaller-leaved mountain form (*C. thymifolia*) ranges along the whole chain of the Andes from Chili up to Mexico; while the little narrow-leaved form (*C. angustissima*) appears to be confined to the mountains of the southern part of the colony. Besides these, two or three other species occur in southern Europe, in the Himalayan region, and in Japan." (Thomson.)

The facts regarding the distribution of our fauna and flora which have been recorded appear to prove the close alliance of a large number of species with those of the northern temperate and sub-Arctic regions; and, if some of the forms now supposed to be identical are ultimately found to be distinct, their near relationship is, however, undoubtedly established.

The most probable explanation of the occurrence of the same or closely allied species of plants and animals at widely separated stations is that they occupied continuous areas of distribution in remote times, when the physical conditions on the earth—climate and distribution of land and water—were different from what they are now.

Very few of our higher forms of animal-life have representatives in the north, but the number of representative and identical species increases as we go down to the lower forms. Mr. A. McKay informs me that the same obtains among the fossils. And, as regards time, a number of our Upper Tertiary fossils are nearly related to or identical with northern forms; the number increases in the Lower Tertiary, and goes on increasing through the Mesozoic formations, till we come to the Palæozoic forms, almost all of which appear to be identical or nearly related to those of northern Europe and America.

We much need a Palæontology of New Zealand; a great quantity of material has been collected, and is waiting in Wellington to be worked up, but a New Zealand palæontologist has not yet come.

Art. XVIII.—*Notes on the Destruction of Kumaras from the Friendly Islands (Tonga), caused by an Imported Weevil, with Descriptions of the Larva, Pupa, and Perfect Insect, &c.*

By Major T. Broun, F.R.E.S.

[*Read before the Auckland Institute, 12th December, 1907.*]

Plate XXII.

During the years 1906 and 1907 I noticed numbers of imported kumaras that had been badly perforated by weevils, so several samples were secured and kept under observation in glass jars, in order that the perfect insect might be reared and identified. That operation was successful.

It was very desirable that that tedious process should be accomplished, because considerable quantities of kumaras might be illegally condemned by some experts of the Agricultural Department, who, no doubt, might imagine that the kumaras were infested with the potato-moth (*Lita solanella*), which belongs to an entirely different order of insects, and no more resembles the weevil than chalk resembles cheese. Indeed, one of the local importers assured me that such illegal condemnation had actually occurred.

Not only does this weevil attack kumaras, which is bad enough when potatoes are scarce and dear, but I have also reared it from island oranges. Here again the question of unauthorised condemnation arises, as the only prohibited insects are the Queensland fruit-fly (*Tephrites tryoni*) and the Mediterranean species (*Halterophora capita*); but another fly, discovered and described by me (*Dacus xanthodes*), which is just as destructive as the Queensland species, though found as far back as December, 1903, and afterwards reared in large numbers from island oranges, mammæ-apples, grenadillas, and more rarely from pineapples, has never been included in the schedule of the Orchard and Garden Pests Act.

The description of the fly (*Dacus xanthodes*) appeared on page 327, vol. xxxvii, of the "Transactions of the New Zealand Institute" for 1904, and also, what is more remarkable, on page 306 of the report of the Agricultural Department for the same year.

DESCRIPTION OF THE KUMARA-WEEVIL.

Cylas turcipennis, Shœnherr.

Generic Characters.

Body apterous, subcylindrical, transversely convex, medially constricted. Mandibles very short. Rostrum one-third shorter than thorax, cylindrical, moderately slender, subparallel. Scrobes antemedian, not visible above, forming deep oval cavities underneath and prolonged backwards as grooves extending to the eyes. Eyes longitudinally oval, lateral, finely faceted, distant from the thorax and each other. Thorax twice as long as broad, deeply constricted behind the middle, base and apex truncate, without ocular lobes. Scutellum absent. Elytra oviform but very elongate; shoulders much narrowed. Legs long; femora slender and stalk-like at the base, somewhat clavate towards the extremity; tibiæ unarmed. Tarsi elongate, 3rd joint deeply bilobed, with dense brush-like soles; between these soles the atrophied minute 4th joint may be detected; claws simple.

Anterior coxæ large and prominent, almost quite contiguous; intermediate globose, separated by the slender mesosternal process. Metasternum elongate. Abdomen elongate, the basal 2 segments of about equal length, their suture indistinct in the middle; 3rd and 4th short, with deep sutures; 5th slightly broader than long.

Male.—Antennæ not geniculate, composed of 9 joints; all of these are transverse, except the large basal joint, which is pyriform, but slender at the base. Club 1-jointed only, cylindrical, nearly twice the length of the preceding 9 joints combined, finely asperate and pilose.

Female.—Antennal articulations 2 to 9 of the funiculus are each longer than those of the male, obconical. Club elongate-oval, similarly pubescent, but only about half as long as that of the other sex.

Obs.—Lacordaire terms the basal joint of the antennæ the scape, giving 8 joints to the funiculus, but as the antennæ are not elbowed I have described them as 9-articulate, with the additional 1-jointed club.

Specific Description.

Elongate, shining; elytra blue; head and rostrum darker; thorax red; legs infuscate red; antennæ nigrescent, but with the club and the base of the 1st joint reddish.

Rostrum moderately slender, finely and distantly punctured rather more closely near the apex. Head slightly and gradually narrowed anteriorly, with very few minute punctures, the interocular space rather dull and feebly bi-impressed. Thorax convex, nearly twice as long as it is broad, behind the middle deeply and widely constricted, its basal portion evidently narrower than the laterally rounded frontal part, its surface smooth, there being only a few minute punctures. Elytra more than twice as long as they are wide, rather wider near the middle than the thorax, much narrowed posteriorly; they bear several series of minute punctures, in each of these there is a very small inconspicuous grey seta. Legs finely setose; tibiæ slightly flexuous, and thickened at the extremity; tarsi pilose above.

Under-side transversely convex. Prosternum somewhat incurved in front. Metasternum and ventral segments dark-blue, the coxæ and mesosternum reddish, sometimes other parts are rufescent. The short 3rd and 4th segments are densely and minutely sculptured. The general sculpture and clothing are much like those of the dorsum.

Length, rost. incl., $3\frac{1}{4}$ lines; breadth, $\frac{5}{8}$ line.

Description of the Larva.

Length, 3 lines; breadth, $\frac{3}{4}$ line.

Cylindrical, with a tendency to become a little arched; 3rd, 4th, and 5th segments just perceptibly broader than the others. The head, 1st segment, rather small, nearly circular, with a fine longitudinal central groove, but without other definite sculpture. Mandibles short and inconspicuous, dark-brown. Trophi small.

Along the back there is an ill-defined linear impression between the 3rd and 10th segments. The 2nd and 13th segments are not well delimited, but between the others there are contractions, so that the side of each of these appears prominent and rounded. The surface is minutely shagreened and more or less uneven, below as well as above, but not distinctly punctate, and there are only a few short greyish setæ visible.

No eyes or legs are perceptible; these latter, however, are represented underneath on the sternal segments in front by smooth nodosities.

In the kumara itself the larvæ are nearly white, but become of a pale brownish-red after immersion in formalin and water.

Description of the Pupa.

Length, $2\frac{1}{2}$ lines.

Colour similar to that of the larva. When viewed from above, the frontal portion of the prothorax is seen to bear 6 minute tubercles, 2 in front and 2 at each side: from each of these a moderately distinct and rather long seta arises.

The lateral prominences near the front represent the bent 4 anterior legs and the antennæ; the posterior pair of legs are apparent below. The elytra follow; these are obviously grooved; the grooves converge and unite by pairs before reaching the extremity. The rudimentary wings appear below the elytra, and are situated closer to the sides of the body, but they are destitute of striæ.

Hind-body with apparently 9 segments, the basal largest and broadly grooved along the middle, the terminal somewhat transparent and provided with 2 flexuous appendages, 1 at each side of the extremity.

Under-side shining. Immature specimens exhibit the head and rostrum, but the former shows no indication of eyes. In a more advanced stage the black eyes and claws of the tarsi, as well as the fuscous mandibles, are quite easily distinguishable under a good lens.

All the preceding descriptions have been taken from specimens reared by me at Auckland.

The attached illustrations were kindly executed by Mr. D. W. Jones, the head teacher of Papakura School.

EXPLANATION OF PLATE XXII.

Fig. 1. *Cylas turcipennis*, male.
Fig. 2. ,, female.
Fig. 3. Section of damaged kumara. The dark spots show the cavities made by the larvæ.
Fig. 4. Larva.
Fig. 5. Pupa.

ART. XIX.—*Notice of the Occurrence of the Lesser Frigate-bird* (Fregata ariel) *in the North Auckland District.*

By T. F. CHEESEMAN, F.L.S., Curator of the Auckland Museum.

[*Read before the Auckland Institute, 12th December, 1907.*]

IN the Supplement to the "Birds of New Zealand," vol. ii, p. 52, published in 1905, Sir W. L. Buller states, with respect to the lesser frigate-bird, that "the example taken on the Wakapuaka coast in 1861, and still preserved in the Nelson Museum, is, so far as I know, the only instance of the occurrence of this species in New Zealand." It therefore seems advisable to put on record the capture of another specimen, this time on the peninsula north of Auckland. Early in the month of April of this year I received from Mr. G. V. New, of Pahi, Kaipara, a freshly killed specimen evidently referable to the species. On inquiry, Mr. New informed me that on leaving his homestead on horseback on the morning of the 30th March, with the intention of driving some sheep, he noticed a large bird, which at a distance he took to be a hawk, endeavouring to carry off a young turkey. He immediately gave chase on his horse, when the bird dropped the turkey, and settled in a neighbouring gully. Riding into this, with the intention of frightening away the bird, Mr. New found himself almost on the top of a large bird altogether unknown to him. It was very slow in rising from the ground, so that he was able to seize it by the tip of one of its wings. After a struggle, he succeeded in mastering it, and took it home, where it lived for a few days. Mr. New's homestead is situated on a narrow neck of land between the Pahi and Arapaoa Rivers, flowing into the Kaipara Harbour, and is about half-way between the east and west coasts of the Island—that is, between twenty-five and thirty miles from the sea.

On examination, the specimen proved to be an adult female. Its total length was 30·9 in.; the spread of the wings from tip to tip was 60·8 in.; the length of the wings from the flexure to the tip of the primaries, 20·75 in.; length of tail, 12·5 in.; length of culmen, 3·7 in. It will be observed that these measurements correspond very closely to the average of those given for *Fregata ariel* by Mr. Ogilvie-Grant in the "British Museum Catalogue of Birds" (vol. xxvi, p. 449). The specimen also agrees with the description given of the plumage, the white collar round the back of the neck, considered to be one of the marks of the species, being specially prominent. The measurements, too, are considerably less than those of *Fregata aquila*, the greater frigate-bird, the only other member of the genus.

Although two species of *Fregata* are generally accepted by ornithologists, they differ little except in size and geographical distribution. The greater frigate-bird is found in all tropical seas, and occasionally strays into temperate regions. Three or four instances of its occurrence in New Zealand have been recorded, and attempts have been made to identify it with the "hokioi" of Maori tradition. In the Northern Hemisphere it has been captured as far north as the coast of Nova Scotia. The lesser frigate-bird has a more restricted range. It has been found from Madagascar to the Molucca Islands, and from thence southwards to Australia, being particularly plentiful in Torres Strait.

The frigate-birds are usually seen singly or in pairs, seldom congregating in any numbers except at their breeding-stations. They are truly oceanic, rarely visiting the land, except during the nesting period. Their marvellous powers of flight have often been described, and need not be specially mentioned here.

Art. XX.—*Notes on the Occurrence of certain Marine* Reptilia *in New Zealand Waters.*

By T. F. Cheeseman, F.L.S., F.Z.S., Curator of the Auckland Museum.

[*Read before the Auckland Institute, 12th December,* 1907.]

In studying the fauna of any country considerable interest always attaches to those species which, though not regular inhabitants, occasionally visit it, frequently straying far from their proper homes. In the case of the birds of New Zealand, there is quite a long list of species which have been recorded as stragglers or wanderers, such as the Australian shrike (*Graucalus melanops*), the wattled honey-eater (*Acanthochæra caruncidata*), the Australian swallow (*Petrochelidon nigricans*), the Australian roller (*Eurystomus australis*), and many others. Full particulars respecting the occurrence of these species will be found in Sir W. L. Buller's classic volumes on the "Birds of New Zealand"; and, in addition, a considerable number of short papers relating to the subject are contained in the volumes of the "Transactions of the New Zealand Institute."

It is not so well known, however, that certain marine *Reptilia* visit the coasts of the northern portion of New Zealand, the species being two turtles or Chelonians, and two water-snakes of the family *Hydrophinæ.* One of the latter occurs so frequently as almost to justify its inclusion as a regular member of the fauna.

As hardly anything has been definitely put on record respecting the occurrence of these species, it appears to me that it is desirable to mention the instances that have come under my own notice. If other observers will do the same we may arrive at more certain conclusions respecting the frequency of the visits of the species, and the circumstances attending them.

I. Leathery Turtle (*Dermochelys coriacea*).

1. In vol. xxv of the "Transactions of the New Zealand Institute," p. 108, I have recorded the first instance of the capture of this species (in 1892) in New Zealand waters. I need not repeat the particulars here, beyond saying that the specimen was obtained in the vicinity of Cape Brett by Captain Subritzky, of the schooner "Medora," and was brought up to Auckland for exhibition. Its total length was a little over 6 ft.

2. Two years later (1894) Captain Subritzky obtained a second specimen, this time between the Bay of Islands and Mongonui, and also brought it to Auckland, where I had an opportunity of examining it in the flesh. It was considerably larger than the first, the total length being over 7 ft.

II. Green Turtle (*Chelone mydas*).

1. Although I have been assured that the well-known green turtle is not infrequently seen off the coast of the North Auckland peninsula, I am only acquainted with two undoubted instances of its capture. In the summer of 1885 some Maoris were fishing a little distance inside the entrance to the Manukau Harbour, and, noticing an object floating on the water, pulled up to ascertain what it was. It proved to be a young turtle basking in the sun, fast asleep. Stealthily approaching it, one of them succeeded in harpooning it, when it was easily secured. They brought their prize to Auckland, when I succeeded in purchasing it from them for a few shillings, and the specimen is now in the Museum. As already stated, it is a young individual, its total length being 2 ft. 9 in.

2. When travelling round the North Cape peninsula in January, 1896, I was shown the carapace of a green turtle which had come ashore a few months previously in Great Exhibition Bay, to the south of Parengarenga Harbour. It was of fair size, the carapace alone measuring nearly 3 ft. in length.

III. Common Sea-snake (*Hydrus platurus*).

1. The first occurrence of this species known to me dates from 1868 or thereabouts, when a living specimen came ashore a little to the south of Port Waikato. It was discovered by some Maoris, who were naturally afraid to touch it, but with some little trouble managed to guide it into a discarded Wellington boot. They then took it to Mr. Dashwood, the proprietor of the store at Port Waikato, who secured the specimen, sacrificing the better part of a bottle of whisky for its preservation. A few months later he gave it to the late Captain Hutton, by whom it was presented to the Auckland Museum, where it still exists. Many years after the capture of the specimen the late Mr. Dashwood gave me a graphic account of the consternation which its arrival created among the Maoris, who were inclined to regard it as a juvenile *taniwha*.

2. Another specimen in the Museum was stranded at Port Charles in 1878, and was presented by Mr. J. B. Graham; but I have no further information respecting it.

3. In 1883 a specimen was picked up on the beach between

Raglan and Woody Head, and was forwarded to the Museum for identification. It was in much too advanced a stage of decomposition to be worth preserving.

4. In 1895 a living specimen was stranded just inside Cape Brett, at the Bay of Islands. It came into the possession of Mr. J. H. Greenway, of Russell, who presented it to the Museum.

5. In the summer of 1898 another specimen came ashore alive at Whangarei Heads. The finder gave it to Mr. C. Cooper, of Auckland, who kindly forwarded it to the Museum.

6. In 1903 a living specimen was picked up at Matata, in the Bay of Plenty, and was promptly forwarded to the Museum by Mr. H. L. Burt.

7. In 1905 Mr. E. V. Smith presented a specimen which was found stranded on the west coast, opposite to Dargaville.

8, 9. In addition to the above, the British Museum possesses two half-grown specimens from New Zealand, apparently without any precise locality or date of capture. (See "British Museum Catalogue of Snakes," vol. 3, p. 268.)

From the above list it is quite evident that this species is of comparatively common occurrence on the coast of the northern portion of the North Island of New Zealand. It would be interesting to ascertain where the individuals breed that visit New Zealand—that is, if the species is not really a permanent resident. According to Semper (quoted in the "Cambridge Natural History," vol. 8, p. 637), the gravid female visits the shores of low islands, there to give birth to its young between the rocks, and she remains with her offspring for some time.

IV. RINGED SEA-SNAKE (*Platurus colubrinus*).

1. In the summer of 1889 an individual of this species came ashore alive near the East Cape. It was forwarded to the office of the *Evening Star*, Auckland, and was very kindly presented to the Museum by the proprietor, Mr. H. Brett.

2. The above is the only specimen that has come under my own notice, but in the British Museum "Catalogue of Snakes" (vol. iii, p. 309) there is a reference to a specimen from New Zealand, presented by Sir George Grey.

Art. XXI.—*Contributions to a Fuller Knowledge of the Flora of New Zealand: No. 2.*

By T. F. Cheeseman, F.L.S., F.Z.S., Curator of the Auckland Museum.

[*Read before the Auckland Institute, 30th October, 1907.*]

For this second instalment of notes under the above title (for the first see Trans. N.Z. Inst., vol. xxxix, p. 439) I am again largely indebted to the kindness of numerous friends and correspondents in various parts of the Dominion. I particularly wish to acknowledge my obligations to Messrs. D. Petrie, H. J. Matthews, F. G. Gibbs, W. Townson, R. H. Matthews, H. Carse, Rev. F. H. Spencer, J. H. Harvey, J. H. Macmahon, and A. Hansen.

I have also incorporated with the notes some observations of my own on certain plants noticed during three short visits to the elevated central plateau of the North Island in the years 1902, 1905, and in January, 1907. During this last visit I was accompanied by the Rev. F. H. Spencer and Mr. A. Allison, of Wanganui. We had hoped to spend a fortnight or three weeks in an exploration of the western flanks of Tongariro, Ngauruhoe, and Ruapehu. A very convenient camp was pitched on the saddle separating Ngauruhoe from Ruapehu, at an elevation of 3,800 ft., and from this as a base we had planned expeditions in all directions. But after three or four days' successful work the weather broke, and veritable torrents of rain fell, with snow on the higher levels. All communication with the various parts of the district was cut off by floods of exceptional height; and we were reluctantly compelled to beat a retreat to the line of the Central Trunk Railway.

I am not without hopes of revisiting the district under more favourable circumstances, and of preparing a detailed account of the vegetation, together with a full list of the species, towards both of which objects I have made some considerable preparations. But for the present this must be deferred.

I. Ranunculaceæ.

Ranunculus Matthewsii.

Mr. H. J. Matthews informs me that this occurs on the mountains above Lake Harris, and on those flanking the left branch of the Matukituki River, western Otago.

Ranunculus insignis.

Moist ravines on the slopes of Tongariro and Ruapehu, but not common; *T. F. C.*

Ranunculus nivicola.

Tongariro, Ngauruhoe, and Ruapehu; altitude, 3,500–6,000 ft.; abundant, usually in sheltered hollows or in localities where it is more or less shaded by scrub or rocks; *T. F. C.*

Although plentiful, it does not form such a prominent feature of the vegetation as on Mount Egmont, nor does it attain the same size.

Ranunculus parviflorus, var. australis.

I have received specimens of this collected on Tiritiri Island by *Mr. A. Hansen.* So far as I am aware, this is the only locality in which it has been found in New Zealand outside the Auckland Isthmus.

III. CRUCIFERÆ.

Cardamine.

A most elaborate and painstaking monograph of *Cardamine*, by Dr. O. E. Schulz, is printed in Engler's "Botanischen Jahrbuchern" for 1903 (vol. 32, pp. 280–623). With respect to the New Zealand species, the author excludes from the genus more than half those included in it by Hooker, as *C. stylosa*, *C. fastigiata*, *C. latesiliqua*, and *C. Enysii.* In this he is probably right; for, as I have pointed out in the Manual, the fruit of these species does not at all agree with the characters of *Cardamine* as usually accepted. With regard to those retained in the genus, he revives Forster's name of *heterophylla* for the plant which Hooker referred to the northern *C. hirsuta*; a species which Schulz insists does not occur anywhere in the Southern Hemisphere. Hooker's variety *corymbosa* of *C. hirsuta* he restores to specific rank; the variety *subcarnosa* he transfers, as a variety, to the South American *C. glacialis*; while *C. depressa* of the Handbook he splits up into the two species *C. depressa* and *C. stellata* of the "Flora Antarctica." With Kirk's *C. bilobata* he does not seem to be acquainted. His arrangement is therefore as follows:—

1. *C. heterophylla*, O. E. Schulz.
    - Var. *micrantha.*
    - Var. *macrantha.*
    - Var. *leiocarpa.*
    - Var. *hirtella.*
    - Var. *macrostylis.*
2. *C. corymbosa*, Hook. f.
3. *C. glacialis*, D.C., var. *subcarnosa.*

4. *C. depressa*, Hook. f.
    Var. *acaulis*.
5. *C. stellata*, Hook. f.

New Zealand botanists will probably prefer to await an opinion from other European authorities on the genus before adopting or rejecting Schulz's views. From the point of view of geographical distribution, it is an important matter to be sure of one's ground in dealing with supposed cosmopolitan species like *C. hirsuta*. If the southern plants referred to *C. hirsuta* by Hooker are really separated from it by differences of specific value, the sooner the fact is recognised the better. On the other hand, an important fact of geographical distribution should not run any risk of suppression through attaching undue weight to minor differences of possibly not more than varietal rank.

Lepidium.

An important monograph of this genus, prepared by Dr. A. Thellung, of Winterthur, has been published under the auspices of the Botanical Museum of the University of Zurich. The author divides the genus into five sections, distinguished mainly by modifications of the fruit, whether winged or wingless, and by the length and position of the style compared with the wing. The New Zealand species all fall into his Section V, *Nasturtioides*, and are arranged as follows :—

1. *L. oleraceum*, Forst.
    Var. *a*, *frondosum*, T. Kirk.
    Var. *b*. *acutidentatum*, T. Kirk.
    Var. *g*, *serrulatum*, n. var., Thellung : "Folia obovata, a medio ad apicem regulariter subtiliter et acute serrata."
2. *L. incisum*, Hook. f. (*L. flexicaule*, T. Kirk).
3. *L. Banksii*, T. Kirk.
    Var. *b*, *ovatum*, T. Kirk.
4. *L. obtusatum*, T. Kirk.
5. *L. sisymbrioides*, Hook. f.
    Subspecies I. *Solandri*, Thellung.
        Var. *typicum*, Thellung.
        Var. *ovatum*, Thellung.
    Subspecies II. *Matau*, Thellung (*L. Matau*, Petrie).
        Var. *b*. *lobulatum*, Thellung.
    Subspecies III. *Kawarau*, Thellung (*L. Kawarau*, Petrie).
        Var. *b*, *dubium*, T. Kirk.
6. *L. Kirkii*, Petrie.
7. *L. tenuicaule*, T. Kirk.
    Var. *b*, *australe*, T. Kirk.

This is practically the same arrangement as that given in Kirk's "Students' Flora" and in my Manual, with the exception that Petrie's two species *L. Matau* and *L. Kawarau* are treated as subspecies of *L. sisymbrioides*. I feel sure that no botanist will agree with this view who is acquainted with the three plants in a living state, or who has studied large suites of specimens of them. Dr. Thellung's monograph contains much information respecting the morphology and classification of the genus, and should be consulted by all New Zealand botanists.

IV. VIOLACEÆ.

Hymenanthera obovata.

At the time of the publication of the Manual the flowers of this species were unknown. I am now indebted to Mr. F. G. Gibbs for specimens of both sexes obtained at the Graham River, Nelson—a locality where I collected it many years ago; and to Mr. H. J. Matthews for female flowers from a cultivated plant.

The following is a description: Flowers axillary or on the branches below the leaves, solitary or in fascicles of 2–4, diœcious. Males: About $\frac{1}{10}$–$\frac{1}{8}$ in. diameter; pedicels decurved, equalling the flowers or shorter, bracteolate below the middle. Sepals ovate, obtuse, free almost to the base; margins minutely fimbriate. Petals free to the base, erect for the lower two-thirds, revolute at the tips, narrow-oblong, obtuse. Anthers coherent; connective produced above the anther into a lanceolate process as long as the anther and fimbriate at the tip; scale at the back of the anther exceeding it, narrow-cuneate. Females: Smaller than the males and less numerous, and on rather shorter pedicels. Petals shorter and broader in proportion. Abortive anthers present. Ovary ovoid; style short; stigmas 2.

Hymenanthera dentata, var. angustifolia.

Saddle between Ngauruhoe and Ruapehu; a few specimens noticed amongst subalpine scrub near Lake Nga Puna a Tama; altitude, 4,300 ft.; *T. F. C.*

The most northern locality yet recorded.

Hymenanthera dentata, var. alpina.

Mr. H. J. Matthews informs me that this has a wide range in Central Otago, being found in dry arid places in most parts of the district. Flowering specimens forwarded by him show that the flowers may be either solitary, or geminate, or arranged in 2–4-flowered fascicles.

VII. Portulacaceæ.

Claytonia australasica.

An abundant plant on the shingly slopes of Tongariro and Ruapehu, ascending to the summit of the former mountain; altitude, 6,500 ft.; *T. F. C.*!

Hectorella cæspitosa.

Dr. A. J. Ewart, of Melbourne, has recently contributed to the Journal of the Linnean Society ("Botany," vol. 38, pp. 1–3) a short memoir dealing with the systematic position of *Hectorella*. He considers that there is nothing in the characters of the genus to connect it more definitely with the *Portulacaceæ* than with the subfamily *Polycarpeæ* of the *Caryophyllaceæ*. Its close general relationship to *Lyallia*, of Kerguelen's Island, has always been admitted; but in *Lyallia* the pair of leaves just below the perianth are considered to be bracts, and in *Hectorella* sepals. The latter conclusion, according to Dr. Ewart, is an error, both the unequal point of origin of the "sepals" and the starting-point of the vascular bundles which enter them being in favour of treating them as bracts. Dr. Ewart comes to the conclusion that *Hectorella cæspitosa* and *Lyallia Kerguelensis* are closely related plants; and that *Hectorella* should consequently be removed to the family *Caryophyllaceæ*, and placed in the neighbourhood of *Lyallia* and the Andine genus *Pycnophyllum*.

XVII. Stackhousiaceæ.

Stackhousia minima.

Grassy places near the foot of the saddle between Ngauruhoe and Ruapehu; altitude, 3,500 ft.; *T. F. C.*

XXII. Leguminosæ.

Corallospartium crassicaule.

Kurow Mountains, Otago; *H. J. Matthews.*

Carmichaelia flagelliformis.

Abundant in the elevated open country surrounding Tongariro and Ruapehu, ascending to 4,000 ft.; also plentiful around Lake Taupo, and descending the valley of the Waikato almost as far as Cambridge, and the Thames Valley to Matamata; *T. F. C.*

XXVI. Droseraceæ.

Drosera stenopetala.

Moist places on the slopes of Mount Hector, Tararua Range; 3,500–4,000 ft.; *D. Petrie!*

Drosera Arcturi.

Swampy places on the saddle between Ngauruhoe and Ruapehu, and on the margin of Lake Nga Puna a Tama ; altitude, 3,500–4,500 ft. ; *T. F. C.*

Drosera spathulata.

With the preceding species, and in many places on the Waimarino Plains, &c. ; altitude, 2,500–4,500 ft. ; *T. F. C.*

XXVII. HALORAGACEÆ.

Haloragis micrantha.

Ascends to 4,500 ft. on the saddle between Ngauruhoe and Ruapehu ; *T. F. C.*

XXVIII. MYRTACEÆ.

Leptospermum scoparium.

I am indebted to *Mr. R. J. Gilberd* for specimens of a form of this with remarkably dark-red flowers—much darker, in fact, than any variety I have previously seen. It also differs from the type in the brownish-green or almost bronze-green colour of the leaves and young branchlets. Mr. Gilberd informs me that some years ago he noticed a single plant of the variety on the banks of the Whau Creek, below Henderson. Observing several young plants under the parent tree with the same peculiarly tinted foliage, he removed two or three into his garden, succeeding in establishing them. They produced flowers of the same dark-red colour, and ripened seed freely. Mr. Gilberd further informed me that he has raised a considerable number of plants from seed, and that they all " come true " to colour.

Pale-red or pink flowered varieties of *L. scoparium* are by no means uncommon, especially near the sea.

Metrosideros Colensoi.

At the time of the publication of the Manual the only locality recorded for this species in the North Auckland peninsula was the Bay of Islands. Mr. H. J. Matthews now informs me that it occurs both at Ruatangata and Puhipuhi, in the Whangarei district. From the same gentleman I learn that it is found in the Lower Clarence Valley, Marlborough—possibly its southern limit.

Metrosideros tomentosa.

Some unusually fine specimens of the pohutukawa exist on Tiritiri Island. At my request Mr. A. Hansen, the resident lightkeeper, has measured the largest, and informs me that the trunk is 28 ft. 6 in. in circumference, and that the spread of the branches, from one side to the other, is 118 ft.

Myrtus pedunculata.

Vicinity of Kaitaia, Mongonui County; *R. H. Matthews!* The most northern station yet recorded.

XXIX. Onagraceæ.

Epilobium glabellum, var. erubescens.

Shingle-slopes on Tongariro, and at the lakes Nga Puna a Tama; altitude, 4,000–5,500 ft.; *T. F. C.*

XXXIII. Umbelliferæ.

Azorella Hookeri.

Shaded ravines at the foot of Tongariro and Ruapehu; altitude, 3,000–4,000 ft.; *T. F. C.*

Oreomyrrhis andicola.

Waimarino Plains, Rangipo Desert, &c., and slopes of Tongariro and Ruapehu; altitude, 2,500–5,000 ft.; *T. F. C.*

Ligusticum dissectum.

Mount Hector, Tararua Range; altitude, 4,000 ft.; *D. Petrie!*

Ligusticum diversifolium.

I am indebted to *Mr. F. G. Gibbs* for a fruiting specimen of this species. It looks wonderfully unlike specimens of *L. carnosulum* in the same stage, on account of the great difference in the involucral bracts, which, as stated in the original description, are very large and ternately multifid in *L. carnosulum*, and small, linear, and entire in *L. diversifolium*. The fruit is very similar in both species, but appears to be more spongy and corky in *L. diversifolium*.

Ligusticum aromaticum.

Slopes of Tongariro, Ngauruhoe, and Ruapehu, abundant, ascending to the summit of the first-mentioned mountain; altitude, 6,500 ft.; *T. F. C.*

Many years ago *Mr. J. H. Kerry-Nicholls* gave me specimens collected at an altitude of nearly 7,500 ft. on Ruapehu.

XXXIV. Araliaceæ.

Pseudopanax ferox.

Mr. D. L. Poppelwell informs me that this occurs in Croydon Bush, near Gore, Southland, which is the most southern locality yet recorded.

XXXVII. RUBIACEÆ.

Coprosma cuneata.

Often forming a fair proportion of the subalpine scrub on the slopes of Tongariro and Ruapehu; altitude, 3,000–5,000 ft.; *T. F. C.*

Coprosma depressa.

Waimarino Plains, Rangipo Desert, &c., and lower portions of Tongariro and Ruapehu; altitude, 3,000–5,000 ft.; *T. F. C.*

Coprosma repens.

Slopes of Tongariro, Ngauruhoe, and Ruapehu, plentiful, especially on moist banks, &c. Ascends to the summit of Tongariro, altitude 6,500 ft.; and is particularly plentiful by the margin of the lakes Nga Puna a Tama, on the saddle between Ngauruhoe and Ruapehu; *T. F. C.*

XXXVIII. COMPOSITÆ.

Olearia nitida.

Subalpine forest on the Waimarino Plains, and ravines at the base of Tongariro and Ruapehu; altitude, 2,500–4,000 ft.; *T. F. C.*

Olearia alpina.

Mr. Petrie, who has had good opportunities of studying this during his recent visit to Mount Hector, Tararua Range, informs me that it is nothing more than a narrow-leaved variety of *O. lacunosa.*

Olearia oleifolia.

Dart Valley, Otago; *H. J. Matthews.*

Olearia nummularifolia.

Slopes of Tongariro, Ngauruhoe, and Ruapehu, abundant; altitude, 3,000–5,000 ft.; *T. F. C.*

Celmisia hieracifolia.

Mount Hector, Tararua Range; altitude, 4,000–5,000 ft.; *D. Petrie!*

Not previously recorded from any part of the North Island.

Celmisia incana.

Slopes of Tongariro and Ruapehu, and low hills at their base, apparently more abundant on the eastern side than on the western; altitude, 3,200–5,000 ft.; *T. F. C.* Mount Hauhungatahi (between Ruapehu and Waimarino), not uncommon; *Rev. F. H. Spencer!*

Celmisia Macmahoni.

Summit of Mount Richmond, Nelson; *J. H. Macmahon!*

Celmisia glandulosa.

Moist places all round the base of Tongariro and Ruapehu, ascending to 4,500 ft. on Mount Kakaramea; *T. F. C.*

Gnaphalium paludosum.

Waimarino Plains, and swampy places on the saddle between Ngauruhoe and Ruapehu; altitude, 2,500–4,000 ft.; *T. F. C.*

Raoulia grandiflora.

Slopes of Tongariro and Ruapehu, ascending to the summit of the first-named mountain; altitude, 6,500 ft.; *T. F. C.*

Raoulia rubra.

Mount Hector, Tararua Range; altitude, 5,000 ft.; *D. Petrie!*

Raoulia Buchanani.

Mountains above Lake Harris, Otago; *H. J. Matthews!*

Helichrysum bellidioides.

Ascends to the summit of Tongariro; altitude, 6.500 ft.; *T. F. C.*

Collected by *J. H. Kerry-Nicholls* at a height of 7,500 ft. on Ruapehu.

Helichrysum leontopodium.

Summit of Mount Hauhungatahi (between Ruapehu and Waimarino); altitude, 5,000 ft.; *Rev. F. H. Spencer.*

Cotula pyrethrifolia.

Mount Hector, Tararua Range; *D. Petrie!*

I am not aware of a previous record from the North Island.

Abrotanella pusilla.

Mount Hector, Tararua Range; altitude, 3,500–4,500 ft.; *D. Petrie!*

This is an interesting rediscovery, the plant having been lost sight of since its first discovery on the Ruahine Range by Mr. Colenso in 1845.

Senecio Bidwillii.

Ascends to 5,500 ft. on the slopes of Tongariro and Ruapehu, and to the summit of Mount Kakaramea; altitude, 5,000 ft.; *T. F. C.*

One of the chief components, with *Dracophyllum recurvum*, *Pimelea buxifolia*, *Dacrydium Bidwillii*, and *Phyllocladus alpinus*, of the subalpine scrub on the above-mentioned mountains; altitude, 3,500 ft. and upwards.

XXXIX. STYLIDIACEÆ.

Phyllachne Colensoi.

Ascends to the summit of Tongariro; altitude, 6,500 ft.; *T. F. C.*

Oreostylidium subulatum.

Not uncommon in boggy places on the Waimarino Plains; altitude, 2,500–3,500 ft.; *T. F. C.*

The most northern locality yet recorded.

XLIII. EPACRIDACEÆ.

Epacris alpina.

Summit of Mount Tauhara, north end of Lake Taupo, altitude 4,500 ft., the most northern locality known to me; also plentiful all round the base of Tongariro and Ruapehu, and ascending on the slopes to quite 5,000 ft.; *T. F. C.*

Archeria racemosa.

Base of Mount Hikurangi, East Cape district; altitude, 1,000 ft.; *G. T. Williams!*

Dracophyllum recurvum.

Slopes of Tongariro, Ngauruhoe, and Ruapehu, ascending to over 5,000 ft., and everywhere forming a large proportion of the subalpine scrub; *T. F. C.* Summit of Mount Kakaramea; *J. Adams* and *T. F. C.*

This and *Senecio Bidwillii* are the two characteristic plants of the district, and in many localities give its vegetation a very peculiar facies.

Dracophyllum Urvilleanum, var. filifolium.

Subalpine scrub on Tongariro and Ruapehu, also on the open country surrounding the mountains; altitude, 3,000–5,000 ft.; *T. F. C.*

XLV. MYRSINACEÆ.

Myrsine nummularia.

Ravines on the western base of Ruapehu; altitude, 3,500 ft.; *T. F. C.*

L. Gentianaceæ.

Liparophyllum Gunnii.

Water-holes on the saddle between Ngauruhoe and Ruapehu, altitude 3,500–4,500 ft., associated with *Carpha alpina*, *Scirpus aucklandicus*, *Carex echinata*, *Oreobolus*, *Drosera spathulata*, and *D. Arcturi* : *T. F. C.* Boggy places on the slopes of Mount Hector, Tararua Range ; *D. Petrie !*

These records are the first for the occurrence of the plant in the North Island. It usually forms flat sheets of considerable extent, and when spangled over with the star-like white flowers presents a by-no-means unattractive appearance.

LII. Convolvulaceæ.

Ipomæa palmata.

Two or three large patches on the cliffs of Tiritiri Island ; *A. Hansen !*

This is an interesting and quite unexpected extension of the range of this fine plant, the southern limit of which had been believed to be at Takou Bay, just to the north of the Bay of Islands.

Dichondra repens.

D. evolvulacea, Britton in Mem. Torrey Bot. Club, v, 1894, should be quoted as a synonym of this species. Dr. Britton appears to have proposed the name on the assumption that *Sibthorpia evolvulacea*, Linn. f., Suppl. Plant. 288 (1781) was the earliest specific epithet. But, as has been pointed out by Mr. Hiern, this is not the case. It is true that Forster, who first published the genus in his " Characteres Generum " (1776), gives no specific name with the description of the genus printed on page 39 ; but the name " *repens* " is quoted with the explanation of the plate on page 40.

LIV. Scrophulariaceæ.

Calceolaria repens.

Lake Brunner, Westland ; *H. J. Matthews !*

Veronica macrocarpa, var. crassifolia.

Mr. Townson has kindly forwarded flowering specimens of this plant. These look so different from all the forms of *V. macrocarpa* that I can entertain little doubt as to its constituting a separate species. I postpone describing it, however, until I have time to make a full comparison. It should be mentioned that its leaves are peculiar, from possessing a very distinct row of fringed pits, or " domitia," on the under-surface just inside the margin. These pits are evident even in dried specimens, and persist in plants cultivated under altogether different surroundings to those of the original habitat of the variety. So far as I am aware, these pits are not at all common in *Veronica*, although I have noticed a few irregularly placed ones on the leaves of *P. macrocarpa* and *V. salicifolia.*

Veronica buxifolia.

Waimarino Plains, Rangipo Desert, &c., and slopes of Tongariro and Ruapehu, stretching all round the mountains; altitude, 3,000–5,000 ft.; *T. F. C.*

Veronica tetragona.

Plentiful all round the base of Tongariro and Ruapehu, and ascending to over 5,000 ft.; *T. F. C.*

A form is frequently seen in which the scale-like leaves are longer and proportionately narrower, and not so closely appressed to the branch. Probably it is an intermediate state between the juvenile stage and the fully matured one, but if so it must persist for many years.

Veronica propinqua.

Rock and Pillar Range, Otago; *R. H. Matthews.*

Veronica Petriei.

Mountains above Lake Harris, Otago; *R. H. Matthews.*

Veronica cataractæ, var. *diffusa.*

Ravines at the base of Tongariro and Ruapehu; altitude, 2,500–4,000 ft.; *T. F. C.*

Veronica Hookeriana.

Shingly or rocky slopes on Tongariro, Ngauruhoe, and Ruapehu; altitude, 4,000–6,000 ft.; *T. F. C.*

A remarkably handsome plant, nowhere more abundant than on the shingle-slopes overlooking the lakes Nga Puna a Tama, on the saddle between Ngauruhoe and Ruapehu. The colour of the flowers has been usually described as white, or white streaked with pink; but almost all the specimens seen by me had bluish-purple or almost violet-purple flowers of varying hue, some lighter, some darker. Only two or three plants were noticed the flowers of which could be called white.

Veronica spathulata.

Shingle-slopes on Tongariro, Ngauruhoe, and Ruapehu, not common, ascending to the summit of Tongariro; altitude, 6,500 ft.; *T. F. C.*

This is a true shingle-plant, with long often tortuous prostrate stems, putting up numerous short erect flowering-branches, often densely compacted. The flowers are nearly always pure white, but in one or two instances I noticed plants bearing pale lavender-blue flowers.

Euphrasia cuneata.

This is an abundant plant on the volcanic plateau in the centre of the North Island. Its most northerly station, so far as I am aware, is on Mount Tauhara, at the north end of Lake Taupo, from whence it stretches eastwards to the Rangitaiki River and the eastern side of the Taupo Plains. South of Taupo it is plentiful on the Waimarino Plains, Rangipo Desert, &c., and on all the mountains—Pihanga, Kakaramea, Tongariro, Ngauruhoe, and Ruapehu—ascending to considerably over 5,000 ft.

Euphrasia zealandica.

Pukeonake Hill, to the west of Ngauruhoe; altitude, 4,000 ft.; *T. F. C.*

The most northern station yet recorded.

LV. Lentibulariaceæ.

Utricularia monanthos.

Near the summit of Mount Kakaramea, altitude 4,800 ft.; by the margins of water-holes on the saddle between Ngauruhoe and Ruapehu, altitude 3,500–4,500 ft.; also in several localities on the Waimarino Plains, altitude 2,500–3,500 ft.; *T. F. C.*

LX. Plantaginaceæ.

Plantago uniflora.

Slopes of Mount Hector, Tararua Range; *D. Petrie!*

Now collected for the first time since its original discovery on the Ruahine Range by Mr. Colenso more than sixty years ago.

LXVI. Piperaceæ.

Piper excelsum, var. major.

Not uncommon on Tiritiri Island; *A. Hansen!*

LXXI. Thymelæaceæ.

Pimelea buxifolia.

Very abundant on the slopes of Tongariro, Ngauruhoe, and Ruapehu; altitude, 3,500–5,500 ft.; *T. F. C.*

One of the characteristic species of the subalpine scrub, and one of the commonest.

LXXVII. CUPULIFERÆ.

Fagus Blairii.

Not uncommon in western Otago—Lake Manapouri, Lake Te Anau, Wakatipu basin, &c.; plentiful at a bend of the river between Lake Te Anau and Lake Manapouri, together with four other species of *Fagus*—*F. Menziesii*, *F. fusca*, *F. Solandri*, and *F. cliffortioides*; *H. J. Matthews!*

LXXIX. ORCHIDACEÆ.

Thelymitra ixioides.

Among *Leptospermum* scrub at Cowes, Waiheke Island; *J. H. Harvey!*

Thelymitra intermedia.

Vicinity of Kaitaia; *R. H. Matthews!* Also a single specimen gathered near Cowes, Waiheke; *J. H. Harvey!*

Thelymitra decora.

This species has evidently a much more extended range than I supposed when I first described it. Waimarino Plains, and south-western base of Tongariro, growing sparingly amongst *T. uniflora* and *T. longifolia*, altitude 2,500–3,700 ft.; *T. F. C.* Near Taumarunui; *T. F. C.* Among *Leptospermum* scrub at Cowes, Waiheke; *J. H. Harvey!*

Thelymitra uniflora.

The most abundant species on the Waimarino Plains, between Central Trunk Railway and Ruapehu; altitude, 2,000–3,500 ft.

Most plentiful on boggy ground, amongst *Schœnus pauciflorus*, *Carpha*, *Oreobolus*, &c., but not absent from the drier portions of the plains as well.

Pterostylis barbata.

I am indebted to *Mr. B. A. Morison*, of Wanganui, for sending me a sketch of what is undoubtedly this species, prepared from specimens obtained by *Mr. E. H. Atkinson* at Day's Bay, near Wellington. This is a marked southern extension of the range of the species, which was not previously known further south than the Upper Thames Valley. *Mr. J. H. Harvey* forwards a 2-flowered specimen obtained on Waiheke Island.

Lyperanthus antarcticus.

Moist places on the subalpine meadows of Mount Hector, Tararua Range; altitude, 3,000–4,000 ft.; *D. Petrie!*

So far as I am aware, this is the first record of the occurrence of the species in the North Island.

Caladenia minor, var. **exigua.**

Vicinity of Cowes, Waiheke Island; *J. H. Harvey!*

Caladenia bifolia.

Waimarino Plains, and saddle between Ngauruhoe and Ruapehu; altitude, 2,500–4,500 ft.; *T. F. C.*

LXXXIII. Juncaceæ.

Luzula Colensoi.

Ascends to the summit of Tongariro; altitude, 6,500 ft.; *T. F. C.*

LXXXVIII. Naiadaceæ.

Potamogeton Cheesemanii.

A depauperated state of this species is found in water-holes on the saddle between Ngauruhoe and Ruapehu, ascending to a height of 4,250 ft.; *T. F. C.*

XCI. Cyperaceæ.

Eleocharis Cunninghamii.

Abundant by water-holes on the saddle between Ngauruhoe and Ruapehu, ascending to 4,500 ft.; *T. F. C.*

Scirpus aucklandicus.

Boggy places on the Waimarino Plains, and on the flanks of Tongariro and Ruapehu; altitude, 2,500–5,000 ft.; *T. F. C.* Swamps near the summit of Kakaramea; altitude, 4,800 ft.; *T. F. C.*

I have nowhere seen this plant more abundant than it is in suitable localities in the above-mentioned districts.

Scirpus americanus.

Near Marton; *W. Townson!*

Schœnus nitens, var. **concinnus.**

Margin of water-holes on the saddle between Ngauruhoe and Ruapehu, ascending to 4,500 ft.; *T. F. C.*

Uncinia rubra.

Various localities on the Waimarino Plains; near Lake Rotoaira; between the Rangitaiki River and Tarawera, on the Taupo–Napier Road; *T. F. C.*

XCII. Gramineæ.

Hierochloe Fraseri.

Waimarino Plains; summit of Mount Kakaramea; slopes of Tongariro and Ruapehu, altitude 2,500–5,000 ft.; *T. F. C.*

Subalpine meadows on Mount Hector, Tararua Range; *D. Petrie!*

Agrostis muscosa.

Waimarino Plains; Lake Rotoaira; slopes of Tongariro and Ruapehu, altitude 2,000–4,500 ft.; *T. F. C.*

Agrostis Dyeri.

Flanks of Tongariro and Ruapehu, abundant, ascending to 5,500 ft.; *T. F. C.*

Trisetum Youngii.

Ravines on the western base of Ruapehu, 3,500–4,500 ft.; *T. F. C.* Mount Hector, Tararua Range; *D. Petrie!*

Amphibromus fluitans.

Vicinity of Marton; *W. Townson!*

Triodia australis.

Alpine meadows on Mount Hector, Tararua Range; altitude, 4,500 ft.; *D. Petrie!*

Not previously recorded from any part of the North Island.

XCIII. FILICES.

Hymenophyllum Malingii.

Subalpine forest on the Waimarino Plains, and near the western base of Ruapehu, altitude 2,500–3,500 ft.; not uncommon, and attaining a large size; *T. F. C.*

Gleichenia Cunninghamii.

Sheltered places among scrub, flanks of Tongariro and Ruapehu, ascending to over 4,000 ft.; *T. F. C.*

Polypodium Billardieri.

I am indebted to *Mr. R. H. Matthews* for specimens of a peculiar "sport" with the tips of the fronds regularly crested, obtained near Kaitaia, north Auckland.

NATURALISED PLANTS.

Galium verum.

I have received specimens of this species collected by *Mr. Donald Ross* at Mahurangi. So far as I am aware, this is the first record of its appearance in New Zealand.

Hakea saligna.

This species, which is occasionally planted for garden-hedges, has established itself in the neighbourhood of Waihi, and, according to *Mr. E. R. Green*, is spreading fast.

Art. XXII.—*Preliminary Note on some Stages in the Development of a* Polychæte.

By H. B. Kirk, M.A., Professor of Biology in Victoria College, Wellington.

Plate XXIII.

In January, 1906, I obtained at Plimmerton some very interesting egg-masses of a *Polychæte.* The facilities for examination were not great; but I was able to keep the developing larvæ under observation for five days, although not without intermission. This year I failed in several attempts to obtain suitable material for further observation.

The masses were found cast up by the tide. In texture they are gelatinous, and in shape they somewhat resemble a barrel open at both ends. The length of the masses is from 20 mm. to 25 mm. The shape of any one of them leaves no doubt that it was produced by a worm provided with a cingulum.

In the gelatinous matter are imbedded eggs and larvæ, the latter in various stages of development, owing probably to fertilisation having been effected at different times. Each ovum has a thin membranous envelope, and, outside this, an envelope, possibly albuminous, more highly refractile than the surrounding gelatinous matter.

Embryos in the earlier stages of development were few. The earliest stage of which I could be certain was one in which eight megameres were surrounded by micromeres, apparently sixty-four in number, but of that number I could not be quite sure.

No trochosphere stage was observed with any certainty.

The earliest certain indication of segmentation of the body is in the appearance of a slight transverse constriction in its anterior part, the body being now broadly oval in shape. This constriction marks the division between the peristomium and the next following segment.

The appearance of the first pair of parapodia was not noted. Stages with the chætigerous sacs of three segments well formed were abundant, and in many of the specimens none of the chætæ had yet reached the surface. In this stage cœlomic pouches are observable; but these correspond with the segments only on the left side. On the right side one pouch is often large;

and sometimes only two are observable. An appearance as of a dorsal blood-vessel with lateral branches is, in prepared specimens, very constant at this stage; but it seems unlikely that such a vessel would yet be established (fig. 2). I did not observe this appearance in living specimens. Two eyes, reddish in colour, are noticeable. There is no trace of tentacles or of anal appendages. A lateral view of a prepared specimen at this stage shows an opening behind each chætigerous sac: these openings are probably nephridiopores.

When four segments follow the peristomium a pair of palps is developed, and the rudiments of a pair of tentacles and of a pair of anal cerci appear (fig. 3). There is no indication of an unpaired tentacle. The notopodium and neuropodium of the appendages of the first pair, those of the peristomium, lose their chætæ and develop as jointed organs with a few rigid hairs. These are to be the peristomial tentacles. In connection with the appendages of each pair is now a pair of flagella. In the case of the peristomium these appear to represent the notopodial cirrus; in the case of the other appendages, the neuropodial cirrus. The egg membrane has by this time disappeared, and the gelatinous matter in the neighbourhood of the larva deliquesces. In this liquid area, which extends constantly, the larva swims by means of its flagella. I am not certain when the flagella disappear; but I could not detect them in any larva that had developed eight segments. Two pairs of small eyes have appeared on the peristomium. In this stage also, that in which four complete segments follow the peristomium, stomodæum and proctodæum appear to develop.

A little later the jaws are observable, and still later they become very noticeable and may be seen to be carried forward with the pharynx, snapping vigorously. The eyes on the prostomium, the first pair that appeared, usually disappear by the time six segments are developed.

Just as the parts of the parapodia of the peristome lose their chætæ, so does the notopodium of the next segment lose its chætæ and develop as a jointed, tactile organ. I saw no change in the neuropodium of this segment (figs. 5 and 6).

I observed the development of several specimens up to thirteen segments; but beyond that time I was unable to keep them alive.

EXPLANATION OF PLATE XXIII.

Fig. 1. Egg-mass; x 1½.
Fig. 2. Dorsal view of larva with three pairs of chætigerous appendages. Cœlomic pouches developing.

Fig. 3. Another larva in which the first pair of appendages, those of the peristome, have lost their chætæ, and are developing as tentacles. Prostomial tentacles and anal cerci appearing. Flagella present. Two pairs of eyes on the peristomium in addition to the pair on the prostomium. Length, 0·98 mm.

Fig. 4. An older larva. Length, 1·08 mm.

Fig. 5. Ventral surface of head of specimen figured in fig. 4, but drawn twenty-four hours later. In the second segment the notopodium is tentacle-like, while the neuropodium still bears chætæ.

Fig. 6. Dorsal view of the head of the same specimen after another twenty-four hours. The prostomial eyes have disappeared.

Art. XXIII.—*Description of a New Species of* Veronica (*Linn.*).

By D. Petrie, M.A.

[*Read before the Auckland Institute, 28th August, 1907.*]

Veronica Astoni, sp. nov.

V. Veronicæ tetragonæ (Hook.) simillima, humilior (2–3 dem. alta), gracilior, arctissime ramosa.

Rami ultimi gracillimi, valde conferti, perobscure aut nequaquam tetragoni.

Folia arcte quadrifariam imbricata, paribus oppositis basi connatis, 1½ mm. longa, basi æque lata, subtriangulata, tumida, valde obtusa et apice rotundata, dorso haud carinata, superne late concava; juniora margine subciliata, provectiora glaberrima.

Flores pauci, parvi, in apicibus ramulorum subsessiles, circa 3 mm. lati, floribus *V. tetragonæ* (Hook.) simillimi, sed omni a parte minores.

Fructus adhuc ignotus.

Crescit in scopulosis jugis Montis Hector apud Tararua Montes in insula boreali Novæ-Zelandiæ.

Floret in mensibus Januario et Februario.

The present species of *Veronica* is closely allied to *V. tetragona* (Hook.), but differs constantly in a number of characters, as set forth above. Its habit of growth very distinct, as it forms low dense rounded or flattened bushes, with branchlets so closely compacted as to be almost touching. The older stems are round, glabrous, and marked by very numerous shallow transverse scars formed by the leaf-traces. The top 2 in. give off great numbers of short branchlets, many of which branch again. Nearly all the slender branchlets fall away in age, so that the main branches show but little bifurcation.

I consider this a perfectly distinct species, as species go in this protean genus. It is not nearly as close to *V. tetragona* as *V. quadrifaria* (T. Kirk) is to *V. tetrasticha* (Hook. f.).

Specimens were first sent to me by Mr. Aston, but as they showed neither flower nor fruit they could not be referred with certainty to the genus. In January of this year, during my short visit to Mount Hector, specimens were obtained in flower, and from these the description has been drawn up.

In Cheeseman's Flora of New Zealand *V. tetragona* is recorded as occurring in the Tararuas, but he does not appear to have examined authentic specimens from that district. It is not unlikely that the present species has been confounded with Hooker's plant. The latter is abundant on Mount Hikurangi, at an altitude of 4,000 ft. and upwards, and it may quite well grow on the Tararuas also, but this must for the present remain uncertain.

Art. XXIV.—*Account of a Visit to Mount Hector, a High Peak of the Tararuas, with List of Flowering-plants.*

By D. Petrie, M.A.

[*Read before the Auckland Institute, 28th August, 1907.*]

Though the Tararua Mountains lie at no great distance from Wellington, where the ablest and most enthusiastic botanical workers of the last generation resided, the vegetation of the higher parts of the range is still but imperfectly known. What we do know has been gleaned from fragmentary collections of plants brought down by surveyors, and by climbers allured to the tops by the prospect of an exhilarating walk and of superb and far-reaching views.

To throw more light on the botanical features of this interesting region, my friends Dr. L. Cockayne and Mr. B. C. Aston lately began a somewhat systematic exploration that has already yielded important results, and has made it possible to prepare a pretty full list of the alpine and subalpine plants.

The higher peaks of the Tararuas reach an elevation of about 5,000 ft. above sea-level. Most of them lie towards th eastern slopes of the range, and have been repeatedly ascended from the side of the Wairarapa Plain. The most extensive area of high alpine meadow or grass land seems, however, to lie at the southern extremity of the high range, in the region of which Mount Hector, 5,106 ft. in height, is the centre. So far as I am aware, no one interested in native plants visited this part of the range until Mr. Aston paid it a flying visit in the early summer of last year. In his company and that of a small party of friends I had the pleasure of visiting the Mount Hector district at the end of January of the present year. The visit was, unfortunately, too short and hurried to allow of close or extensive observation, but a brief record of it may not be devoid of interest, and may haply prove an aid and stimulus to further exploration.

The whole of the main Tararua Range appears to be of comparatively recent elevation, in the geological sense of the term "recent." The river-valleys issuing from its heights are deep, narrow, and steep-sloped, while their upper parts are gorge-like. Alluvial flats bordering the river-bed are absent, or very scanty. Such as exist are composed of shingle overlaid by sand and finer sediment, and are practically destitute of swamp. The very gradual elevation of the range is attested by the existence of the Manawatu Gorge, which crosses the range at its northern extremity, and carries the drainage of the eastern slopes of a large part of the Tararua and Ruahine Ranges, as well as that of the lower eastern hilly country, to the west coast of the Island. Obviously the elevation of the mountain axis was so slow as to allow the Manawatu River to deepen its valley almost as rapidly as the land was elevated. The erosion of the gorge did not, indeed, continuously keep pace with the upheaval of the range, for at one stage the water coming from the eastern part of its basin was ponded back, and formed an extensive lake in the district of which Woodville is now the centre. But its waters appear never to have risen high enough to flow eastward by any of the depressions lying on that side of the basin. The main Tararua Range thus presents a striking contrast to the lower ranges that run southward from it as far as Wellington Harbour. Here the Hutt Valley, formerly eroded to a much greater depth than is now seen, has been filled up to a comparatively high level by the waste of the mountains, owing to continuous recent depression. The wide valley-flats of the Wainuiomata and other streams in this region equally testify to former deep erosion followed by a filling-up of the valley as a result of depression.

The whole of the slopes of the Tararua Range were at no distant historical date completely clothed with forest. On the lower slopes much of this covering has been cleared and the land converted into pasture, but the main slopes to a great width are still forest-clad, though the process of clearing goes steadily forward. The whole tract above the level of the forest and its limiting zone of subalpine scrub is still virgin country—a fine specimen of primitive montane New Zealand, as yet wholly undisturbed by man and the sheep and cattle that he brings in his train. On the tops I saw no trace of the presence of any animal alien to primitive Maoriland. Traces of pigs were observed high up on the forest ridge, but even these were scanty. This condition is likely to be maintained for some years more, so that a thorough examination of the region can most likely be carried out before the natural balance of vegetation, that has been established under long-prevailing conditions, is seriously modified. Lying as the high range does almost at the doors of the capital of the colony, this task should not be impossible of accomplishment.

Mount Hector is the culminating-point of an extensive elevated plateau that forms the most southerly and probably the widest part of the Tararua Range. Around it are to be seen some thousands of acres of gently sloping ridges of alpine grass or meadow land, singularly free from bog, though wet depressions and wide shallow valleys are not uncommon. It is most easily approached from the western side, by way of the Otaki Valley. This valley, in its lower part, shows that a quite recent elevation of this part of the range to a height of 60 ft. to 80 ft. has taken place, for the river now flows along a narrow precipitous gorge of that depth, hollowed out in the bottom of an older and much wider valley, the southern border of which is deeply covered by fan-like delta deposits of *débris* carried down by the small northward-flowing tributary streams and brooks. The river must have flowed at a higher level for a lengthened period, since it has, by meandering, eaten away the high and steep sides of the valley to a general width of nearly half a mile. At present the bottom of the river-gorge has a steep slope, and the whole of its narrow bed is occupied by sand and shingle banks, to the complete exclusion of vegetation. Had the slope been as great during the erosion of the older and wider valley it is not easy to see how it could have been excavated to its present width. The facts noted show that a considerable elevation of the western part of the range must have taken place in quite recent days.

In the lower part of the Otaki Valley, as far as our party followed it, few plants of special interest were observed, the vegetation being that common to the valleys and foothills of this part of the Wellington District. On the rocky banks, however, were seen *Carmichaelia odorata*, in full flower and deliciously scented; *Carmichaelia flagelliformis*, in young fruit; a form of *Olearia nitida* with narrow-oblong leaves, like the peculiar variety of that species occurring at the Karangahake Gorge (Ohinemuri County), differing therefrom chiefly in the colour of the tomentum on the under side of the leaves, which was that normal to the species: *Gnaphalium keriense; Veronica catarractæ;* and *Azorella trifoliolata.*

After threading the lower valley or gorge of the Otaki for some eight or nine miles, our way lay up a long, wooded, gently rising ridge that led straight to the alpine meadow. The forest on the lower slopes is essentially a tawa forest, with the usual admixture of rata, rimu, kahikatea, pukatea, kohekohe, horopito or pepper-tree, and shade-loving *Coprosmas*, chiefly *C. grandifolia* in the gullies, and *C. lucida*, *C. robusta*, and *C. Colensoi* at higher levels. The supplejack grew abundantly towards the foot of the slopes, showing how wet the forest land always is at this level. On the higher parts of the ridge beeches became the predominant trees, *Fagus fusca* and *Fagus Menziesii* being both abundant. *Fagus apiculata*, though not observed by me, probably also grows here; at any rate, it is found in similar stations on the eastern and southern flanks of the range. In the beech forest, species of *Panax* become fairly plentiful, also *Coprosma lucida* and *Coprosma Colensoi*. Small bushes of *Griselinia littoralis* are not unfrequent, but it nowhere attains the dimensions of a tree. The ground vegetation consisted largely of mosses and ferns, with patches of *Astelia nervosa* (the shade form of the species), *Uncinia australis*, and *Microlæna avenacea*. *Enargea marginata* hung in considerable abundance from the stems of trees and tree-ferns, displaying its pretty white flower-cups and partly ripe fruit, while the beautiful star-like blossoms of *Libertia pulchella* bespangled the carpet of moss.

I was greatly interested in the remarkable leaf-variation shown by *Drimys axillaris* at increasing elevations on this ridge. At the lower levels the leaves had the typical somewhat obtuse tip and subcuneate outline, and the typical dark glossy green tint on the upper surface, with the usual pale glaucous green or greyish tint on the under surface. At increasing heights the leaves became progressively longer, narrower, and more acute, while the colour of the upper surface grew more and more decidedly red, and that of the under surface grew more and more decidedly a creamy yellow. At the highest levels at which it was observed the foliage had assumed a form barely distinguishable as regards the coloration of both leaf-surfaces from the species known as *Drimys colorata*, so common on the edges of bush land in the lower parts of Otago and Southland, differing only in the longer, narrower, and more pointed leaves and the flat, even margins. Before seeing the series of forms growing on this ridge I was a firm believer in the specific distinctness of *Drimys colorata*, but the instructive series of leaf-variations here observed has considerably shaken my confidence in this opinion. To any botanist who has leisure, a study of the materials to be readily met with on this ridge will certainly yield important data for settling the relations in rank of *D. axillaris* and *D. colorata*. It is probable that the leaf-variations under notice are mainly due to the stronger insolation experienced at the higher levels, where the competing vegetation is lower and much less crowded.

As noted above, *Coprosma Colensoi* here forms quite an important element in the shrubby forest undergrowth. It varies but little with elevation, all the plants showing rather large petiolate leaves of uniform size, shape, and texture, except at and near the tips of the higher branchlets, where they become narrower and more obtuse. The leaves are in general $\frac{3}{4}$ in. to 1 in. long, and $\frac{1}{3}$ in. to $\frac{1}{2}$ in. wide, and are very similar to those of *C. fœtidissima*, also fairly abundant here. Nowhere in this neighbourhood did I see any plant approaching the narrow obtuse-leaved forms of the species that abound in the higher wooded parts of the Hutt Valley and elsewhere in the eastern wooded uplands of the North Island. At the time of my visit the plants were all past flower; a few in opener situations had ripe drupes, oblong in outline, nearly as thick as a pea, and of a deep-red colour; but in general the drupes were only half-grown. The pyrenes were large for the size of the drupes. Further inquiry must settle whether the narrow-leaved form which I have distinguished as *C. Banksii* is really conspecific with the plant under notice.

The shade form of *Astelia nervosa* is plentiful on the higher parts of the ridge, while the mountain form abounds in wonderful profusion for 600 ft. or 800 ft. above the alpine scrub. The shade form had long, rather thin, glabrous leaves, and grew in small compact tufts. The pistillate plants bore abundance of half-ripe fruit. As the top of the ridge became more exposed, the leaves became shorter, more coriaceous, more or less silky, and more strongly tufted, while on the higher open slopes the plants grew in wide low tufts or tussocks, with foliage of a greyish-white or greyish-yellow hue, so abundant was the coating of silky hairs. Though thousands of plants were seen on the open uplands, and they were so abundant and slippery that walking over them was slow and fatiguing work, I did not see a single plant in flower or fruit. This is a very singular fact, and is probably due to flies being practically absent from this habitat during the flowering season, owing to the boisterous winds that almost constantly prevail here at that time. If the pollen were carried by the wind from the staminate to the pistillate flowers, a fair number of plants would surely have set fruit. Vegetative multiplication is very vigorous, and this no doubt compensates for the apparent rarity of regular propagation by seed. In sharp contrast with this was the abundance of seed that had set in *Astelia linearis*, which is plentiful in all boggy stations on the open uplands. Nowhere, I imagine, could we see a finer series of the various forms which this variable species may assume under different conditions of shade and water-supply than this locality furnishes. The gradations observed leave no shadow of doubt in my mind that *Astelia grandis* of Hooker f. is simply a shade- and moisture-loving form of the smaller silky-leaved mountain plant that has for long been taken to represent the type of Banks and Solander's species. Mr. Cheeseman, who has for the present united the two species, expresses the opinion that further research may disclose characters to separate the silky mountain form as a distinct species. This I consider most unlikely, as the extreme states of the species here graduate into each other by such insensible steps, and in such evident response to changing conditions, that there can be no reasonable doubt that all belong to a single variable specific type. The lower uplands of Mount Hector are well worth visiting were it only to examine the evidence of this gradual transition.

For some distance before entering the subalpine scrub, a notable change in the prevailing vegetation is observed. *Olearia Colensoi*, forming stout, low, widely branching shrubs, becomes the predominant plant, with *Panax Sinclairii*, *Panax anomalum*, *Senecio elæagnifolius*, and *Pittosporum rigidum* as subordinate elements, and *Uncinia cæspitosa*, *Uncinia filiformis*, *Libertia pulchella*, and *Phormium Cookianum* as undergrowth.

The width of the subalpine scrub is nowhere great on the western slopes of Mount Hector. It consists of the usual dense, stunted, level-topped, and almost impenetrable tangle of xerophytic shrubs common to this mountain-belt in the North Island. The principal plants here comprising the scrub were *Olearia Colensoi* (much stunted), *Dracophyllum longifolium*, *Panax anomalum*, *Panax Sinclairii*, *Senecio elæagnifolius*, *Gaultheria rupestris* (in dense bushes), *Pimelea Gnidia* (also in dense bushes), a dwarf form of *Olearia nitida*, *Olearia lacunosa*, *Olearia excorticata* (rare), *Pittosporum rigidum*, *Coprosma cuneata*, *Veronica salicifolia* (a short broad-leaved form), *Phormium Cookianum*, and *Astelia nervosa*, with *Uncinia filiformis* and *Viola filicaulis* among the undergrowth. Along the sheltered edges of the subalpine scrub grew abundance of the short mountain form of *Euphrasia cuneata* (in full bloom), with tufts in wet spots of *Ourisia macrophylla* and *Hierochloe redolens*. In a drier station here was seen what is probably the true *Ourisia Colensoi*.

On emerging from the exasperating scrub you suddenly enter the alpine grass or meadow region, and have done with all forest and shrubby growth. The mountain meadow consists of extensive bare slopes and undulating ridges covered by a varied low vegetation, among which *Astelia nervosa* is, at the lower levels, by far the most abundant plant. *Ligusticum dissectum* is also very plentiful. Mixed with these are *Aciphylla Colensoi* (var. *conspicua*), *Gentiana patula*, *Celmisia spectabilis*, and rare plants of *Uncinia purpurea* (var. *fusco-vaginata*) Grasses formed an important element in this assemblage. *Danthonia Raoulii* and its variety *flavescens* were abundant, but neither here nor at any higher level on the mountain was this species found in flower, though the plants grew with great luxuriance. Other grasses occurring in this lower tract were a distinct-looking, tufted, wiry form of *Danthonia semiannularis*, a wiry, strongly tufted form of *Deyeuxia setifolia*, *Ehrharta Colensoi*, *Agrostis Dyeri*, *Deyeuxia Forsteri*, and an erect, wiry, short-leaved form of *Deschampsia tenella*, differing strongly in habit from the flaccid drooping plant that one finds in the open woodlands of eastern Otago, where I first observed the species.

In the more level spots considerable areas of shallow, half-peaty, half-swampy soil are met with, and here the vegetation is very different. The most abundant and most characteristic plant is *Abrotanella pusilla*, a species that has not been seen since Colenso discovered it, nearly sixty years ago, on the Ruahine Range. It is a very slender, low, densely matted, moss-like plant, with an inflorescence that barely exceeds the leaves, carpeting quite a large proportion of all wet and boggy ground. With it occur *Astelia linearis* (in fine fruit), *Carpha alpina*, *Centrolepis viridis*, *Caltha novæ-zelandiæ*, *Oreobolus pumilio*, *Liparophyllum Gunnii*, *Juncus antarcticus*, *Drosera stenopetala*, *Uncinia compacta*, *Lyperanthus antarcticus*, and a few other species of less interest. On the drier edges of the boggy stations *Gentiana bellidifolia*, in full flower and very variable in height and branching, was common, and here a few patches of *Triodia australis* were also found. The small *Abrotanella* ascends almost to the top of the mountain, and in drier stations forms more compact and rather taller tufts.

On the edge of a shallow sheltered basin at no great height above the level of the subalpine scrub grew some fine plants of *Olearia lacunosa*, still in full bloom, and exhaling a strong and agreeable perfume. This is without doubt the plant that Buchanan has distinguished as *Olearia alpina*. So far as I am aware, this botanist never saw it growing in its native habitat, and he probably had very imperfect specimens before him when he concluded that it was a new species. It differs from the ordinary states of *O. lacunosa* only in having slightly narrower leaves, and in my judgment does not even rank as a distinct variety. The narrower foliage seems to me a natural adaptation to the very exposed situations in which the plant grows here. It is a much-branched shrub, reaching a height of 6 ft. to 9 ft., and is well worthy of cultivation, both for its elegant habit and for its sweet perfume.

Several hundred feet of alpine meadow have to be ascended before *Astelia nervosa* ceases to be the predominant plant. On its disappearance the grasses and other plants that share the lower levels with it continue to a great elevation, and new associates are gradually introduced. The most conspicuous of these are *Helichrysum leontopodium* (the North Island edelweiss), a most striking plant, growing in considerable profusion, and *Celmisia hieracifolia*, fairly plentiful in the drier stations. *Dracophyllum uniflorum* appears sparingly also in dry spots, and *Helichrysum Traversii* and *Veronica buxifolia* were seen in a few places, also a luxuriant form of *Bulbinella Hookeri*. *Forstera* (two forms, probably *F. Bidwillii* and *F. tenella*) and *Phyllachne Colensoi* become fairly common in wet stations, while *Raoulia grandiflora* puts in its appearance, to become more and more plentiful as you mount towards the tops.

At an elevation of about 4,300 ft. a new whipcord *Veronica* is noticed. It grows on well-drained slopes with a surface of sand and finely or coarsely broken rock. Allied to *V. tetragona*, it is smaller in all its parts, lower in growth, and more densely and compactly branched. Fortunately it was in full flower, so that its position in the genus could be determined with certainty. Here *Carex acicularis* grows in the crevices and nooks of the broken rocky western slopes.

The grasses now receive fresh additions, as *Poa Colensoi*, *Poa Kirkii* (var. *McKayi*), and *Poa imbecilla* (a short, slender alpine form) make their appearance in fair abundance. On the rocky faces on the western slope *Raoulia rubra* now becomes plentiful. It grows in very dense, rounded, low cushions, and in low flattened patches often a foot or two in diameter, and sends down stout, tough roots to a great depth in the crevices and joints. It was found in good condition, though rather past flower, the flowering having been very abundant this season. The present species, like several of its congeners, exhibits a remarkable capacity for retaining moisture, the cushions all proving as wet as a half-saturated sponge, and this though there had been a succession of bright, windy days. At this level *Myrsine nummularia* appears sparingly.

At all levels of the alpine meadow *Epilobium nummulari-*

folium (var. *pedunculare*) was a common occupant of bare wet spots. *E. alsinoides* and *E. erectum* (*mihi*) are also present, but in sparing quantity. At about 4,000 ft. another species, either undescribed or a form of *E. gracilipes*, becomes abundant in the drier situations, while in wet ones *E. erubescens* is not uncommon.

The main plateau is now reached. Its surface is not much diversified, as it consists of low, wide, rounded ridges, with wide, shallow hollows and valleys between. It is everywhere covered by grasses and a varied low vegetation. *Danthonia Raoulii* and its variety *flavescens*, which maintain throughout this alpine district their obviously distinct appearance and habit, are the predominant plants. The other grasses have mostly run out, much of the ground being, no doubt, too wet for their support, though the snowy covering that obtains during the colder months helps in determining their absence. *Raoulia grandiflora* is still plentiful, and *Euphrasia revoluta*, *Ranunculus geraniifolius* (varying greatly in size, but mostly very dwarf), *Astelia linearis*, and *Caltha novæ-zealandiæ* become abundant. *Carpha alpina* reappears in plenty, while a remarkably dwarf form of *Forstera tenella* still struggles for existence. A very slender dwarf *Scirpus* (no doubt *S. aucklandicus*, var. *subcucullata*) forms a short grass-like sward in the wetter spots, and sorry slender tufts of *Schœnus pauciflorus* occur here and there. The fruits of the latter were all found to be ergotised. *Plantago Brownii*, varying greatly in size according as its station is sodden or fairly dry, is not uncommon; while *P. uniflora* is plentiful in all the wetter hollows. The latter was an interesting find, as the typical form of the species has not been seen since Colenso made his famous journey over the Ruahine Range.

One of our party went as far as the trig. station that lies some distance back on the plateau, and he brought back specimens of *Ranunculus insignis*, *Cotula pyrethrifolia*, *Coprosma ramulosa* (which was observed lower down), *Claytonia australasica*, *Cardamine hirsuta* (var. *subcarnosa*), *Geum parviflorum*, *Helichrysum bellidioides*, *Ourisia cæspitosa*, and *Poa novæ-zealandiæ*.

One of my chief objects in undertaking this journey was to gain an acquaintance with *Helichrysum fasciculatum* (Buch.) and *H. Loganii* (T. Kirk), but I had not the good fortune to come across either. Time did not allow of my examining the steep rocky slopes on the western edge of the plateau, and a number of plants are likely to grow there which our party overlooked, and among them both of the above may well occur.

A conspicuous feature in the Mount Hector alpine meadow is the scarcity of shrubby plants above the level of the subalpine scrub. The alpine forms of *Dracophyllum*, *Veronica*, and *Olearia*, so usual in similar alpine districts, were practically absent. *Celmisias*, too, were few, only two species being noted; *C. glandulosa* and *C. incana* were nowhere observed.

At the lower levels *Astelia nervosa* determined the general appearance of the land, and at all higher levels *Danthonia Raoulii* played the same *rôle*. On the high plateau no shrubby growth of any kind was present, the heavy long-lying snows of winter being no doubt responsible for this.

Introduced plants have as yet hardly obtained any footing on the alpine meadow of the Tararuas. In years to come, when the wide belt of forest land on the slopes of the range has been more largely cleared off, a free invasion may be expected, and the changes that will then ensue will afford the œcologists of the future an instructive field for research.

It is not easy to combine a watchful regard for the plants about your feet with that free range of the eye that is required to note and dwell on scenic beauties, but the most absorbed plant-lover could not be blind or indifferent to the grand and extensive views that the high tops command. The western plains as far as snow-capped Egmont and Ruapehu, the distant ghostly outlines of the Kaikouras and the high ranges of southern and western Nelson, the whole neighbourhood of Cook Strait, and the plains and hilly country away to the eastern ocean, all lie spread out as it were at your feet. The most pleasing feature of the noble prospect was the view of the many prosperous towns and villages that dotted the wide and fertile plains of the Lower Rangitikei and Manawatu. How changed from the times of Ruaparaha, some two generations ago!

I append a list of the flowering-plants hitherto observed on the higher parts of the Tararuas. In the case of plants observed by Dr. Cockayne no indication of the height of the habitat is given; the remainder were noted by Mr. Aston or myself. A very few are quoted on the authority of Cheeseman's "Manual of the New Zealand Flora." The list is probably fairly complete, though future exploration will no doubt add to it. The names of the species are those adopted in Cheeseman's work mentioned above. Many of the low-level plants enumerated by Dr. Cockayne were omitted from my own list of the Mount Hector plants, which purposely included little beyond alpine and subalpine species. Heights are given only with species observed by myself, and are merely approximate. A few of the plants were collected only by Mr. Aston.

LIST OF FLOWERING-PLANTS OBSERVED ON THE TARARUA RANGE.

Clematis indivisa, *Willd.*
.. hexasepala, *D.C.*
Ranunculus insignis, *Hk. f.* 5,000 ft.
.. geraniifolius, *Hk. f.* 4,500 ft.
.. tenuicaulis, *Cheesm.*
.. hirtus, *Banks and Sol.* 200 ft.
Caltha novæ-zealandiæ, *Hk. f.* 3,000–4,500 ft.
Drimys axillaris, *Forster.* 500–2,500 ft.
.. colorata, *Raoul.*
Cardamine hirsuta, *L.*, *var.* subcarnosa. 5,000 ft.
.. (species uncertain).
Viola filicaulis, *Hk. f.* 3,000 ft.
Melicytus ramiflorus, *Forst.* 200 ft.
.. lanceolatus, *Hk. f.*
Pittosporum tenuifolium, *Banks and Sol.* 400 ft.
.. rigidum, *Hk. f.* 2,000–3,000 ft.
.. cornifolium, *A. Cunn.*
Stellaria parviflora, *Banks and Sol.* 200 ft.
Claytonia australasica, *Hk. f.* 5,000 ft.
Hoheria populnea, *A. Cunn.*, *var.* lanceolata.
Aristotelia racemosa, *Hk. f.*
.. Colensoi, *Hk. f.*
Elæocarpus dentatus, *Vahl.*
.. Hookerianus, *Raoul.* 500 ft.
Geranium microphyllum, *Hk. f.* 3,000 ft.
Oxalis magellanica, *Forst.*
Melicope simplex, *A. Cunn.* 200 ft.
Dysoxylum spectabile, *Hk. f.* 600 ft.
Pennantia corymbosa, *Forst.* 200 ft.
Alectryon excelsum, *Gaertn.* 200 ft.
Coriaria ruscifolia, *L.*
,, thymifolia, *Humb. and Bonp.*
Carmichaelia odorata, *Col.* 200 ft.
.. flagelliformis, *Col.* 200 ft.
.. ,, *var.* corymbosa.
Sophora tetraptera, *J. Mull.*, *var.* microphylla. 150 ft.
Rubus australis, *Forst.* 500 ft.
,, schmidelioides, *A. Cunn.* 2,500 ft.
Geum parviflorum, *Smith.* 5,000 ft.
Acæna novæ-zealandiæ, *T. Kirk.*
,, sanguisorbæ, *Vahl.* 200 ft.
Carpodetus serratus, *Forst.* 200 ft.
Weinmannia racemosa, *Linn. f.* 1,000 ft.

Drosera stenopetala, *Hk. f.* 3,000–4,000 ft.
.. spathulata(?), *Labill.*
Gunnera monoica, *Raoul*, *var.* strigosa. 3,000 ft.
Leptospermum scoparium, *Forst.*
Metrosideros florida, *Smith.*
.. hypericifolia, *A. Cunn.* 4,000 ft.
.. robusta, *A. Cunn.* To 4,000 ft.
.. scandens, *Sol.* 200 ft.
Myrtus pedunculata, *Hk. f.* 2,500 ft.
.. bullata, *Sol.*
Epilobium junceum, *Sol.* 3,200 ft.
.. pubens, *A. Rich.*
.. tenuipes, *Hk. f.*
.. Hectori(?), *Haussk.*
.. alsinoides, *A. Cunn.* 3,500 ft.
.. insulare, *Haussk.* 200 ft.
.. rotundifolium, *Forst.*
.. linnæoides, *Hk. f.*
.. nummularifolium, *R. Cunn*, *var.* pedunculare. 3,000–4,500 ft.
.. macropus(?), *Hk.* (Aston.)
.. gracilipes(?), *T. Kirk* (or allied species). 4,000 ft.
.. glabellum, *Forst.*
.. erubescens, *Haussk.* 4,000 ft.
.. erectum, *Petrie.* 3,500 ft.
Fuchsia excorticata, *Linn. f.* 300 ft.
Hydrocotyle elongata, *A. Cunn.* 200 ft.
.. dissecta, *Hk. f.*
.. novæ-zealandiæ, *D.C.*
Azorella Hookeri, *Drude.* 200 ft.
Oreomyrrhis andicola, *Endl.* 3,500 ft.
Aciphylla Colensoi, *Hk. f.*, *var.* conspicua. 3,000–4,500 ft.
.. squarrosa, *Forst.* (flaccid form).
.. Munroi, *Hk. f.*
Ligusticum dissectum, *T. Kirk.* 3,000–4,500 ft.
.. aromaticum, *Hk. f.* 3,800 ft.
Panax simplex, *Forst.* 1,500 ft.
.. Edgerleyi, *Hk. f.* 1,500 ft.
.. anomalum, *Hk.* 3,000 ft.
.. Sinclairii, *Hk. f.* 3,000 ft.
.. Colensoi, *Hk. f.*
.. arboreum, *Forst.* 2,000 ft.
Schefflera digitata, *Forst.*
Pseudopanax crassifolium, *C. Koch.*
Griselinia littoralis, *Raoul.* 1,500–2,500 ft.
Alseuosmia macrophylla, *A. Cunn.* 500 ft.

Coprosma grandifolia, *Hk. f.* To 300 ft.
.. lucida, *Forst.* 1,500–2,500 ft.
.. robusta, *Raoul.* To 2,000 ft.
.. rhamnoides, *Hk. f.*
.. ramulosa, *Petrie.* 4,500 ft.
.. fœtidissima, *Forst.* To 3,000 ft.
.. Colensoi, *Hk. f.* 1,500–2,800 ft.
.. cuneata, *Hk. f.* 3,000 ft.
.. repens, *Hk. f.* 3,500 ft.
.. Banksii, *Petrie.*
Nertera depressa, *Banks and Sol.*
.. dichondræfolia, *Hook. f.* 2,000 ft.
Lagenophora petiolata, *Hk. f.*
Olearia Colensoi, *Hk. f.* 2,500–3,000 ft.
.. nitida, *Hk. f.* To 3,000 ft.
.. Cunninghamii, *Hk. f.* 500 ft.
.. excorticata, *Buch.* 3,000 ft.
.. lacunosa, *Hk. f.* 2,800–3,500 ft.
.. alpina, *Buch.*, is the same as the above.
Celmisia spectabilis, *Hk. f.* 3,000–4,500 ft.
.. hieracifolia, *Hk. f.* 3,800–4,500 ft.
Gnaphalium Keriense, *A. Cunn.* 200 ft.
.. Traversii, *Hk. f.* 4,000 ft.
Raoulia tenuicaulis, *Hk. f.*
.. grandiflora, *Hk. f.* 3,800–5,000 ft.
.. rubra, *Buch.* 4,500 ft.
Helichrysum bellidioides, *Willd.* 5,000 ft.
.. filicaule, *Hk. f.*
.. Loganii, *T. Kirk* (*ex Cheeseman's Manual*).
.. leontopodium, *Hook. f.* 3,800–4,400 ft.
.. fasciculatum, *Buch.* (*ex Cheeseman's Manual*).
Cotula pyrethrifolia, *Hk. f.* 5,000 ft.
Abrotanella pusilla, *Hk. f.* 3,000–4,500 ft.
Brachyglottis repanda, *Forst.*
Senecio lagopus, *Raoul.* 3,800–4,400 ft.
.. latifolius, *Banks and Sol.*
.. Kirkii, *Hk. f.* 2,000 ft.
.. elæagnifolius, *Hk. f.* 3,000 ft.
.. .. *var.* Buchanani.
.. Bidwillii, *Hk. f.* 3,800 ft.
Taraxacum officinale, *Wigg.*
Phyllachne Colensoi, *Berggr.* 3,800–5,000 ft.
Forstera Bidwillii (?), *Hk. f.* 3,800 ft.
.. tenella, *Hk. f.* 3,800–4,800 ft.
Pratia angulata, *Hook. f.*
Gaultheria antipoda, *Forst.*

Gaultheria rupestris, *R. Br.* 3,000 ft.
Pentachondra pumila, *R. Br.* 3,000–4,000 ft.
Cyathodes acerosa, *R. Br.*
,, empetrifolia, *Hk. f.* 3,200 ft.
Leucopogon fasciculatus, *A. Rich.*
Dracophyllum longifolium, *R. Br.* 3,000 ft.
,, Urvilleanum, *A. Rich, var.* filifolium (Aston).
,, rosmarinifolium, *R. Br.*
,, uniflorum, *Hk. f.* 3,800 ft.
Myrsine salicina, *Heward.*
,, Urvillei, *A. D.C.* 1,000 ft.
,, divaricata, *A. Cunn.*
,, nummularia, *Hk. f.* 3,800 ft.
Olea montana, *Hk. f.*
Parsonsia heterophylla, *A. Cunn.*
,, capsularis, *R. Br.*
Gentiana patula, *Cheesm.* 3,000–4,200 ft.
,, bellidifolia, *Hk. f.* 3,000–3,500 ft.
Liparophyllum Gunnii, *Hk. f.* 3,000 ft.
Calceolaria repens, *Hk. f.*
Veronica salicifolia, *Forst.* To 3,000 ft.
,, lævis, *Benth.*
,, buxifolia, *Benth.* 3,800 ft.
,, Astoni, *sp. nov.* 4,000 ft.
,, catarractæ, *Forst.* 200 ft.
Ourisia macrophylla, *Hook.* 3,000 ft.
,, Colensoi (?), *Hk. f.* 3,300 ft.
,, cæspitosa, *Hk. f.* 5,000 ft.
Euphrasia cuneata, *Forst.* 3,000 ft.
,, revoluta, *Hk. f.* 4,000–5,000 ft.
Plantago Brownii, *Rapin.* 4,800 ft.
,, uniflora, *Hk. f.* 4,800 ft.
Hedycarya arborea, *Forst.* 800 ft.
Laurelia novæ-zealandiæ, *A. Cunn.* 400 ft.
Bielschmiedia tawa, *Benth. and Hk. f.* To 1,000 ft.
Pimelea Gnidia, *Willd.* 3,000 ft.
Drapetes Dieffenbachii, *Hook., var.* laxa. 4,000 ft.
Loranthus Colensoi, *Hk. f.*
Urtica incisa, *Poir.*
Fagus Menziesii, *Hk. f.* To 2,000 ft.
,, fusca, *Hk. f.* 2,000 ft.
,, apiculata, *Col.*
,, Solandri, *Hk. f.*
Podocarpus totara, *D. Don.* 400 ft.
,, ferrugineus, *D. Don.* 600 ft.
,, dacrydioides, *A. Rich.* 300 ft.

Dacrydium cupressinum, *Sol.* 800 ft.
Dendrobium Cunninghamii, *Lindl.* 2,000 ft.
Earina mucronata, *Lindl.* 1,500 ft.
Thelymitra uniflora, *Hk. f.*
Prasophyllum Colensoi, *Hk. f.* 3,500–4,500 ft.
Lyperanthus antarcticus, *Hk. f.* 3,200 ft.
Caladenia bifolia, *Hk. f.* 3,500 ft.
Corysanthes triloba, *Hk. f.*
Gastrodia Cunninghamii, *Hk. f.*
Libertia ixioides, *Sprengel.*
,, pulchella, *Sprengel.* 2,500–3,000 ft.
Rhipogonum scandens, *Forst.* 500 ft.
Enargea marginata, *Banks and Sol.* 2,000–3,000 ft.
Cordyline indivisa, *Steud.* 2,500 ft.
,, Banksii, *Hk. f.*
Astelia linearis, *Hk. f.* 3,000–4,800 ft.
,, Cunninghamii, *Hk. f.* 2,000 ft.
,, Solandri, *A. Cunn.* 300 ft.
,, nervosa, *Banks and Sol.* 2,000–3,800 ft.
Dianella intermedia, *Endl.*
Phormium Cookianum, *Le Jolis.* 3,000 ft.
Bulbinella Hookeri, *Benth and Hk. f.* 4,000 ft.
Juncus antarcticus, *Hk. f.* 3,000–4,500 ft.
,, novæ-zealandiæ, *Hk. f.* 3,000 ft.
Luzula campestris, *D.C.* 3,000 ft.
Freycinetia Banksii, *A. Cunn.*
Centrolepis viridis, *T. Kirk.* 3,000 ft.
Scirpus aucklandicus, *Hk. f.* 3,000 ft.
,, ,, *var.* subcucullata. 4,500 ft.
Carpha alpina, *R. Br.* 3,000–4,800 ft.
Schœnus pauciflorus, *Hk. f.* 4,800 ft.
Gahnia setifolia, *Hk. f.*
,, pauciflora, *T. Kirk.*
Oreobolus pumilio, *R. Br.*, *var* pectinatus. 3,000–4,000 ft.
Uncinia purpurata, *Petrie, var.* fusco-vaginata. 3,500 ft.
,, compacta, *R. Br.* 3,000 ft.
,, cæspitosa, *Boott.* To 2,800 ft.
,, australis, *Persoon.* To 2,800 ft.
,, filiformis, *Boott.* 3,000 ft.
,, rupestris, *Raoul.*
Carex acicularis, *Boott.* 4,000 ft.
,, ternaria, *Forst.*
,, dissita, *Sol.*, *var.* monticola.
Oplismenus undulatifolius, *Beauv.* To 1,200 ft.
Ehrharta Colensoi, *Hk. f.* 3,000–4,200 ft.
Microlæna avenacea, *Hk. f.* To 2,500 ft.

Hierochloe redolens, *R. Br.* 3,000 ft.
,, Fraseri, *Hook. f.* 3,500–4,000 ft.
Alopecurus geniculatus, *L.* 200 ft.
Agrostis muscosa, *T. Kirk* (Aston).
,, Muelleri, *Benth.* 4,000 ft.
,, Dyeri, *Petrie.* 3,000–4,000 ft.
Deyeuxia Forsteri, *Kunth.* 3,200 ft.
,, setifolia, *Hk. f.* 3,000–4,500 ft.
Deschampsia tenella, *Petrie.* 3,000–4,500 ft.
Trisetum antarcticum, *Trinius* (*Aston*).
,, Youngii, *Hk. f.* (*Aston*).
Danthonia Raoulii, *Steudel.* 3,000–5,000 ft.
,, ,, *var.* flavescens. 3,000–5,000 ft.
,, semiannularis, *R. Br., var.* 3,000–4,000 ft.
Arundo conspicua, *Forst.*
Triodia australis, *Petrie.*
Poa novæ-zealandiæ, *Hackel.* 5,000 ft.
,, anceps, *Forst.*
,, Colensoi, *Hk. f.* 3,800–4,500 ft.
,, Kirkii, *Buch., var.* McKayi. 3,800–4,500 ft.
,, imbecilla, *Forst.* 4,000 ft.

Art. XXV.—*Some Hitherto-unrecorded Plant-habitats (III).*

By L. Cockayne, Ph.D.

[*Read before the Philosophical Institute of Canterbury, 11th December,* 1907.]

With regard to some of the species noted below, it is possible they may be mentioned prior to the publication of this paper in one or other of the reports I am preparing for the Department of Lands and Survey, but nevertheless I am keeping them here, as it seems convenient to have such unrecorded species together in one publication. A considerable number of the species recorded are from Stewart Island, but certain critical plants from that island are omitted until I publish a general account of the vegetation of that district. Of the remainder, the only one worthy of special mention is *Pittosporum patulum*, a plant hitherto only recorded from the north-west Nelson district, and which has not as yet been found in the intervening country, much of which is certainly well suited as a habitat. Mr. Bond, who collected the specimen, noted only two plants, which were growing within two chains of one another just inside the edge of the bush.

FILICES.

Loxsoma Cunninghamii, R. Br.

Beneath *Leptospermum scoparium*, near River Waipoua, Hokianga County. L. C. !

Dicksonia lanata, Col.

Forest on Mount Hauhungatahi, forming large part of undergrowth up to 1,200 m. L. C. !

Polystichum cystotegia (Hook.), Armstg.

Stony ground near summit of Mount Anglem, Stewart Island. Gibbs, Laing, Crosby-Smith, and L. C. !

Asplenium Lyallii, Moore.

Shore of Paterson Inlet, on rocks, Stewart Island. L. C. !

Asplenium Richardi, Hook. f.

In shade of rock, south of Ruapehu. W. Townson !

Blechnum nigrum (Col.), Mett.

(1.) Moist gullies in forest near Half-moon Bay, Stewart Island; Mrs. Josling, L. C. ! (2.) Moist gullies, Waipoua Forest, chiefly upland portion, Hokianga County; L. C. !

Hypolepis millefolium, Hook.

Base of Table Hill, Stewart Island. L. C. !

Polypodium Billardieri (Willd.), C. Chr. (= *P. australe*, Mett.).

Forest on Bluff Hill. L. C.

Polypodium Billardieri (Willd.), C. Chr., var. **rigidum** (Homb. and Jacq.).

Forest at base of Mount Anglem, Stewart Island. L. C. !

SPERMAPHYTA.

TAXACEÆ.

Dacrydium Colensoi, Hook.

Waipoua Forest. L. C. !

Dacrydium Kirkii, F. Muell.

Waipoua Forest. L. C.

Dacrydium Bidwillii, Hook. f.
Longwood Range. L. C.!

Dacrydium laxifolium, Hook. f.
Longwood Range. L. C.!

Phyllocladus alpinus, Hook. f.
Longwood Range. L. C.!

GRAMINEÆ.

Microlæna stipoides, R. Br.
Kapiti Island. L. C.!

Agrostis Muelleri, Benth.
Ruapehu, at 1,800 m.; and Tongariro, at 1,500 m.–1,600 m. L. C.!

Agrostis Dyeri, Petrie.
Stewart Island. L. C.!

Calamagrostis Billardieri (R. Br.), Steud.
Dunes, Mason's Bay, Stewart Island. Laing and L. C.!

Deschampsia cæspitosa, Beauv.
Swampy ground, Kapiti Island. L. C.!

Deschampsia Chapmani, Petrie.
Mount Anglem, Stewart Island. Gibbs, Crosby-Smith, Laing, and L. C.!

Danthonia flavescens, Hook. f.
Mount Anglem, Stewart Island. Gibbs, Laing, Crosby-Smith, and L. C.!

Danthonia pungens, Cheesem.
Extremely common on Mount Anglem and Table Hill, Stewart Island. L. C.!

Arundo conspicua, Forst. f.
Bluff Hill. L. C.!

Poa novæ-zealandiæ, Hack.
Ruapehu, where water oozes on scoria slope at 1,800 m. L. C.!

Poa Astoni, Petrie.
Coastal rocks, Paterson Inlet, Stewart Island. L. C. !

Agropyrum scabrum (R. Br.), Beauv.
Stewart Island. L. C. !

CYPERACEÆ.

Elæocharis acuta, R. Br.
Swampy ground, Stewart Island. L. C. !

Elæocharis Cunninghamii, Boeck.
Swampy ground, Stewart Island. L. C. !

Scirpus sulcatus, Thouars, var. **distigmatosa**. C. B. Clarke.
Stewart Island. L. C. !

Scirpus frondosus, Banks and Sol.
Dunes, Mason's Bay, Stewart Island. Laing and L. C. !

Gahnia procera, Forst.
Forest on Bluff Hill. L. C. !

Uncinia purpurata, Petrie.
Bluff Hill. L. C. !

Uncinia compacta, R. Br.
Stewart Island. L. C. !

Uncinia pedicillata, Kük.
Forests, Stewart Island. L. C. !

Uncinia rubra, Boott.
Old dunes, Mason's Bay, Stewart Island. Laing and L. C. !

Uncinia rigida, Petrie.
Old dunes, Mason's Bay, Stewart Island. Laing and L. C. !

Carex pyrenaica, Wahl.
Where water oozes on scoria slope, Ruapehu, 1,800 m.; and more common on Tongariro, at 1,500 m. L. C. !

Carex secta, Boott.
Stewart Island. L. C. !

Carex Raoulii, Boott.
Bluff Hill. L. C.!

Carex pumila, Thunb.
Dunes, Stewart Island. L. C.

Carex Œderi, Ehrh., var.
Stewart Island. L. C.!

LILIACEÆ.

Astelia nervosa, Banks and Sol., var. montana, Kirk.
Longwood Range. L. C.!

Phormium Cookianum, Le Jolis.
(1.) Stewart Island, sea-level to subalpine; Gibbs, Laing, Crosby-Smith, and L. C.! (2.) Longwood Range; L. C.!

URTICACEÆ.

Urtica incisa, Poir.
Forests, Stewart Island. L. C.!

POLYGONACEÆ.

Muehlenbeckia complexa, Meissn.
Stewart Island. L. C.!

LORANTHACEÆ.

Loranthus micranthus, Hook. f.
Stewart Island; not common. L. C.!

AIZOACEÆ.

Mesembryanthemum australe, Sol.
Stewart Island. L. C.!

PORTULACACEÆ.

Claytonia australasica, Hook. f.
Muddy ground, Longwood Range. L. C.!

CARYOPHYLLACEÆ.

Colobanthus Billardieri, Fenzl.
Summit of Mount Tama, and on Ruapehu to 1,800 m. L. C.!

Scleranthus biflorus (Forst.), Hook. f.
Stewart Island. L. C.!

Ranunculaceæ.

Ranunculus acaulis, Banks and Sol.
Bluff Hill. L. C.!

Caltha novæ-zealandiæ, Hook. f.
Longwood Range. L. C.!

Cruciferæ.

Cardamine uniflora, Hook. f.
Stewart Island. (This is usually considered a variety of *C. hirsuta*, L., but in my garden it remains constant, and reproduces itself true from seed.)

Saxifragaceæ.

Donatia novæ-zealandiæ, Hook. f.
Longwood Range. L. C.!

Pittosporaceæ.

Pittosporum rigidum, Hook. f. (South Island var.)
Subalpine scrub, volcanic plateau, North Island, at 1,200 m. L. C.!

Pittosporum patulum, Hook. f.
Forest on Maitland Creek, at head of Lake Ohau. J. H. C. Bond!

Pittosporum Kirkii.
Waipoua Forest. L. C.!

Rosaceæ.

Rubus schmidelioides, A. Cunn.
Bluff Hill. L. C.!

Rubus schmidelioides, var. **coloratus.**
Stewart Island. L. C.!

Acæna novæ-zealandiæ, Kirk.
Bluff Hill. L. C.!

Potentilla anserina, L.
Stewart Island. L. C.!

Leguminosæ.

Carmichaelia prona, Kirk.

Stony beach near mouth of River Rakaia, Canterbury. L. C. !

Euphorbiaceæ.

Euphorbia glauca, Forst. f.

Dunes, Mason's Bay, Stewart Island. Laing and L. C. !

Coriariaceæ.

Coriaria thymifolia, Humb. and Bonpl.

Mason's Bay, Stewart Island. Laing and L. C. !

Elæocarpaceæ.

Aristotelia Colensoi, Hook. f.

Amongst other shrubs on bank of Rakiahua River, Stewart Island. L. C. !

Malvaceæ.

Plagianthus divaricatus, Forst.

Half-moon Bay, Stewart Island. Gibbs, Crosby-Smith, Laing, and L. C. !

Plagianthus cymosus, Kirk.

Port Hills, in remains of forest just above Lyttelton. Petrie and L. C. !

Guttiferæ.

Hypericum japonicum, Thunb.

Stewart Island. L. C. !

Violaceæ.

Hymenanthera, sp.

Mount Anglem, Stewart Island. Gibbs, Laing, Crosby-Smith, and Cockayne ! (Recorded by Kirk, but not in Cheeseman's Manual.)

Hymenanthera obovata, Kirk.

Titahi Bay, Wellington. Aston, A. H. Cockayne, L. C. !

Viola filicaulis, Hook. f.

(1.) Bed of River Waipoua ; L. C. ! (2.) Common in gullies of beech forests, volcanic plateau, North Island ; L. C. !

MYRTACEÆ.

Metrosideros albiflora, Sol.
Waipoua Forest. L. C. !

Metrosideros diffusa, Sm.
Kaihu Valley, on rocks. L. C. !

Myrtus pedunculata, Hook. f.
Bluff Hill. L. C. !

ONAGRACEÆ.

Epilobium pallidiflorum, Sol.
Stewart Island. L. C. !

Epilobium junceum, Sol.
Stewart Island. L. C. !

Epilobium pictum, Petrie.
Stewart Island. L. C. ! (This is evidently a widely dispersed species in New Zealand.)

Epilobium macropus, Hook. f.
Ruapehu, where water oozes from beneath scoria, 1,800 m. altitude. L. C. !

Epilobium insulare, Hausskn.
Stewart Island. L. C. !

Epilobium nerterioides, A. Cunn.
Stewart Island. L. C. !

Epilobium novæ-zealandiæ, Hausskn.
Stewart Island. L. C. !

Epilobium brevipes, Hook. f.
Gorge of Broken River, Canterbury, on face of cliff. L. C. !

Fuchsia procumbens, R. Cunn.
On bank of stream, Kawerua, Hokianga County. L. C. !

HALORRHAGIDACEÆ.

Gunnera prorepens, Hook. f.

(1.) Bluff Hill; L. C.! (2.) On *Sphagnum*, gully of Oturere River, volcanic plateau, North Island. L. C.!

Gunnera strigosa, Col.

Bank of Waipoua River. L. C.!

ARALIACEÆ.

Schefflera digitata, Forst.

Forest on Bluff Hill. L. C.!

UMBELLIFERÆ.

Azorella Hookeri, Drude.

Bed of River Waipoua, in forest. L. C.!

Oreomyrrhis andicola, Endl.

Rakiahua Valley, Stewart Island. L. C.!

Aciphylla flabellata (Kirk), comb. nov.

Cliffs at southern extremity of Mason's Bay. Laing and L. C.!

Angelica geniculata (Forst. f.), Hook. f.

Base of Mount Torlesse, on western side. L. C.!

CORNACEÆ.

Corokia Cotoneaster, Raoul.

Rare in *Nothofagus cliffortioides* forests, east of volcanic plateau. L. C.!

ERICACEÆ.

Gaultheria perplexa, T. Kirk.

Longwood Range. L. C.!

EPACRIDACEÆ.

Pentachondra pumila (Forst. f.), R. Br.

Longwood Range. L. C.!

MYRSINACEÆ.

Suttonia divaricata (A. Cunn.), Hook. f.

Forest, Bluff Hill. L. C.!

Gentianaceæ.

Liparophyllum Gunnii, Hook. f.

Bogs, volcanic plateau east and west of volcanic ranges. L. C. !

Apocynaceæ.

Parsonsia heterophylla, A. Cunn.

Stewart Island. L. C. !

Convolvulaceæ.

Calystegia tuguriorum (Forst. f.), R. Br.

Boraginaceæ.

Myosotis Cheesemanii, Petrie.

Cliffs, gorge of Broken River. L.C. !

Myosotis spathulata, Forst. f.

Bed of Rakiahua River, Stewart Island. L. C. !

Labiatæ.

Mentha Cunninghamii, Benth.

Stewart Island. L. C. !

Scrophulariaceæ.

Veronica elliptica, Forst., var.

Titahi Bay, Cook Strait, Wellington. B. C. Aston, A. H. Cockayne, and L. C. !

Ourisia Colensoi, Hook. f.

(I do not think this is identical with the North Island plant.)

(1.) Longwood Range, in subalpine scrub; Crosby-Smith and L. C. ! (2.) Bank of creek in forest, Mount Anglem, Stewart Island; Gibbs, Laing, Crosby-Smith, and L. C. !

Ourisia cæspitosa, Hook. f.

(1.) Tongariro, 1,500 m.; L. C. (2.) West of volcanic plateau, 1,200 m.; Phillips, Turner !

Ourisia prorepens, Petrie ?

Mount Anglem, Stewart Island. Gibbs, Laing, Crosby-Smith, and L. C. !

Euphrasia Dyeri, Wettst.

Longwood Range. L. C. !

RUBIACEÆ.

Coprosma lucida, Forst. f.
Bluff Hill. L. C. !

Coprosma areolata, Cheesm.
Stewart Island. L. C. !

Coprosma rhamnoides, A. Cunn.
Bluff Hill. L. C. !

Coprosma parviflora, Hook. f.
Bluff Hill. L. C. !

Coprosma ramulosa, Petrie.
Stewart Island. L. C. !

Coprosma Kirkii, Cheesm.
Sea-coast, Kawerua, Hokianga County. L. C. !

Coprosma fœtidissima, Forst.
Khandallah Domain, and upper portion of Day's Bay forest, Wellington. A. H. Cockayne and L. C. !

Coprosma Colensoi, Hook. f.
Upper forest of Ruapehu, on west. L. C.

Coprosma cuneata, Hook. f.
Longwood Range. L. C. !

Coprosma microcarpa, Hook. f.
(1.) Abundant as undergrowth in all the beech forests of the volcanic plateau at 900 m. to 1,200 m.; L. C. ! (2.) Upper portion of mixed *Nothofagus* forest, Day's Bay, Wellington. A. H. Cockayne and L. C. !

Coprosma Petriei, Cheesm.
Volcanic plateau not far from Waiouru, at 900 m. altitude. L. C.

Nertera dichondræfolia (A. Cunn.), Hook. f.
Bluff Hill. L. C. !

Galium umbrosum, Sol.
Stewart Island. L. C. !

CANDOLLEACEÆ.

Forstera sedifolia, L. fil., var. **oculata,** Cheesm.

Longwood Range. L. C.

COMPOSITÆ.

Olearia virgata, Hook. f.

(1.) Rakiahua Valley, Stewart Island, amongst shrubs on river-bank; L. C. ! (2.) Wet ground near Karioi, south of Ruapehu; L.C. !

Celmisia incana, Hook. f.

South and west of Ruapehu, forming large mats at 1,500 m. altitude. L. C. !

Gnaphalium trinerve, Forst. f.

Stewart Island; very common, taking possession of road-cuttings, &c., and on the increase. Gibbs, Laing, Crosby-Smith, and L. C. !

Raoulia glabra, Hook. f.

Near Half-moon Bay, Stewart Island. Laing, Gibbs, Crosby-Smith, and L. C. !

Helichrysum grandiceps, Hook. f.

Table Hill Range, Stewart Island. L. C. !

Cotula Traillii, Kirk.

(1.) Base of Bluff Hill; L. C. ! (2.) Dog Island and Centre Island; L. C. !

Cotula squalida, Hook. f.

Bluff Hill. L. C. !

Erechtites arguta, D.C.

Kapiti Island. L. C. !

Senecio scorzonerioides, Hook. f.

Table Hill, Stewart Island; very plentiful. L. C. !

Senecio elæagnifolius, Hook. f.

Longwood Range. L. C. !

Taraxacum glabratum (Forst. f.), Cockayne.

Stewart Island. L. C. !

Art. XXVI.—*Notes on the Spread of* Phytophthora infestans, *with Special Reference to Hybernating Mycelium.*

By A. H. Cockayne.

[*Read before the Wellington Philosophical Society, 4th September, 1907.*]

The behaviour of a well-known plant-disease under changed environment, or in localities where the disease has not previously existed, is a matter of the most vital importance to the student of plant-pathology. Here in New Zealand we have an exceptionally rich field for the study of the biology of many plant-parasites, for in this country the great majority of our most dangerous plant-diseases are aliens, having been in the first place imported on one or other of their hosts.

The wide expanse of ocean which separates these islands from other lands forms a barrier which precludes the supposition that they could have been introduced by spores or other reproductive bodies blown hither by the wind. Once introduced, the ecological factors for many of these diseases being pre-eminently suitable for their requirements, they have thriven here as well as, if not better than, in their original home. Others which in other countries are justly looked upon as dangerous plant-parasites have, on acclimatisation here, been quite unable to cause sufficient damage to rank them as markedly injurious. Others, again, which in their native country appear to live more or less in equilibrium with their hosts, have, since their introduction here, become virulently epidemic, and are the cause of much annual loss both to the farmer and fruit-grower.

In these notes I shall confine myself to some observations on the ecology of the Irish potato-disease (*Phytophthora infestans*).

Introduction into New Zealand.

There are no definite records of when and how *Phytophthora infestans* was first introduced into this country. On the epidemic outbreak of this disease in November, 1904, Professor Thomas made the following statement: "The same disease (*Phytophthora infestans*) appeared some twelve years ago, but it was not so prevalent as on the present occasion." Further, he says, "Moreover, it is no new thing here, having been in the country, to my certain knowledge, for the past twelve years." Mr. T. W. Kirk, in the report of the Department of Agriculture for 1905, writes, "Twelve years ago there was a mild outbreak in the Auckland Province, but it has not been heard of since till last year." For my part, I consider that the epidemic outbreak in Auckland in 1904 was in no way connected with the sporadic ones which occurred previously. The cause can be attributed to the fresh importation of *Phytophthora* mycelium in imported potatoes. There are only two ways that *Phytophthora* can possibly have been introduced here—either by resting mycelium in diseased tubers, or by asexual spores or oospores; but as these latter have never been definitely discovered, its introduction by means of them is most unlikely. The asexual spores of *P. infestans* are naturally short-lived, and are in no way provided with any adaptations to withstand the desiccation that they would undergo in passing through the tropics. Therefore it is almost certain that the introduction of this disease into New Zealand was by means of dormant mycelium hidden away in the tissues of affected tubers. This view is greatly strengthened by the discovery, on numerous occasions during the past two years, of varieties of imported potatoes in which the presence of *Phytophthora* mycelium was clearly demonstrated.

All potatoes which are now imported into New Zealand are carefully examined by the Agricultural Department, and those lines found affected with *Phytophthora* are at once destroyed.

ACTION OF PHYTOPHTHORA ON POTATO-TUBERS.

There are still many gaps in our knowledge of the full life-history of the Irish potato-disease, and the exact pathological processes that obtain in so-called diseased tubers are but imperfectly understood. That the disease is transmitted from season to season by means of mycelium permeating the tissues of the tubers themselves has been now abundantly proved. Massee has given the name "hybernating mycelium" to that portion of the vegetative body of a fungus which has the power of remaining quiescent during the dormant period of the host's existence, and which can return to normal development as soon as the host commences to develop. It follows naturally that those fungi which are able to develop hybernating mycelium do not require the same amount of varied spore-formation as those which are not so equipped. The formation of winter spores would be decidedly superfluous, and such fungi can be more specialised in the direction of producing summer and generally short-lived spores, whose object is to rapidly infect large masses of their hosts, provided the environment is suitable.

The finest example of hybernating mycelium is found, as Freeman has shown, in the fungus affecting the various species of *Lolium*, especially *L. temulentum*. In over 70 per cent. of the seed of this weed that I have examined masses of resting mycelium have been found in the tissue interior to the aleurone layer. This mycelium remains inactive until the *Lolium* seed begins to germinate, when it develops and keeps pace with the growth of the host, and finally re-forms resting mycelium in the developing seed. No mode of spore-formation, either sexual or asexual, has ever been noted, and the fungus appears to live in perfect harmony with its host. This almost symbiotic union between the fungus and host is of the utmost biologic importance in the economy of hybernating mycelium, for it is at once apparent that if the fungus can live on its host throughout the dormant season without causing any marked injury, there is all the more chance of the host developing in a normal and more or less healthy manner during the next season, and thus allow the perpetuation of the fungus; whereas if the resting mycelium caused serious pathological changes in the host, the latter would probably be killed outright, and the resting mycelium would die at the same time.

A considerable amount of material has been examined by me during the past three years, showing both the ordinary and the hybernating mycelium of *Phytophthora infestans*, and a certain amount of interesting information on the perpetuation of this fungus has thus been gathered together.

The exact manner by which the mycelium of *P. infestans* reaches the tuber has not been as yet satisfactorily ascertained, and for this purpose detailed and careful examination in the field would be necessary. Two methods have been suggested—firstly, that the mycelium spreads from the leaf downwards through the stem until it reaches the tuber; and, secondly, that spores developed on the conidiophores fall to the ground, and are washed by rain or carried by other agencies directly on to the surface of the tubers. I am inclined to think that both these processes occur in nature, but that the mycelium, which descends down the stem and then enters the tubers, alone forms hybernating mycelium, and that the spores which reach the tubers by mechanical and other means do not develop into resting mycelium, but are more or less directly responsible for the rapid rotting that so often occurs with *Phytophthora* attack. This view gains great weight from the fact that healthy tubers on the surface of which *Phytophthora* spores are scattered, but on which resting mycelium has not been observed by me, rapidly develop a rot. Recently Matruchot and Molliard have declared that *Phytophthora* does not of itself cause a rot in potato-tubers, but that after the tubers become affected the rot that sets in is due to microbes that become associated with the *P. infestans*. This view, notwithstanding the high authorities from whence it has originated, I am inclined to combat; although I must admit that in the majority of the cases I have examined secondary infection by bacteria and other fungi, notably *Fusarium oxysporum*, plays an extremely important part in the rotting that occurs in tubers which have been primarily attacked by *P. infestans*. It is a well-known fact that tubers bearing the characteristic marks associated with *Phytophthora* attack often remain during the whole winter without any trace of rot setting in. When these are examined under a magnification of about 100 diameters, large amounts of dormant mycelium will be seen in those portions of the tissues of the tubers that abut on the darkened and discoloured areas, which are said to be caused by *Phytophthora;* and in such cases no other fungi or bacteria will be found associated with the *Phytophthora* mycelium. This observation gains considerably in significance when it is stated that in those tubers on which an active rot is present resting mycelium can hardly ever be discovered, although there will be an abundance of bacteria and other fungi, both parasitic and saprophytic.

If slices of potatoes showing resting mycelium of *Phytophthora infestans* are placed in petri dishes, and kept moist in a temperature of about 60° to 70° Fahr., the mycelium will rapidly become active, and in a few days an abundant crop of spores will be developed. This shows that the mycelium is not in a very dormant condition, but is really on the border-line between active and hybernating mycelium. This is a very important point, inasmuch as it shows the liability, under certain conditions, of the mycelium to become active even when no growth on the part of the host takes place, and in this particular distinguishes it sharply from the more specialised resting stages in the life-history of other fungi, such as many of the *Ustilagineæ*.

When tubers with the resting mycelium of *P. infestans* are planted, the fungus develops rapidly through the tissues of the developing plant, and if the weather is humid and warm the mycelium becomes markedly negatively geotropic, and if the conditions remain favourable for its development it quickly makes its way into the leaves, on the under surfaces of which it soon produces an abundant supply of spores, which, blown by the wind, can soon spread infection far and wide. If, however, the weather-conditions remain unfavourable for its development, no spores at all may be produced, and to all outward appearance the potato-plants remain quite healthy. In such a case it is not known whether the fungus can again form resting mycelium without the intervention of a spore-producing stage, as is done in the case of *Lolium temulentum*, but I am inclined to consider that such can and often does occur.

The Tropic Movements of Phytophthora Mycelium.

A peculiar feature of the biology of the mycelium of *Phytophthora infestans* is that, after primary infection has taken place on the leaf or stem, it is markedly positively geotropic. On the other hand, as has been mentioned previously, the mycelium developing from the dormant portion becomes negatively geotropic. For my part, I attribute this not to the action of gravity, but to the result of chemotactic stimulus, and that the mycelium in all cases follows the direction in which food materials are stored. This would account for the apparently contradictory influence which gravity has up to the present been considered to produce.

An important point, and one which appears to have been lost sight of, is the fact that in tomatoes attacked by *Phytophthora* the direction of the mycelium is in general negatively geotropic, or, as I take it, the mycelium is chemotactically attracted by the food material stored in the fruit; whereas in the potato the mycelium is positively geotropic, being attracted downwards by the chemotactic stimulus of the tubers.

Art. XXVII.—*Note on the Gabbro of the Dun Mountain.*

By Dr. P. Marshall.

Communicated by Mr. R. Speight.

[*Read before the Philosophical Institute of Canterbury, 11th December, 1907.*]

Captain Hutton first called attention to this rock,* and correctly described some of its peculiarities. Its coarse structure and its simple composition (for it contains only two minerals) were both noted. The specimen was given to him by Sir J. von Haast, and the field relations of the rocks were unknown.

The two minerals were called by Hutton anthophyllite and saussurite, which he supposed to be derived from anorthite or labradorite. In a later paper† he again classed the rock as saussurite-gabbro, but classed the ferro-magnesian mineral as diallage, enstatite, and hornblende in different portions.

A geological report of the district by E. H. Davis‡ does not refer to gabbro rocks specifically, though it is probably in-

* Trans. N.Z. Inst., vol. xix, p. 412.

† Journ. Roy. Soc. N.S.W., vol. xxiii, p. 154.

‡ Geological Reports, 1870–71, p. 103.

cluded in the confused mass of feldstone, bronzite, anthophyllite, &c., referred to on page 118 of that report.

Hochstetter* refers to dykes of diallage rock in the dunite of this region.

A visit to the district in December, 1906, enabled me to collect specimens, though in the many localities in which the rock was found I was unable to do anything in the way of determining its field relations, for I found it nowhere *in situ*, though blocks were abundant on the north-east slopes of the Dun Mountain and in the valleys of the Maitai Stream and Roding River, especially where they issue from the magnesian country. Microscopic examination showed that the so-called saussurite was entirely isotropic, as previously mentioned by Hutton. In all my specimens the ferro-magnesian mineral was diallage.

In the fresh specimens the white mineral was absolutely clear and colourless in section, but in weathered specimens it was somewhat cloudy. A specimen was obtained absolutely pure for analysis, and it gave the following result :—

	1.	2.
SiO_2	39·56	38·60
Al_2O_3	23·73	24·18
CaO	31·90	35·03
MgO	3·15	0·97
Ign.	..	1·10
Total	98·34	99·96

1. Grossularite-gabbro, Dun Mountain, Nelson, New Zealand.
2. Grossularite, River Iset, Peru.

From a comparison with the adjacent analysis of typical grossularite it will be seen that the chemical composition of the mineral shows clearly enough that it should be referred to grossularite. The percentage of magnesia is high, though when the nature of the adjoining dunite magma is considered such a percentage is to be expected.

The specific gravity of the mineral confirms this result. From a specimen of absolute purity the following result was obtained : G. 3·502. The average specific gravity for the examples quoted ("Dana's System of Mineralogy") is rather over 3·5. The refractive index has not yet been measured, though from the aspect of the surface in section the value appears below that usual for grossularite.

* "New Zealand," p. 475.

The saussurite-gabbro therefore becomes a grossularite-gabbro. I can find no reference to a similar rock, though in Rosenbusch's "Physiographie der Mossigen Gesteine," 1906, 3rd edition, p. 338, it is stated that garnet occurs as an accessory constituent of gabbro, though it is not said whether grossularite is the type referred to.

The only field relation that was determined for this gabbro was its proximity to the Maitai limestone which fringes the peridotite intrusion on the north-west. This fact causes the author to offer the suggestion that the peculiar rock type has resulted from the digestion of some of the limestone at the periphery of the magma. Captain Hutton has already described a pyroxenite from the district. It contains a large amount of bastite, often in large plates, but otherwise consists entirely of diallage. In addition, peculiar white rock masses project from the surface of the hill in various places. These have been called felsite and felstone by Davis, but they are probably the material which was afterwards found by Skey to be wollastonite—a conclusion with which the author agrees.

The presence of masses of wollastonite appears to offer confirmation of the suggestion offered that digestion of masses of the Maitai limestone has taken place.

Art. XXVIII.—*The Analyses of certain New Zealand Meat Products.*

By A. M. Wright, F.C.S. (Berlin), M.Am.C.S.

[*Read before the Philosophical Institute of Canterbury, 6th November,* 1907.]

Numerous papers have been published on the frozen meat of New Zealand, but up to the present no work appears to have been recorded upon the food-products of lesser importance which are closely associated with the frozen-meat trade.

I. Boned Beef.

The following analyses show that this class of meat contains equal nutritive value with the ordinary flesh of healthy cattle. For comparison, figures given by Mitchell* are quoted.

* "Flesh Foods," p. 47.

—	Boned Beef.			Average.		
	Ox.	Cow.	Veal.	Ox.	Cow.	Veal.
Water	71·13	63·14	76·28	72·03	70·96	78·82
Nitrogenous substances ..	21·76	18·92	21·93	20·96	19·86	19·86
Fat	6·25	17·14	1·02	5·41	7·70	0·82
Nitrogen-free extractives ..	..	..	..	0·46	0·41	..
Ash	0·86	0·80	0·77	1·14	1·07	0·50
Nitrogen	3·48	3·03	3·51	..	..	..
Calculated to Dry Substance.						
Nitrogenous substances ..	75·37	51·33	92·48	74·93	68·38	93·76
Fat	21·65	46·50	4·30	19·34	26·52	3·87
Ash	2·98	2·17	3·22	..	..	..
Nitrogen	12·06	8·22	14·79	12·00	11·13	15·01

II. MEAT-EXTRACTS.

The following are the analyses of the principal meat-extracts manufactured in the colony, together with the analyses of Australian and South American extracts :—

—	New Zealand.								South American.	Australian.
	1.	2.	3.	4.	5.	6.	7.	8.		
Moisture	21·79	17·16	13·10	24·21	13·46	17·28	20·65	16·42	19·04	19·48
Organic matter ..	59·95	65·58	67·78	59·44	69·43	62·82	71·51	69·91	59·57	62·59
Sodic chloride ..	3·36	3·14	4·11	2·89	3·03	3·68	1·78	3·43	4·22	3·71
Other mineral salts ..	14·90	14·12	15·01	13·46	14·08	16·22	6·06	10·24	17·17	14·22
Fat	0·33	0·38	0·41	0·34	0·46	0·26	14·10	0·31	0·28	0·36
Substance insoluble in water	1·02	..	..	0·36	..	0·21	..	..	..	..
Substance insoluble in 50 per cent. alcohol, but soluble in water	4·61	5·38	8·21	7·45	10·92	3·38	..	5·22	6·92	3·23
Substance insoluble in 80 per cent. alcohol, but soluble in water and 50 per cent. alcohol	15·16	20·92	16·82	15·08	22·48	18·58	..	13·36	12·93	11·24
Substance soluble in 80 per cent. alcohol	57·42	56·54	61·87	52·90	53·14	60·55	..	65·00	61·11	66·05
Nitrogen insoluble in 50 per cent. alcohol	0·32	0·48	0·62	0·58	0·71	0·29	..	0·42	0·46	0·28
Nitrogen insoluble in 80 per cent. alcohol, but soluble in 50 per cent. alcohol	1·25	1·64	1·39	1·22	1·96	1·39	..	1·06	1·15	0·97
Nitrogen soluble in 80 per cent. alcohol	7·15	7·69	8·31	6·85	7·93	7·83	..	9·25	7·29	8·07
Total nitrogen ..	8·72	9·81	10·32	8·65	10·60	9·51	8·26	10·73	8·90	9·32
Creatine	4·82	3·88	..	..	6·19	..	..	6·21	5·03	4·11

The meat-extracts numbered 1 to 6 are from various factories in the colony. The substance insoluble in water in Nos. 1 and 4 was meat-fibre, while that in No. 6 was phosphate of lime. No. 7 was made from sheep-heads, and was sold as "stock."

The high fat-content was mainly brain-fat, and, as this fat readily emulsifies with water, it could not be readily removed from the liquor; this article is not now manufactured in this colony. No. 8 was taken from a trial lot of rabbit-extract, and, while this article is not manufactured in New Zealand, its analysis indicates the possibility of utilising this material.

For permission to publish these results I have to express my thanks to the general manager of the Christchurch Meat Company (Limited), in whose laboratory most of the work was carried out.

ART. XXIX.—*The Fixation of Atmospheric Nitrogen by Nitrogen-fixing Bacteria in Certain Solutions.*

By A. M. WRIGHT, F.C.S. (Berlin), M.Am.C.S.

[*Read before the Philosophical Institute of Canterbury, 11th December, 1907.*]

THIS paper is the record of the work carried out preliminary to soil experiments to determine under what conditions of alkalinity and acidity nitrogen-fixing bacteria will fix atmospheric nitrogen.

A solution of 1 gram each of cane-sugar, ammonium-sulphate, magnesium-sulphate, and potassium-sulphate in 1 litre of water was prepared; to 10 cubic centimeters of this solution 100 milligrams of cotton-wool containing the bacteria were added. This was then rendered acid or alkaline. The degrees of acidity or alkalinity are expressed as parts of calcium-oxide per million, this being the usual method of expressing these results in soil-determinations.

The experiments were carried out in Kjeldahl digestion flasks. At the end of the experiment it was merely necessary to add mercury and sulphuric acid, and proceed with the nitrogen determination as in other Kjeldahl estimations.*

NEUTRAL SOLUTION.

Days.	Nitrogen found. Mg.	Nitrogen fixed. Mg.
0	2·1	..
3	2·7	0·6
7	3·4	1·3
10	4·2	2·1
14	5·1	3·0
21	6·7	4·6
28	8·8	6·7

* Bull. No. 81, Bureau of Chemistry, U.S.A. Dept. of Agric., p. 152.

ACID SOLUTIONS.

	1.		2.		3.	
Days.	Nitrogen found. Mg.	Nitrogen fixed. Mg.	Nitrogen found. Mg.	Nitrogen fixed. Mg.	Nitrogen found. Mg.	Nitrogen fixed. Mg.
0	2·1	..	2·1	..	2·1	..
3	2·4	0·3	2·2	0·1	2·1	..
7	3·1	1·0	2·6	0·5	2·2	0·1
10	3·9	1·8	2·9	0·8	2·2	0·1
14	4·3	2·3	3·0	0·9	2·4	0·3
21	5·6	3·5	3·2	1·1	2·6	0·5
28	6·7	4·6	3·6	1·5	2·8	0·7

Experiment 1. Acidity required, 254 parts of CaO per million to neutralise solution.

Experiment 2. Acidity required, 646 parts of CaO per million to neutralise solution.

Experiment 3. Acidity required, 1,050 parts of CaO per million to neutralise solution.

ALKALINE SOLUTIONS.

	1.		2.	
Days.	Nitrogen found. Mg.	Nitrogen fixed. Mg.	Nitrogen found. Mg.	Nitrogen fixed. Mg.
0	2·1	..	2·1	..
3	2·8	0·7	2·6	0·5
7	3·7	1·6	3·2	1·1
10	4·8	2·7	4·1	2·0
14	5·5	3·4	4·9	2·8
21	7·1	6·0	6·5	4·4
28	9·3	7·2	8·5	6·4

	3.		4.	
Days.	Nitrogen found. Mg.	Nitrogen fixed. Mg.	Nitrogen found. Mg.	Nitrogen fixed. Mg.
0	2·1	..	2·1	..
3	2·4	0·3	2·3	0·2
7	2·9	0·8	2·5	0·4
10	3·8	1·7	2·9	0·8
14	4·5	2·4	3·1	1·0
21	6·1	4·0	3·7	1·6
28	7·8	5·7	4·2	2·1

Experiment 1. Alkalinity equals 254 parts of CaO per million.
,, 2. ,, 646 ,,
,, 3. ,, 1,050 ,,
,, 4. ,, 1,400 ,,

It will be seen from the above that the bacteria fix nitrogen in the greatest quantity when the media are neutral or slightly alkaline. In slightly acid media the nitrogen is fixed in less quantities, while when the acidity is 1,050 parts per million the fixation is relatively small. The fixation also decreases as the alkalinity increases over 254 parts per million.

For permission to publish these results I have to express my thanks to the general manager of the Christchurch Meat Company (Limited), in whose laboratory much of the work in connection with this paper was carried out.

Art. XXX.—*The Transformation of Barley into Malt.*

By Percy B. Phipson, F.C.S.

[*Read before the Wellington Philosophical Society, 1st November, 1905.*]

The practice of malting and brewing has been known from very ancient times. Herodotus describes (Herodotus, Book II, cap. 77) beer prepared from barley as the ordinary drink of the Egyptians in his day (430 B.C.), and, in common with other writers of antiquity, he ascribes the art of brewing to Isis, wife of Osiris, better known as Rameses II (1960 B.C.). It is therefore a matter of surprise that, although the process of malting has been carried on for close on four thousand years, so little is really known about it except by persons connected with that industry.

In the present paper I intend giving a short description of the barley-corn, an explanation of the chemical changes that take place within the barley-corn during germination, and an account of the method by which these changes are brought about in practice.

The first subject to receive attention is the structure of the barley-corn. You will notice that the grain is spindle-shaped, and about ⅓ in. in length, one end being sharper than the other: this was the end that was attached to the ear of barley previous to threshing. Again you will notice that the grain is enveloped by a very strong skin or husk—paleæ—consisting of the inner and outer palea. Beneath the paleæ are two coats or skins, the first known as the "pericarp," and the second, which is really the true covering of the seed, is known as the "testa." A narrow furrow runs down the more convex side of the grain; this side is known as the "ventral" side, while the other, which is comparatively flat and smooth, is termed the "dorsal" side.

If we now bisect a grain of barley longitudinally—that is, through the ventral furrow—we shall find that the grain con-

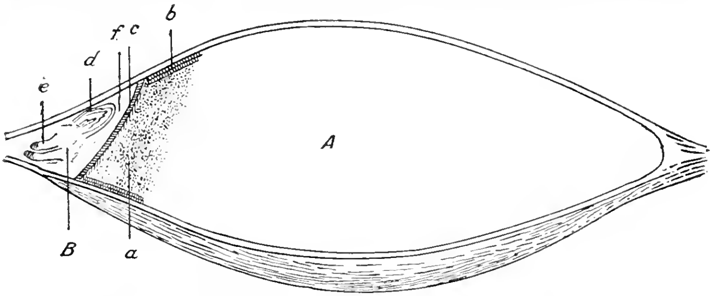
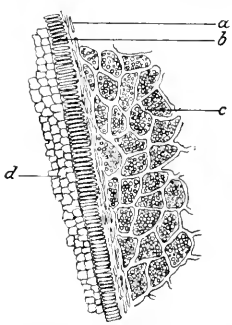


DIAGRAM OF A LONGITUDINAL SECTION OF A BARLEY-CORN.

A, endosperm; B, germ. *a*, starch-containing cells of the endosperm; *b*, aleurone layer; *c*, absorptive epithelium of the scutellum; *d*, plumule; *e*, rootlets; *f*, scutellum.

sists of two principal parts—(1) the germ or embryo (the part endowed with actual life); (2) the endosperm, the starchy portion of the grain.

The germ, which in the dried barley-corn forms only about one-thirtieth of the whole, is separated from the endosperm by a barrier known as the "scutellum." This scutellum consists of layers of compressed empty cells; and on the side which is pressed on the endosperm is situated a layer of elongated cells, known as the "absorptive epithelial layer." These cells have most important functions, and play an important part in the feeding of the young embryo when it commences to develop into a young plant.



SECTION SHOWING EPITHELIUM (GREATLY MAGNIFIED).

a, Empty compressed starch cells of the endosperm; *b*, absorptive epithelium; *c*, starch-containing cells of the endosperm; *d*, scutellum.

The germ consists of two distinct parts—plumule and rootlets. During germination this plumule becomes the acrospire of the malt, and if the seed were sown in the ground and germination pushed on to completion the acrospire would develop into the actual stem of the plant, and, under similar conditions, the rootlets would form the roots.

The endosperm consists of a mass of starch-cells, intermingled with irregular and spherical particles of nitrogenous matter, the whole contained in compartments of cellulose, and forming a store of foodstuff to supply the germ until it has grown sufficiently to enable it to draw nourishment through its roots and leaves.

Immediately under the skin is a triple layer of thick-walled square-shaped cells, known as the "aleurone cells." These cells contain finely granulated nitrogenous matter, and also small spherules of fat or oil. It is not clear what their immediate function is, but, seeing they are in contact with the starch-cells of the endosperm and the bulk of the germ, they may take some active part in the transfer of food from the former to the latter.

Now, although the substances in the endosperm are intended as a food-supply for the germ, they are in an entirely unavailable condition, for, in the first place, the scutellum will prevent the passage to the germ unless these substances are in a state of solution, and, in the second place, such a solution must be a diffusible one. Now, starch, which constitutes the bulk of the endosperm, is practically insoluble, and the nitrogenous matters are almost entirely so, while such portions of them as do dissolve in water yield non-diffusible solutions.

With the object of rendering the amount of foodstuff available for the young germ, the epithelial layer of the scutellum, which I have previously described, has the property, when sufficient water is present, of secreting soluble ferments, or enzymes, which have the power of acting on the starch and nitrogenous matter and rendering them both soluble, and the solutions of which are diffusible. The enzyme which acts upon starch is diastase, while that which acts upon nitrogenous matter is vegetable pancreatin, and is probably similar to peptase.

Now, although by the aid of the two ferments, diastase and peptase, the two difficulties of solubility and diffusibility are overcome, the foodstuffs in the endosperm are not even yet available for the nutrition of the germ. I mentioned previously, in speaking of the contents of the endosperm, that both the starch and gluten cells were enclosed within compartments of cellulose, and, as this cellulose tissue is impervious both to diastase and peptase, it is necessary that another enzyme should be secreted to dissolve this cellulose. This enzyme is called "cytase," and its action, of course, precedes the action of both the other ferments. Cytase is secreted in the region of the scutellum, and slowly passes through the grain, and its passage may be noted by the progressive softening of the corn as it dissolves the cellulose, the original hardness of the grain being due to this substance. Cytase converts the cellulose into sugar (dextrose), and this, passing through the scutellum, is used by the germ as food.* The diastase acts upon the now exposed starch and converts it into maltose, no dextrin being formed. The maltose passes from where it is formed in the endosperm to the germ, but, while transfusing, this scutellum is apparently converted into cane-sugar in an unascertained manner. This cane-sugar now formed is used by the germ as food. A portion of it is inverted into invert sugar by an enzyme called "invertase" that is secreted in the neighbourhood of the rootlets.

While these changes are taking place an analogous process is also going on with the nitrogenous matter. The nitrogenous constituents of malt consist principally of glutens. These are acted upon by the peptase, and are converted into peptones, amides, amido-acids, and albuminoids proper, the former passing readily through the scutellum and forming the nitrogenous portion of nutriment of the germ.

From the above you will realise what an enormous amount of energy is lying dormant within the germ of the barley-corn, and only waiting the addition of water at a suitable temperature to bring these numerous and complex changes about.

On a commercial scale the process is carried out in the following manner: The barley, after having been thoroughly cleaned by passing through screening machinery, and graded to take out the light, thin corns, is then immersed in water in a large tank known as the cistern. The barley is allowed to soak for about fifty hours; but, of course, this will vary very much according to the nature of the barley and the temperature of the steep-water, which should be from 50° to 55° Fahr. If the water is below this temperature it tends to delay germination.

While in the cistern the barley absorbs about 50 per cent. of water, and its proportions increase considerably in bulk. The lower the initial moisture of the barley the more rapidly does it absorb water. This is a matter of importance, as barley grown on undulating land—as much of the New Zealand barley is—invariably shows great irregularity in the amount of initial moisture; consequently some of the grain absorbs more water than the other while in the cistern, which, in turn, means uneven growth. To remedy this, many maltsters now adopt the system of sweating prior to steeping. By the term "sweating" is meant kiln-drying. The barley, before being stored in bins, is subjected to a temperature of about 100° Fahr. on the

* H. Brown and Morris.

kiln for about eight hours. By this means the amount of moisture is reduced.

During the steeping stage the water is changed several times, partly because the water dissolves a certain amount of organic matter from the grain which would afford a supply of food for the numerous bacterial organisms that adhere to the barley, and also because the accompanying aeration due to the draining of the barley greatly assists to bring about germination.

The grain having been steeped—that is, sufficiently soaked—it is now laid out upon the growing-floor. It is usual to commence the process by what is known as "couching the malt" for twelve or eighteen hours—that is, keeping it up to a depth of 12 in. or 18 in.; this allows the heat to accumulate, and starts the act of germination more rapidly than would be the case if the grain were laid out in a shallow piece.

After couching, the next process is flooring. The couch is broken down, and the grain is laid evenly over the floor to the depth of 3 in. or 4 in. The depth entirely depending upon the temperature, naturally on a warm, muggy day the grain will be spread thinner than on a cold day, and *vice versa*.

In about twenty-four hours after the removal of the grain from the cistern the rootlets begin to make an appearance in the form of a white protrusion at one end of the barley-corn. On the following day many of the corns will show from one to three distinct rootlets, and on the third day nearly the whole of the grain will have three or four roots. By the third day the acrospire—that is, the stalk part of the germ—will begin to move up the back of the corn.

During all this time a respiratory process is proceeding—that is, the corn is actually inhaling atmospheric oxygen and exhaling carbon-dioxide, and any undue accumulation of this latter gas either stops its growth or seriously impedes it; provision has therefore to be made for removing the carbon-dioxide and supplying fresh oxygen. This necessary aeration is secured by turning the malt. The turning is effected with broad flat wooden shovels, and as each shovelful is thrown forward a dexterous turn of the wrist scatters it thinly and evenly on the floor in front. This turning usually takes place both morning and evening.

On the fifth or sixth day the roots will begin to probably lose their fresh appearance, and become yellowish; this shows that the piece is becoming deficient in moisture. It is therefore sprinkled with water from a long-spouted watering-can made for this purpose. The amount of sprinkling-water used is usually about half a gallon to the bushel, and the whole of this is applied during the fifth and sixth days. This should supply sufficient moisture to carry on germination until the acrospire has reached about two-thirds or three-quarters up the back of the corn, when germination has proceeded far enough.

Directly the cellulose has been all converted, all further change in the barley-corn represents dead loss, so that when we have accumulated sufficient cytase to remove the rest of the cellulose tissue, the piece is thickened slightly and allowed to remain for eighteen or twenty-four hours without turning. By this means the growth is to a certain extent stopped, the piece collects heat and loses moisture, and the rootlets become shrivelled in appearance; this part of the process is known as "withering." On the floors working at the above temperatures it will take about twelve days to arrive at the withering stage. Working at a higher temperature, and using a larger quantity of sprinkling-water, it would be possible to obtain the same amount of growth in eight or nine days; but in this case a larger amount of carbo-hydrate and soluble nitrogenous matter is formed in the germ than it has time to assimilate; consequently, these bodies would remain in the malt, and pass over into the brewer's wort, with disastrous results.

During the later stages of growth upon the floors mould will unfortunately begin to make an appearance, the damaged and broken corns being the first attacked. For this reason as many as possible of the broken corns are removed prior to steeping; but, although broken corns can be mechanically removed, this does not apply to corns that are slightly skinned. Hence, however careful the maltster may be, a certain amount of mould is inevitable. For this the grower is almost entirely to blame, the damage to the grain being either due to setting the threshing-machine too close—and this is frequently done intentionally, so as to break off the awn as short as possible, and so give the barley a plump appearance—or because the grower is anxious to get a large amount of grain threshed in a given time, the machine, in consequence, being driven at too high a speed. It is not too much to say that much of the New Zealand barley is really unfit for malting for this one reason—the grower will not realise that barley for malting should have an awn.

The withering stage having been completed, the grain is now loaded on to the kiln, where it is subjected to two distinct though continuous processes—viz., drying and curing.

The object of drying is twofold—firstly, we want to effectually arrest any further growth in the malt; and, secondly, we want to reduce the percentage of moisture existing at the time of loading the kiln—generally about 45 per cent.—to a point at which we can commence curing in safety.

In this part of the process it is necessary to proceed with great care, as if the heat is applied too rapidly the starch in the external layers of the endosperm becomes gelatinised and vitreous, and also to a certain extent caramelised; also, the diastase contained in the malt is very sensitive to heat in the presence of moisture, but when dry will stand exposure to fairly high temperatures.

In order to expel the moisture while at a low temperature the malt must not form a layer of more than 8 in. in thickness; the air-holes in the kiln are kept open to admit of large volumes of air passing through, and the malt is frequently forked and loosened. During this time the temperature is kept at about 80° or 90° Fahr.

As the moisture-percentage decreases, the heat is allowed to rise, so that by the time the percentage of moisture has been reduced to 12 per cent. or 15 per cent., the temperature will have increased to about 130° Fahr. By this time the malt is what is termed "hand dry." When this point is reached, the drying ceases and curing commences. The air is nearly all shut out, and the temperature is raised to about 180° Fahr. for pale malt or about 200–230° for "high dried," and the malt is maintained at this temperature for about eight hours. By keeping the malt at this high temperature we restrict the diastatic character of the malt to certain limits dependent upon the type of malt which we wish to turn out, and also obtain the products upon which depend the character and aroma of the article produced. The moisture-percentage is also reduced to 1 per cent. or under.

During the whole of the process of drying and curing the heat is obtained directly from the fires—that is to say, the heat and combustion products pass direct through the layer of malt, the malt being supported on a floor of woven wire or perforated tiles, the fires being placed immediately under the floor, but at such a distance as will prevent scorching the kiln; in fact, in construction resembling a chimney. The fuel used is either anthracite coal or coke.

At the finish of the curing stage the malt is passed through screening machinery to remove the rootlets, which, although shrivelled up, still adhere to the grain, and finally the malt is stored away in airtight bins until required.

ART. XXXI.—*On Isogonal Transformations: Part II.*

By EVELYN G. HOGG, M.A., Christ's College, Christchurch.

[*Read before the Philosophical Institute of Canterbury, 4th December, 1907.*]

1. IF from a point P perpendiculars PD, PE, PF be drawn to the sides BC, CA, AB respectively of the triangle of reference ABC, it is easily shown that the perpendiculars from A, B, and C on EF, FD, and DE respectively are concurrent in a point P′, and that the points P and P′ are isogonal conjugates.

If now the point P be supposed to move on to the circle ABC, the point P′ will move to infinity, and the pedal triangle DEF will become the Simson line of the point P. Hence we derive the important theorem—"The isogonal conjugate of a point on the circumcircle of the triangle of reference lies at infinity in a direction perpendicular to the Simson line of the given point."

2. In this paper use will also be made of the following theorem: "The Simson lines of the extremities of a chord of a circle intersect at an angle equal to that at which the chord cuts the circle." This may be easily proved from the consideration that if the perpendicular drawn from any point P on the circle ABC to BC meets that circle again in the point A′, then AA′ is parallel to the Simson line of P.

3. It has been shown in section 4 of Part I of this paper that the asymptotic angle of the circumconic which is the isogonal transformation of a chord of the circumcircle of the triangle of reference is equal to the angle at which that chord cuts the circle. Combining this with sections 1 and 2 of this paper, we see that the asymptotes of the conic which is the isogonal transformation of a chord PQ of the circle ABC are perpendicular to the Simson lines of the points P and Q.

In general, if S′ be the isogonal transformation of a curve S, and if S cut the circle ABC in the points P, Q, R ......, then the directions of the asymptotes of S′ are perpendicular to the Simson lines of the points P, Q, R ......

4. If the position of a point P be determined by the intersection of the circle ABC and the conic whose equation is

$$l\beta\gamma + m\gamma\alpha + n\alpha\beta = o,$$

then the Simson line of the point P is perpendicular to the line $l\alpha + m\beta + n\gamma = o$. and its equation may be written

$$\frac{\frac{a}{l}\left(\frac{b}{m}-\frac{c}{n}\right)}{\frac{d\Omega}{dl}}\alpha + \frac{\frac{b}{m}\left(\frac{c}{n}-\frac{a}{l}\right)}{\frac{d\Omega}{dm}}\beta + \frac{\frac{c}{n}\left(\frac{a}{l}-\frac{b}{m}\right)}{\frac{d\Omega}{dn}}\gamma = o$$

where

$$\Omega \equiv l^2+m^2+n^2-2mn\cos A-2nl\cos B-2lm\cos C.$$

5. The isogonal transformation of a tangent to the circle ABC is a parabola circumscribed to that triangle. If the tangent touch at the point P, then the axis of the parabola is perpendicular to the Simson line of the point P. The isogonal transformations of two tangents TP, TQ are two parabolas having their axes inclined at an angle equal to that at which PQ cuts the circle ABC. Parallel tangents transform isogonally into two parabolas passing through four concyclic points and having their axes mutually perpendicular.

6. Let four points A, B, C, D (no three of which are collinear) be taken, and let the triangles formed by omitting in turn each of the points be called Δ_1, Δ_2, Δ_3, Δ_4: let also the isogonal conjugates of A, B, C, D with regard to the triangles Δ_1, Δ_2, Δ_3, Δ_4 be called respectively A′, B′, C′, D′. If the tangents from A′, B′, C′, D′ touch the circumcircles of Δ_1, Δ_2, Δ_3, Δ_4 in $P_1Q_1 : P_2Q_2 : P_3Q_3 : P_4Q_4$, then the two parabolas which can be drawn through the four given points may be regarded as the isogonal transformation of any pair of tangents to the corresponding circumcircle. Hence we see that the eight points of contact of the tangents may be arranged in two groups of four points such that the Simson lines of the points of each group are parallel to one another. This result may also be expressed by saying that each of the chords of contact PQ cuts its associated circle at the same angle—viz., the angle at which the axes of the parabolas are inclined to each other.

7. If the direction of the axis of a parabola circumscribing the triangle ABC be given, the line of which the parabola is the isogonal transformation may be constructed in the following manner: Draw through A a chord AA′ perpendicular to the given direction: let the perpendicular from A′ on BC meet the circle ABC in the point P, then the tangent at P to the circle ABC will isogonally transform into a parabola whose axis is perpendicular to the Simson line of P, and therefore parallel to the given direction.

8. Let a straight line L ≡ $l\alpha + m\beta + n\gamma = o$ be taken, and let p be its distance from the centre of the circle ABC and ϕ

the angle at which it cuts that circle. Then if $p < R$, the radius of the circle ABC, L will isogonally transform into the hyperbola $S \equiv l\beta\gamma + m\gamma\alpha + n\alpha\beta = o$, whose eccentricity ($\epsilon$) is given by the relation $\epsilon = \sec\frac{\phi}{2}$. From this we may deduce the following expression for the eccentricity:—

$$\epsilon^2 = \frac{2R}{p + R}$$

We now proceed to the case where $p > R$. Suppose the line $L' \equiv l'\alpha + m'\beta + n'\gamma = o$ be drawn parallel to L and passing through the pole of that line with respect to the circle ABC. Let p' be the distance of L' from the centre of the circle ABC, and let L' cut that circle at the angle ϕ'.

The line L transforms into an ellipse, and the angle (ψ) between its equi-conjugate diameters, expressed in terms of the invariants Θ, Θ', is given by

$$\cos^2\psi = \frac{\Theta'^2 - 4\,\Theta}{\Theta'^2}$$

Taking S to be $2l\beta\gamma + 2m\gamma\alpha + 2n\alpha\beta = o$, we have

$$\Theta' = -\,2\,(l\cos A + m\cos B + n\cos C)$$

$$\Theta = -\,l^2\sin^2 A - m^2\sin^2 B - n^2\sin^2 C + 2\,mn\sin B\sin C + 2\,nl\sin C\sin A + 2\,lm\sin A\sin B,$$

whence
$$\cos^2\psi = \frac{\Omega}{(l\cos A + m\cos B + n\cos C)^2}$$

where

$$\Omega = l^2 + m^2 + n^2 - 2mn\cos A - 2nl\cos B - 2lm\cos C.$$

We also have

$$p^2 = \frac{R^2\,(l\cos A + m\cos B + n\cos C)^2}{\Omega}$$

and $pp' = R^2$,

therefore

$$\cos\psi = \frac{R}{p} = \frac{p'}{R} = \cos\psi'$$

Hence we derive the result that the angle between the equi-conjugate diameters of S is equal to the angle at which L' cuts the circle ABC.

Moreover, since L and L' are parallel, their isogonal transformations, S and S', will intersect in four concyclic points: the chords of the circle joining these four points will be equally inclined to the axes of each of the conics: in other words, the axes of the two conics will be parallel, and therefore the Simson lines of the two points in which L' cuts the circle ABC will be perpendicular to the equi-conjugate diameters of the ellipse S. The directions of the axes of that conic may therefore be determined.

If ϵ and ϵ' are the eccentricities of S and S′ respectively, we have

$$\epsilon^2 = \frac{2R}{p + R}, \quad \epsilon'^2 = \frac{2R}{p' + R}$$

Eliminating p and p' by means of the relation $pp' = R^2$, we have

$$\epsilon^2 + \epsilon'^2 = 2.$$

9. The foci of any conic inscribed in the triangle of reference are isogonal conjugates. If the trilinear co-ordinates of one focus be $(\alpha_0\beta_0\gamma_0)$, then the co-ordinates of the other focus will be $\left(\frac{\kappa^2}{\alpha_0}, \frac{\kappa^2}{\beta_0}, \frac{\kappa^2}{\gamma_0}\right)$ where κ is the semi-minor axis of the conic.

The conic may be regarded as the envelope of a variable line $l\alpha + m\beta + n\gamma = o$, which moves so that the product of the perpendiculars on it from the foci is equal to κ^2. The relation between l, m, n is easily found to be

$$mn\alpha_0\Theta_1 + nl\beta_0\Theta_2 + lm\gamma_0\Theta_3 = o,$$

where

$$\Theta_1 \equiv \beta_0^2 + \gamma_0^2 + 2\beta_0\gamma_0 \cos A$$

$$\Theta_2 \equiv \gamma_0^2 + \alpha_0^2 + 2\gamma_0\alpha_0 \cos B$$

$$\Theta_3 \equiv \alpha_0^2 + \beta_0^2 + 2\alpha_0\beta_0 \cos C,$$

and the equation of the inscribed conic is

$$\sqrt{\alpha\alpha_0\Theta_1} + \sqrt{\beta\beta_0\Theta_2} + \sqrt{\gamma\gamma_0\Theta_3} = o$$

If D be the focus $(\alpha_0\beta_0\gamma_0)$, then Θ_1, Θ_2, Θ_3 are respectively $(DA \sin A)^2$, $(DB \sin B)^2$, $(DC \sin C)^2$.

10. If we take D to be the incentre of the triangle ABC, then $\Theta_1 = 4r^2 \cos^2\frac{A}{2}$, $\Theta_2 = 4r^2 \cos^2\frac{B}{2}$, $\Theta_3 = 4r^2\cos^2\frac{C}{2}$, and we obtain the equation of the incircle, viz.,

$$\cos\frac{A}{2}\sqrt{\alpha} + \cos\frac{B}{2}\sqrt{\beta} + \cos\frac{C}{2}\sqrt{\gamma} = o$$

In a similar manner the equations of the ex-circles may be at once determined.

Let D be the centre of the circle ABC, then

$$\frac{\Theta_1}{\sin^2 A} = \frac{\Theta_2}{\sin^2 B} = \frac{\Theta_3}{\sin^2 C} = R^2,$$

and we find the equation of the inscribed conic having its foc at the circum- and ortho-centres of the triangle of reference to be

$$\sin A \sqrt{\alpha \cos A} + \sin B \sqrt{\beta \cos B} + \sin C \sqrt{\gamma \cos C} = o$$

This conic has the nine-point circle of the triangle as its auxiliary circle, and its eccentricity is

$$\sqrt{1 - 8 \cos A \cos B \cos C}$$

If three conics be inscribed in the triangle of reference (supposed acute), the middle points of the perpendiculars from the vertices on the opposite sides being each a focus of one conic, then the major axes of the conics all pass through the centroid of the triangle.

11. The polar of any point with respect to a rectangular hyperbola self-conjugate with respect to the triangle of reference passes through its isogonal conjugate. Taking the equation of the hyperbola to be $l\alpha^2 + m\beta^2 + n\gamma^2 = o$, where $l + m + n = o$, the polar of any point $P(\alpha'\beta'\gamma')$ is $l\alpha'\alpha + m\beta'\beta + n\gamma'\gamma = o$, which passes through $P'\left(\frac{1}{\alpha'}, \frac{1}{\beta'}, \frac{1}{\gamma'}\right)$. Let the polars of P and P′ intersect in P″, then the co-ordinates of P″ are $\left(\frac{U'}{l}, \frac{V'}{m}, \frac{W'}{n}\right)$, where $U = \alpha(\beta^2 - \gamma^2)$, $V = \beta(\gamma^2 - \alpha^2)$, $W = \gamma(\alpha^2 - \beta^2)$. Hence the point P″ lies on

$$\frac{U'}{\alpha} + \frac{V'}{\beta} + \frac{W'}{\gamma} = o,$$

a conic which passes through P and P′. Since its equation is independent of l, m, n, we derive the following theorem: Given a fixed triangle and a fixed point, the locus of the intersection of the polars of the given point and its isogonal conjugate with regard to rectangular hyperbolas having a given self-conjugate triangle is a conic passing through the vertices of that triangle, the given point, and its isogonal conjugate.

The tangent at any point of the rectangular hyperbola $l\alpha^2+m\beta^2+n\gamma^2 = o$ passes through its isogonal conjugate. If O be the centre of the hyperbola, and if its asymptotes meet the circle ABC again in the points X, Y, then these points are the isogonal conjugates of the points in which the hyperbola is touched by its asymptotes: hence the diameter XY of the circle ABC will isogonally transform into a rectangular hyperbola whose asymptotes are parallel to those of $l\alpha^2 + m\beta^2 + n\gamma^2 = o$.

The equation of XY is easily found to be

$$\frac{l}{a}(c\beta + b\gamma) + \frac{m}{b}(a\gamma + c\alpha) + \frac{n}{c}(b\alpha + a\beta) = o$$

The tangents to the above hyperbola at the in- and ex-centres form the standard quadrilateral

$$l\alpha \pm m\beta \pm n\gamma = o$$

The equation of the line joining the middle points of the diagonals of this quadrilateral is

$$\frac{l^2\alpha}{a} + \frac{m^2\beta}{b} + \frac{n^2\gamma}{c} = o$$

Hence, since $l+m+n = o$, the envelope of this line is the circle ABC, and the line touches its envelope at the centre of the corresponding hyperbola.

The tangents to this hyperbola at its intersections with the conic $\lambda\beta\gamma + \mu\gamma\alpha + \nu\alpha\beta = o$ meet the quartic $l\beta^2\gamma^2 + m\gamma^2\alpha^2 + n\alpha^2\beta^2 = o$ in four points lying on the straight line $\lambda\alpha + \mu\beta + \nu\gamma = o$.

12. Let five points A, B, C, D, E, no three of which are collinear, be taken. If any three—say, A, B, C—be taken as the vertices of the triangle of reference, and the isogonal conjugates D′ E′ of the two remaining points be constructed, then the conic through the five given points may be regarded as the isogonal transformation of D′ E′ with respect to the triangle ABC. If, therefore, D′ E′ touch the circle ABC, then will each of the lines A′ B′, A′ C′ ...... formed in a corresponding manner touch the circles CDE, BDE ...... respectively. If the line D′ E′ cut the circle ABC at an angle ϕ, then the lines A′ B′, A′ C′ ...... will cut the corresponding circle CDE, BDE ...... at the same angle ϕ, and the Simson lines of the points of intersection of each line with its associated circle will form two sets of parallel lines.

13. In connection with the theory of isogonal transformation are certain curves which remain unaltered when the coordinates of any point (α, β, γ) are changed into $\left(\frac{1}{\alpha}, \frac{1}{\beta}, \frac{1}{\gamma}\right)$ Among such curves we have the conics of the forms

$$\alpha^2 \pm \beta\gamma = o$$
$$\alpha^2 + \beta\gamma \pm \kappa\alpha(\beta + \gamma) = o$$

Other curves are homogeneous functions of U, V, W, such as

$$\frac{U}{\alpha_0} + \frac{V}{\beta_0} + \frac{W}{\gamma_0} = o \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \text{(i)}$$

$$\frac{U}{l}\left(\frac{b}{m} - \frac{c}{n}\right) + \frac{V}{m}\left(\frac{c}{n} - \frac{a}{l}\right) + \frac{W}{n}\left(\frac{a}{l} - \frac{b}{m}\right) \quad \ldots \quad \text{(ii)}$$

$$\sqrt{\alpha_0 U} + \sqrt{\beta_0 V} + \sqrt{\gamma_0 W} = o \quad \ldots \quad \ldots \quad \text{(iii)}$$

If P be any point $(\alpha\beta\gamma)$, and P′ its isogonal conjugate, then (i) expresses that PP′ passes through the fixed point $(\alpha_0\beta_0\gamma_0)$, (ii) expresses that PP′ is parallel to the line $l\alpha+m\beta+n\gamma=o$, and (iii) expresses that PP′ touches the conic $\frac{\alpha_0}{\alpha}+\frac{\beta_0}{\beta}+\frac{\gamma_0}{\gamma}=o$.

Such curves as the above possess the property that the tangent at any point transforms isogonally into a conic touching the curve at the isogonal conjugate of the point of contact of the tangent.

ART. XXXII.—*Right-sidedness.*

By JOSHUA RUTLAND.

Communicated by T. W. Kirk.

[*Read before the Wellington Philosophical Society, 7th August, 1907.*]

Plate XXIV.

SOON after the red deer became sufficiently numerous in the Pelorus bush to justify the Marlborough Acclimatisation Society issuing shooting licenses I commenced collecting heads of all ages, regardless of their appearance, my object being to study the growth of the horns.

Many of the heads that came into my possession appeared deformed, owing to the right and the left horns differing much in size and outline. This want of symmetry I soon perceived was common to animals of every age, from fawns with simple horns to old stags with many-branched antlers.

Looking over a collection of these unsymmetrical heads to ascertain whether there were any marks of violence which might account for the deformity, I noticed that in all the right horn was larger and better shaped.

After this discovery I carefully examined every deer's head —shapely or unshapely—that came within my reach, and found that wherever there was a perceptible difference in the size of the two horns the right horn, without exception, was larger than the left.

The accompanying photograph (Plate XXIV) by Mr. Paul Clifford shows two fawns' heads and the head of an old stag, in all of which the greater size of the right horn is very conspicuous. The fourth head, at the top of the picture, appears quite symmetrical from a short way off, but a closer examination shows the right horn is stouter than the left. Several heads of this description have come under my notice, showing that the difference in the size of the horn does not always amount to a deformity.

In a note to an article published in the *Zoologist* for March, 1904, Mr. A. Heneage Cocks records the following: "I have never seen the fact noticed that the right eye of young mammals opens before the left. I do not remember an exception among wild animals, nor even among domestic animals, though it is very likely some occur in the latter class. From the time the lids of the right eye begin to part to the time the left eye is fully opened takes generally from thirty-six to forty hours." Commenting on this the editor of *Knowledge* remarks, "The fact is as new to us as it is to Mr. Cocks, and requires an explanation. The suggestion naturally occurs that the phenomenon is connected with 'right-handedness' in the human species."

It would be interesting to discover whether stags, when fighting, use the right and left horns indiscriminately, or whether they endeavour to strike with one horn more than the other.

Art. XXXIII.—*A New* Placostylus *from New Zealand.*

By Henry Suter.

[*Read before the Wellington Philosophical Society, 2nd October,* 1907.]

Plate XXV.

Many years back, when reading Dr. A. Lesson and Martinet's "Les Polynésiens," I came across, in vol. iv. (1884), p. 227, the following passage, of which I made a note: "Le *Bulimus hongi*, Pupuharakeke, se trouve surtout près du cap Nord; il y abonde parmi les *Phormiums*. Cette belle coquille est de couleur chocolat foncé, avec l'intérieur blanc ou orange brillant; elle a près de 4 pouces de long. On dit que le *Bulimus vibratus* abonde sur les Trois Rois."

When Captain J. Bollons told me last autumn that he had to visit and stay for several days at the Great King Island, I asked him to be good enough to have a search made for specimens of *Placostylus*, if time would permit it. How great was my joy when in the middle of April, 1907, he brought me a number of living and some empty specimens of a large and distinct *Placostylus* he had been successful in finding under dead leaves on the Great King Island. I was prepared for a form similar to that found at Cape Maria van Diemen, but certainly not for such a distinct new species. My very best thanks are due to Captain J. Bollons for his courtesy and the trouble he has taken to procure the specimens.

The following is a description of the very remarkable new species :—

Placostylus bollonsi, n. sp. Plate XXV, figs. *a*, *b*, *c*.

Shell large, oblong-conic, with a very obtuse apex, rimate, fairly solid, axially closely striate, brown, peristome simple. Sculpture : The first 3 whorls are finely and regularly axially costate and mostly not punctate ; the 3rd and sometimes the 4th and part of the 5th whorl distinctly broadly plicate at the suture above ; the following whorls are densely wrinkle-striate, the striæ of unequal strength, slightly oblique and crossed by distant spiral striæ, which are mostly obsolete upon the base. Some examples show a secondary axial sculpture on the 4th and 5th whorl, consisting of strongly oblique costæ, which are directed forwards, and reticulate the primary axial sculpture, forming a more or less distinct network. On the last 2 whorls a distinct narrow groove is margining the suture below. Colour yellowish-brown, with numerous narrow blackish-brown streaks on the lower whorls, the apical whorls usually denuded and flesh-coloured ; peristome white, aperture purplish-red within ; a whitish narrow subsutural border is sometimes present, but it is much less conspicuous than in *P. hongii* and very often wanting. Epidermis brown, thin, slightly shining. Spire elevated-conic, with a very blunt apex, $1\frac{1}{4}$ to $1\frac{1}{2}$ times the height of the aperture ; outlines very slightly convex. Protoconch of 3 convex whorls, the nucleus with a raised inner carina. Whorls $6\frac{1}{2}$, the first few but little descending, lightly convex ; base flatly rounded. Suture not deep, somewhat uneven, margined below on the lower whorls. Aperture vertical, pyriform, angled above, broadly rounded and somewhat angled towards the pillar below. Peristome continuous ; outer lip not expanded and not much thickened, rounded and smooth, rarely with very slight indications of denticles within. Basal lip slightly expanded, smooth or with a few indistinct notches. Columella oblique, lightly concave, indistinctly folded above ; inner lip not broad, with a well-marked rim forming the continuation of the basal lip ; very rarely a few small tubercles may be found on the lower part of the parietal wall, but usually it is quite smooth. The umbilical fissure is always small.

Diameter, 40 mm. ; height, 91 mm. Type.

Diameter, 43 mm. ; height, 99 mm. One of the largest specimens.

Animal black, irregularly and coarsely granular, the granules arranged in longitudinal rows on the back, sloping on the sides, a band of squarish and large granules along the pedal margin.

Anterior tentacles short, ommatophores distant, long, granular, with very broad bases. Foot broad, narrowly rounded behind. Mantle margin even, with a fold on the under surface in front of the respiratory orifice. Genital orifice behind the right ommatophore.

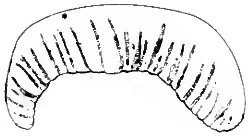


Fig. 1.

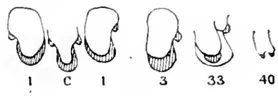


Fig. 2.

Jaw (fig. 1) arcuate, attenuated at the ends, irregularly striated by infoldings of the membrane.

Radula (fig. 2) tongue-shaped, of about 130 transverse rows of teeth, which are nearly straight, forming a very obtuse angle, salient posteriorly. Formula of radula: 20 . 30 . 1 . 30 . 20. The central tooth elongated, with a long and broad mesodont and a low and broadly rounded mesocone; usually there are two minute side-cusps present. Lateral teeth, numbering about 30, with a very broad rounded mesodont, the mesocone short and broad; there is no endodont, but the ectodont is distinct, narrowly rounded, bearing a minute cutting-point. The marginals are narrower and with two cutting-points; towards the margins they are getting very narrow and indistinct, and it is impossible to exactly ascertain their number.

Reproductive Organs (fig. 3).—The male organ is very large, with the retractor muscle at its apex and the walls very thick. The vas deferens enters near the apex, and it is free only for a very short distance at the base. The albumen-gland is large. The most remarkable feature is the absence of a receptaculum seminis, which is present in *P. hongii*.

Fig. 3.

Remarks.—The teeth of the radula differ somewhat from those of *P. hongii*: in the latter the central tooth has no side cusps, the transition teeth between laterals and marginals are getting tricuspidate, and most of the marginals show the same character. There is no difference in the reproductive organs of the two species except the absence of the spermatheca in *P. bollonsi*, and I found it to be absent in four specimens which I dissected.

The anatomy of *P. hongii* has been ably described and figured by Mr. R. Murdoch in Proc. Mal. Soc., vol. iii, p. 324, pl. 16, fig. 8.

P. bollonsi is distinguished from all the other species of the genus known to me by the obtuse, broadly rounded apex. Interesting features are the costate, very rarely punctate protoconch, and the loss of the spermatheca. As I pointed out in my paper on *P. hongii ambagiosus* (Journ. de Conch., vol. liv, p. 255), it is very likely that during the Pliocene a form closely allied to *P. bivaricosus solidus*, Eth., spread from Lord Howe Island southward, and that from it was derived *P. hongii ambagiosus*, and from this again the more simple form of *P. hongii*. We may not be very far from the truth if we assume that *P. hongii* and *P. bollonsi* are the offsprings of a common ancestor, and we may look upon the Great King species as a splendid example of the originating of a new species by isolation.

It gives me very great pleasure to unite the name of the discoverer of this interesting and fine shell with the species.

Since writing the above Captain J. Bollons has revisited the Great King Island, and to his unremitting kindness I am indebted for an egg and embryonic shell of *P. bollonsi*. As was to be expected, the egg is very large, elongately regularly oval, rounded at both ends, calcareous, thin, white, finely granular, with a few larger granules irregularly interspersed; its length is 18 mm.; diameter, 13 mm. Compared with the egg of *P. hongii*, which measures 7 mm. by $5\frac{1}{2}$ mm., it is a real giant. The egg of *Paryphanta busbyi* is 13 mm. by 11 mm. The embryonic shell, of $3\frac{1}{4}$ whorls, is axially finely ribbed, and on the upper half of the last whorl the riblets are decussated by fine spiral liræ. There is a distinct, narrow, and open umbilicus. Height, 17 mm.; diameter, 12 mm.; height of aperture, 13 mm.

EXPLANATION OF PLATE XXV.

Figs. *a*, *b*. *Placostylus bollonsi*. Suter. Type specimen.
Fig. *c*. ,, ,, Specimen showing the reticulated sculpture.

Art. XXXIV.—*Result of Dredging for* Mollusca *near Cuvier Island, with Descriptions of New Species.*

By Henry Suter.

[*Read before the Wellington Philosophical Society, 2nd October, 1907.*]

Plates XXVI, XXVII, and XXX.

The species enumerated in this list were dredged by Captain J. Bollons, of the Government steamer "Hinemoa," in 38 fathoms, five miles south of Cuvier Island. My sincere thanks are due to Captain Bollons for kindly handing me over the interesting material for study.

1. **Acanthochites rubiginosus** (Hutton).

Tonicia rubiginosa, Hutt., Trans. N.Z. Inst., vol. iv, 1871 (1872), p. 180.

A few valves.

2. **Emarginula striatula**, Quoy and Gaimard.

Voy. "Astrolabe," Zool., vol. iii, 1834, p. 332, pl. lxviii, figs. 21–22.

Two specimens.

3. **Minolia plicatula**, Murdoch and Suter.

Trans. N.Z. Inst., vol. xxxviii, 1905 (1906), p. 299, pl. xxvi, figs. 47–49.

Several specimens.

4. **Cyclostrema sub-tatei**, Suter.

Trans. N.Z. Inst., vol. xxxix, 1906 (1907), p. 258, pl. ix, figs. 6–8.

One specimen.

5. **Ethalia zelandica** (Hombron and Jacquinot).

Rotella zelandica, H. and J., Voy. Pole Sud., Zool., vol. v, 1854, p. 53, pl. xiv, figs. 5–6.

A broken shell.

6. **Cocculina tasmanica** (Pilsbry).

Acmæa parva tasmanica, Pils., Nautilus, vol. ix, 1895, p. 128.

One specimen.

7. **Cocculina compressa**, Suter.

Proc. Mal. Soc., vol. viii, 1908.

One specimen, smaller and laterally less compressed than the type, which is from Flat Point.

8. **Rissoina (Zebina) parvilirata**, Suter.

Trans. N.Z. Inst., vol. xxxix, 1906 (1907), p. 257, pl. ix, fig. 5.

Two specimens.

9. **Rissoina (Eatoniella) cuvieriana**, n. sp. Plate XXVII, fig. 3.

Shell small, ovate, imperforate, thin and fragile, pellucid, somewhat shining. Sculpture consisting of very fine oblique growth-lines, crossed by microscopic fine and close spiral striæ, very faint on the spire-whorls. Colour yellowish-brown, with a darker band below the suture and upon the umbilical tract. Spire conical, slightly higher than the aperture; outlines almost straight. Protoconch small; whorls convex and smooth. Whorls 6, convex, the last of considerable size; base rounded. Suture not much impressed. Aperture oblique, oval, angled above, distinctly effuse below. Peristome discontinuous, simple, sharp. Columella vertical, somewhat concave, white; inner lip not reflexed, with a sharp edge, spreading as a thin white callosity over the parietal wall. Operculum unknown.

Diameter, 3·5 mm.; height, 5·8 mm.

Type in my collection. One specimen.

Remarks.—In coloration this species resembles the much smaller *R. fuscozona*, Sut.

10. **Seila terebelloides** (Von Martens).

Cerithium (*Bittium*) *terebelloides*, v. Mart., Crit. List, 1873, p. 26.

One specimen, with perfect apex.

11. **Seila bulbosa**, Suter.

Proc. Mal. Soc., vol. viii, 1908.

One specimen; the apex lost.

12. **Triphora infelix**, Webster.

Trans. N.Z. Inst., vol. xxxviii, 1905 (1906), p. 307, pl. xxviii, fig. 6.

Several specimens.

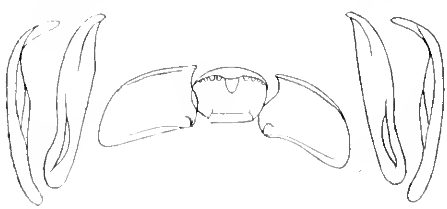
13. **Xenophora neozelanica**, n. sp. Plate XXVI, figs. 1 and 2.

Phorus onustus, Reeve, Hutton, Cat. Mar. Moll., p. 31 (not of Reeve). *P. conchyliophorus*, Born, Hutton, Journ. de Conch., 1878, p. 30. *Xenophora conchyliophora*, Born, Hutton, Proc. Linn. Soc. N.S.W., vol. ix, p. 943 (not of Born). *X. pallidula*, Reeve, Index, p. 79 (not of Reeve).

Shell large, trochiform, imperforate, upper surface almost concealed by agglutinated shells. Sculpture: Strong, oblique, irregular growth-lines are crossed by oblique, flexuous, and sometimes strongly curved striæ, usually more prominent near the periphery, which is in places produced into long, hollow, and deeply grooved spines, situated between the attached shells: base with numerous inequidistant and sharp-ridged revolving ribs, the interstices with fine threads of growth or almost smooth. Colour white or light-yellowish; the ridges upon the base yellowish to reddish-brown. Spire conical; outlines mostly slightly convex. Protoconch small, conic, of a few convex smooth whorls, polished and white, with marks of agglutination of very small foreign bodies. Whorls about 9 to 10, first slowly then more rapidly increasing; the last whorl carinated; base flat, concave towards the periphery. Aperture low and broad, inside porcellaneous, highly polished. Outer lips very much produced along the periphery, the upper and outer wall forming a roof, the inside of which is porcellaneous. Columella short, subvertical, arcuate, continued below into the horizontal, arcuate, sharp, and deflexed basal lip; inner lip expanded over the umbilical tract, forming a thick white and shining callus, and extending in a thin layer over the parietal wall. Operculum subquadrangular, with a long and narrow muscular impression.

Diameter, 68 mm.; height, 35 mm. Type.

Diameter, 70 mm.; height, 58 mm. Another specimen; dead shell.



The fig. shown above represents a row of teeth of the radula.

Type in my collection.

Hab.—Ten miles west of Cuvier Island, in 32 fathoms.

Remarks.—A specimen obtained by trawling near Tiritiri was identified by the late Captain Hutton as *X. pallidula*, Reeve. This Japanese species, of which I used a good specimen for comparison, is no doubt nearly allied to our form, but the sculpture and colouring of the base is quite different. The late Dr. E. von Martens declared the New Zealand shell to be *X. conchyliophora*, Born; but this West Indian shell has the base brown, with light spiral striæ. The shells attached to our species are mostly valves of *Chione mesodesma* and *stutchburyi*.

14. **Calyptræa scutum,** Lesson.

Voy. "Coquille," Zool., vol. ii, 1830, p. 395.

Several specimens.

15. **Natica zelandica,** Quoy and Gaimard.

Voy. "Astrolabe," Zool., vol. ii, 1832, p. 237, pl. lxvi, figs. 11–12.

A number of very small young shells.

16. **Cyclostoma philippinarum** (Sowerby).

Scalaria philippinarum, Sow., Proc. Zool. Soc., 1844, p. 12.

One young shell; perfect apex.

17. **Crossea cancellata,** Tenison-Woods.

Proc. Roy. Soc. Tasm., 1877 (1878), p. 31, and 1882 (1883), p. 169.

One adult specimen.

18. **Pyramidella (Syrnola) pulchra** (Brazier).

Syrnola pulchra, Braz., Proc. Linn. Soc. N.S.W., vol. i, 1877, p. 285; Hedley, Rec. Austr. Mus., vol. iv, p. 25, pl. xvi, fig. 20.

One specimen; apex lost. This is an addition to our fauna.

19. **Pyramidella (Syrnola) lurida,** n. sp. Plate XXVII, fig. 4.

Shell small, subulate, imperforate, smooth and polished. Sculpture consisting of very fine and close microscopic spiral striæ; the fine and nearly straight growth-lines distinct. Colour white. Spire high, subulate, much higher than the aperture; outlines but faintly convex. Protoconch heterostrophe, globular, of 1 smooth and polished whorl. Whorls 7, regularly increasing, faintly convex; base rounded. Suture well impressed, margined below by a distinct narrow smooth band. Aperture subvertical, elongate-ovate, angled above and narrowly rounded below. Outer lip thin and sharp. Columella subvertical, arcuate, with a distinct plait above, which is continued as a narrow ridge over the pillar down to the base, and uniting with the basal lip; there is no callosity upon the parietal wall. Operculum unknown.

Diameter, 1·6 mm.; height, 6 mm.

Type in my collection.

Several specimens were obtained.

20. **Odostomia (Evalea) chordata,** n. sp. Plate XXVII, fig. 5.

Shell small, elongate-ovate, subperforate, slightly scalar, rather thin, polished. Sculpture consisting of very fine and close microscopic spiral striæ, and in addition a few subequidistant flat spiral cords, distinct only on the body-whorl: their number is about 9; those on the middle of the whorl are less conspicuous; the growth-lines are vertical, close, and fine, but some are more prominent. Colour white. Spire elevated-conic, about $1\frac{1}{2}$ times the height of the aperture; outlines straight. Protoconch small, heterostrophe, of 1 upright whorl, smooth and shining. Whorls 6, regularly increasing, flatly convex, somewhat contracted below at the suture, and slightly projecting above out from the suture; base flat. Suture deep, narrowly margined below. Aperture oblique, pyriform, slightly and broadly effuse below. Outer lip thin and sharp. Columella vertical, strongly arcuate, with a moderate plait above, situate rather deep within the aperture; inner lip very narrow, spreading as a very thin callous layer over the parietal wall. Umbilical fissure narrow.

Diameter, 1·9 mm.; height, 3·8 mm.

Type in my collection.

One specimen only.

21. **Odostomia (s. str.) incidata,** n. sp. Plate XXVII, fig. 6.

Shell small, subulate, narrowly subperforate, with a fine groove on the periphery of the body-whorl, fairly solid, polished. Sculpture consisting of excessively fine dense microscopic spiral lines; on the third whorl a very fine groove appears above and close to the suture, a little more distant and better marked on the next volution, and continued on the periphery of the last whorl: growth-lines vertical, fine, but distinct. Colour white. Spire elevated-conical, about $2\frac{1}{2}$ times the height of the aperture; outlines almost straight. Protoconch small, heterostrophe, tilted at a right angle to the axis, of 1 convex whorl, smooth and shining. Whorls 6, regularly increasing, slightly shouldered and convex; base rounded. Suture channelled, lightly margined below. Aperture oblique, oval, angled above, effuse below. Outer lip moderately convex, thin, and sharp. Columella short, strongly arcuate, with a very strong plait above; inner lip very narrow. Umbilical chink a mere fissure.

Diameter, 1·8 mm.; height, 4·5 mm.

Type in my collection.

One perfect specimen.

22. **Eulima oxyacme**, n. sp. Plate XXVII, fig. 7.

Shell small, subulate, sharply pointed, pellucid, polished, straight, thin and fragile. Sculpture formed by very fine straight growth-lines only. Colour white. Spire elevated-conic, with a sharp apex, not quite twice the height of the aperture; outlines perfectly straight. Protoconch minute, globose. Whorls 8, regularly increasing, flat, the last high; base flattish. Suture linear, superficial, false-margined below. Aperture subvertical, lanceolar, high and narrow, narrowly angled above, acuminate below. Outer lip slightly convex, very thin and sharp; basal lip very narrowly rounded, and a little produced. Columella vertical, straight, narrowed to a point below. Parietal wall concave below, convex above.

Diameter, 1·8 mm.; height, 5·1 mm.

Type in my collection.

One specimen.

23. **Vulpecula biconica**, Murdoch and Suter.

Vulpecula (*Pusia*) *biconica*, M. and S., Trans. N.Z. Inst., vol. xxxviii, 1905 (1906), p. 289, pl. xxxiii, fig. 22.

A number of specimens. The sculpture is very variable in its development, from faint to very bold.

24. **Vulpecula marginata** (Hutton). Plate XXVII, fig. 8.

Turricula marginata, Hutton, Trans. N.Z. Inst., vol. xvii, 1884 (1885), p. 315, pl. xviii, fig. 4; Pliocene Moll., p. 47.

Shell small, fusiform, rather thin, axially costate and spirally lirate. Sculpture consisting of fine spiral liræ, usually 2; 2 below the suture broader and much more prominent; about 7 on the penultimate whorl; they are again more conspicuous on the base; straight angularly rounded axial riblets extend over all the whorls, the protoconch excepted, 14 to 15 on a whorl, and they vanish only on approaching the base, the interstices of about the same width as the riblets; only the two stronger spirals below the suture pass over the axials. Colour white. Spire elevated-conic, about the same height as the aperture; outlines slightly convex. Protoconch small, papillate, of 1½ smooth and convex whorls, the nucleus excentric. Whorls 5 to 6, the last high, moderately convex, the base distinctly contracted. Suture impressed, margined below. Aperture narrow, rather broadly angled above, with a short widely open and slightly recurved canal below, its base slightly notched. Outer lip thin and sharp, lightly convex, contracted below. Columella subvertical, with 4 equally spaced and slightly oblique plaits, which decrease in size towards the base; the uppermost plait continued as a strong riblet over the neck; inner lip thin and narrow, spreading over the concave parietal wall.

Diameter, 2·5 mm.; height, 7·5 mm. Pliocene type of 6½ whorls.

Diameter, 2·5 mm.; height, 6·2 mm. Recent example of 5 whorls.

Type in the Canterbury Museum, Christchurch.

A number of specimens were obtained.

V. marginata, n. subsp. angulata.

Distinguished from the species by the following characters: The shell is slightly more ventricose, all the whorls below the protoconch distinctly shouldered, the axial costæ somewhat nodulous upon the carina; the spiral liræ are much more numerous, and consequently finer; the suture is undulating, more or less distinctly margined below, but the two more prominent cinguli are wanting; the outer lip is angled above.

Diameter, 2·5 mm.; height, 5·5 mm. Specimen of 5 whorls.

Type in my collection.

A few specimens; apparently more rare than the preceding species.

25. Siphonalia nodosa (Martyn).

Buccinum nodosum, Mart., Univ. Conch., vol. i, 1784, fig. 5.

A few quite young specimens, with perfect apex.

26. Nassa suturalis dunkeri, n. n.

Nassa intermedia, Dunker, Verh. Zool. Bot. Ges. Wien, vol. xvi, 1866, p. 909 (not of Forbes).

Dunker's species being generally accepted as a subspecies of *Nassa suturalis*, Lamarck, but his name being preoccupied in the genus, I propose the above name.

One specimen was obtained.

27. Trophon ambiguus (Philippi).

Fusus ambiguus, Phil., Abbild. und Beschr. neuer Conch., Fusus, 1844, pl. i, fig. 2.

Two young specimens of 6 whorls and perfect apices.

28. Trophon pusillus, Suter.

Trans. N.Z. Inst., vol. xxxix, 1906 (1907), p. 253, pl. ix, fig. 2.

Five specimens of 6 whorls each ; larger than the type, which has 5 whorls.

29. Mitrella choava (Reeve).

Columbella choava, Reeve, Conch. Icon., 1858, fig. 239.

A few specimens, white, smaller than littoral shells.

30. Ancilla mucronata (Sowerby).

Ancillaria mucronata, Sow., Thesaur., vol. iii, 1859, p. 63, pl. ccxi, figs. 11–12.

One broken shell.

31. Ancilla bicolor (Gray).

Ancillaria bicolor, Gray, Jukes' Voy. " Fly," vol. ii, 1847, p. 357, pl. i, fig. 4.

A number of small shells.

32. Marginella allporti, Tenison-Woods.

Proc. Roy. Soc. Tasm., 1875 (1876), p. 28.

A number of specimens, but only a few with colour-markings.

33. Marginella albescens, Hutton.

Cat. Mar. Moll., 1873, p. 19.

Two specimens, a little higher than the type.

34. Bathytoma nodilirata (Murdoch and Suter).

Pleurotoma tuberculata, T. W. Kirk, Trans. N.Z. Inst., vol. xiv., 1881 (1882), p. 409 (not of Gray). *P. nodilirata*, M. and S., Trans. N.Z. Inst., vol. xxxviii, 1905 (1906), p. 284, pl. 22, xxii, figs. 10–11.

One specimen.

35. Drillia lævis (Hutton).

Pleurotoma lævis, Hutt., Cat. Mar. Moll., 1873, p. 12.

One imperfect specimen.

36. Daphnella chariessa, n. sp. Plate XXVII, fig. 9.

Shell very small, fusiform, thin and fragile, spirally lirate, white. Sculpture consisting of narrow sharply elevated spiral liræ below the protoconch, 4 on the third and fourth, 5 on the penultimate whorl, and about 14 on the body-whorl; the interstices slightly broader than the liræ, and ornamented with fine, dense, straight growth-lines. Colour white. Spire elevated-conic, a little higher than the aperture: outlines almost straight. Protoconch papillate, of 2 smooth lightly convex whorls, the second high. Whorls 5, regularly increasing, moderately convex, indistinctly flattened below the suture; base slightly contracted. Suture impressed, but not deep. Aperture a little oblique, high and narrow, sides subparallel, rounded above, with a short widely open and truncated canal below. Outer lip thin and sharp, slightly angled above, straight in the middle, and oblique below, denticulated on the outside by the spiral riblets; sinus just below the suture, broadly rounded, not deep. Columella subvertical, smooth, almost straight, turned to the left towards the canal below; inner lip thin and very narrow, spreading over the slightly excavated parietal wall.

Diameter, 1·7 mm.; height, 4·5 mm.

Type in my collection.

Two specimens, one adult.

Remarks.—This species is allied to *D. conquisita*, Suter, which, however, is broadly shouldered, has less and further-apart spiral ribs, and the growth-lines much more raised and more distant.

37. Daphnella psila, n. sp. Plate XXVII, fig. 10.

Shell very small, fusiform, thin, almost smooth, but the base distinctly spirally striate, white. Sculpture: Excessively fine microscopic striæ are present on all whorls, those of the protoconch excepted, crossed by fine dense straight growth-lines; the body-whorl with broad flat equidistant spiral ribs, numbering about 20, with narrow linear interstices; they are distinct at the base, but more or less effaced on the upper part of the whorl. Colour light-yellowish-white. Spire elevated-conic, with a blunt apex, a little higher than the aperture; outlines straight. Protoconch of 1½ smooth and polished whorls, the nucleus broadly rounded. Whorls 5, regularly increasing, very flatly convex; base lightly contracted. Suture moderately impressed. Aperture slightly oblique, high and narrow, sides subparallel, angled above, with a short broad and truncated canal below. Outer lip thin and sharp, gently curved above, broadly rounded below. Columella vertical, smooth, straight, but bent to the left below; inner lip very narrow, extending over the lightly excavated parietal wall.

Diameter, 2·6 mm.; height, 6 mm.

Type in my collection.

One specimen.

38. **Actæon craticulatus**, Murdoch and Suter.

Trans. N.Z. Inst., vol. xxxviii, 1905 (1906), p. 281, pl. xxi, fig. 6.

One specimen.

39. **Solidula alba**, Hutton.

Buccinulus albus, Hutt., Cat. Mar. Moll., 1873, p. 51. *Solidula alba*, Hutt., Index, p. 69.

Two young examples.

40. **Mnesthia thetidis** (Hedley).

Cylichna thetidis, Hedley, Mem. Austr. Mus., vol. iv, 1903, p. 395, fig. 111.

A number of specimens.

41. **Cadulus spretus**, Tate and May.

Trans. Roy. Soc. S. Austr., vol. xxiv, 1900, p. 102; Proc. Linn. Soc. N.S.W., 1901, p. 420, pl. xxv; fig. 52.

One specimen.

42. **Nucula nitidula**, A. Adams.

Proc. Zool. Soc., 1856, p. 51.

One live specimen and a number of valves. When the outer layer of the shell is broken off, beautiful radiate fine striation appears.

43. **Nucula hartvigiana**, Pfeiffer.

N. sulcata, A. Adams, Proc. Zool. Soc., 1856, p. 53 (not of Brown). *N. hartvigiana*, Pfr., Malak. Blätt., 1864, p. 57. *N. lacunosa*, Hutton, Proc. Linn. Soc. N.S.W., vol. ix, 1884, p. 528.

A few valves.

44. **Leda bellula**, A. Adams.

Proc. Zool. Soc., 1856, p. 49; Hedley, Trans. N.Z. Inst., vol. xxxviii, p. 70. *L. concinna*, A. Ad., Index, p. 95 (not of Adams).

45. **Arca (Bathyarca) cybæa** (Hedley).

Bathyarca cybæa, Hedley, Trans. N.Z. Inst., vol. xxxviii, 1905 (1906), p. 71, pl. i, figs. 3–4.

Two valves.

46. **Glycymeris laticostata** (Quoy and Gaimard).

Pectunculus laticostatus, Q. and G., Voy. "Astrolabe," Zool., vol. iii, 1835, p. 466, pl. lxxvii, figs. 4–6.

A few small valves.

47. **Glycymeris velutina**, n. sp. Plate XXX, figs. 1 and 2.

Pectunculus striatularis, Lamarck, Hutton, Cat. Mar. Moll., p. 80; Index, p. 94 (not of Lamarck).

Shell small, rounded-triangular, solid, moderately convex, finely radially ribbed, with zigzag or radial brown streaks, equivalve and subequilateral. Beaks central, slightly curved forwards, close together, small, and low. Anterior end with the dorsal margin descending, nearly straight, slightly angled on meeting the basal margin; posterior end with the dorsal margin sloping, but more convex, rounded on meeting the basal margin, which is regularly convex. Lunular area slightly flattened. Sculpture consisting of numerous close and fine radial riblets, about 9 per mill., on the centre of the valves, crossed by very fine dense concentric striæ. Epidermis brown, horny, persistent near the margins, velvety, beset with numerous fine short bristles. Colour whitish or yellowish-brown, with reddish-brown zigzag or radial streaks, which, however, are usually very faint in specimens from deep water. Interior white, porcellaneous, faintly radially striate, sometimes stained with dark-brown on the anterior lower end; basal margin very prominently crenate. Hinge-plate broad and rather high, its upper margin horizontally straight, the lower margin regularly concave; teeth numerous, uninterrupted in the middle, more or less hooked, decreasing in size distally, finely pectinated. Ligament external, thick, amphidetic. Anterior adductor-scar slightly smaller than the posterior. Pallial-line simple, well marked.

Length, 24 mm.; height, 22 mm.; diameter, 12·5 mm. Type.

Length, 22 mm.; height, 23 mm.; diameter, 14 mm. More triangular example.

Type from Nelson, in my collection.

A number of valves.

Remarks.—*G. striatularis*, Lam., occurring in Tasmania and Australia, is a much larger shell, more broadly ovate and with much broader radial ribs. Our species is very nearly related to *G. holoserica*, Reeve, of the same habitat, which, however, is more elongate, has for some distance straight horizontal dorsal margins, and the hinge-plate is usually lower; the sculpture is the same in the two.

48. **Philobrya meleagrina** (Bernard).

Hochstetteria meleagrina, Bern., Bull. d. Nat. du Mus., 1896. *Philobrya meleagrina*, Bern., Journ. de Conch., vol. xlv, 1897, p. 12, pl. i, fig. 3.

One valve.

49. **Dacrydium radians**, n. sp. Plate XXVII, fig. 11.

Shell small, equivalve, inequilateral, inflated, oblong and very high, semitransparent, thin and fragile, radially finely ribbed. Beaks very small, rounded, directed forwards; prodissoconch small, broadly ovate, concentrically very finely striated. Anterior end vertical, straight, dorsally sharply rounded, posterior end moderately convex, its dorsal part sloping and straightened, basal margin acutely convex. Lunular area broadly flattened. Sculpture consisting of numerous fine flatly rounded radial riblets of equal strength and equidistant, the interstices of the same width as the riblets; these are crossed by fairly regularly spaced distant concentric sharp ridges. Colour white. Interior slightly nacreous, showing the radial sculpture; margin minutely crenulate. Posterior hinge-plate narrow, straight, sloping, with numerous small teeth, slightly increasing in size as they recede from the resilifer, the anterior hinge-plate beginning suddenly with a small tubercle behind the beak, narrower than the posterior plate, curved, with numerous small teeth. Ligament internal. Anterior adductor-scar beneath the dorsal margin, oval and high; posterior scar at the end of the hinge-plate.

Length, 3·5 mm.; height, 5·5 mm.; diameter, 1·6 mm. The largest valve.

Type in my collection.

A number of valves.

50. **Pecten medius**, Lamarck.

Anim. s. Vert., vol. vi, 1819, p. 163.

A few small valves.

51. **Myochlamys convexus**, Quoy and Gaimard.

Pecten convexus, Q. and G., Voy. "Astrolabe," Zool., vol. iii, 1835, p. 443, pl. lxxvi, figs. 1–3.

A number of valves.

52. **Myochlamys radiatus**, Hutton.

Pecten radiatus, Hutt., Cat. Mar. Moll., 1873, p. 82.

Many small valves.

53. **Cuna delta** (Tate and May).

Carditella delta, T. and M., Trans. Roy. Soc. S. Austr., vol. xxiv, 1900, p. 102.

A perfect specimen and a few valves.

54. **Cardita calyculata** (Linnæus).

Chama calyculata, L., Syst. Nat., 10th ed., 1758, p. 692.

A small valve.

55. **Venericardia corbis** (Philippi).

Cardita corbis, Phil., Enum. Moll. Siciliæ, vol. i, 1836, p. 55.

A number of valves.

56. **Venericardia difficilis** (Deshayes).

Cardita difficilis, Desh., Proc. Zool. Soc., 1852 (1854), p. 103, pl. xvii, figs. 16–17.

Valves of different size.

57. **Venericardia zelandica** (Deshayes).

Cardita zelandica, Desh., Proc. Zool. Soc., 1852 (1854), p. 103; pl. xvii, figs. 16–17. *C. lutea*, Hutton, Man. N.Z. Moll., 1880, p. 159. *C. compressa*, Reeve, Hutton, Proc. Linn. Soc. N.S.W., vol. ix, p. 527 (not of Reeve).

A few perfect specimens and valves.

58. **Loripes concinna**, Hutton.

Trans. N.Z. Inst., vol. xvii, 1884 (1885), p. 323; Plioc. Moll., p. 83, pl. ix, fig. 90.

One perfect example and some valves.

59. **Divaricella cumingii** (Adams and Angas).

Lucina (*Cyclas*) *cumingii*, Ad. and Ang., Proc. Zool. Soc., 1863, p. 426, pl. xxxvii, fig. 20.

A few very small valves.

60. **Diplodonta zelandica** (Gray).

Lucina zelandica, Gray, in Yate's N. Zeal., 1835, p. 309.

One valve.

61. **Neolepton antipodum** (Filhol).

Kellia antipodum, Filh., Compt. Rend., vol. xci, 1880, p. 1095. *Neolepton antipodum*, Filh., Hedley, Trans. N.Z. Inst., vol. xxxviii, 1905 (1906), p. 74, pl. i, fig. 5.

A few perfect specimens and many valves.

62. **Rochefortia reniformis**, n. sp. Plate XXVII, fig. 12.

Shell small, elongately oval, fairly solid, equivalve, inequilateral, compressed, minutely reticulated. Beaks small, sharply pointed, adjacent, directed backwards; prodissoconch minute, oval, smooth and shining. Anterior end longer, its dorsal margin slowly descending and faintly convex, anterior margin regularly convex; posterior dorsal margin straight, sloping; posterior margin convex, similar to the anterior margin; basal margin straight, with a slight sinus in the middle. Sculpture consisting of subequal and inequidistant strong concentric riblets, sharply rounded, with the interstices of about the same width; as they recede from the beak they are getting much stronger and more distant; some well-marked periods of rest are usually visible at regular intervals; radial fine threads are reticulating the concentric sculpture. Epidermis thin, light-brown. Colour light-brown, whitish when the epidermis is lost. Interior white, porcellaneous, the growth-periods well marked, the margins smooth. Hinge with a triangular resilifer under the beaks; right valve with 2 divergent strong and elevated cardinals, the anterior with a pectinated edge; left valve with 2 dorsal narrow laminæ, the posterior of which is triangularly elevated. Ligament consisting of an internal resilium only. Adductor-scars fairly large. Pallial-line simple, uninterrupted, distant from the margins.

Length, 7·2 mm.; height, 5 mm.; diameter, 3 mm.

Type from Hauraki Gulf, in my collection.

Mostly small valves were obtained.

63. **Mactra scalpellum**, Reeve.

Conch. Icon., vol. viii, 1854, pl. xix, fig. 106.

A few small valves.

64. **Chione stutchburyi** (Gray).

Venus stutchburyi, Gray, in Wood's Index Test., Suppl., 1828, fig. 4.

A few valves.

65. **Chione mesodesma** (Quoy and Gaimard).

Venus mesodesma, Q. and G., Voy. "Astrolabe," Zool., vol. iii, 1835, p. 532, pl. lxxxiv, figs. 17–18.

A few valves.

66. **Dosinia subrosea** (Gray).

Arthemis subrosea, Gray, in Yate's N. Zeal., 1835, p. 309.

One small valve.

67. Macrocallista multistriata (Sowerby).

Cytherea (*Callista*) *multistriata*, Sow., Thes. Conch., vol. ii, 1851, p. 628, pl. cxxxvi, fig. 177.

A few small valves.

68. Protocardia pulchella (Gray).

Cardium striatulum, Sow., Proc. Zool. Soc., 1840, p. 105 (not of Brocchi.). *C. pulchellum*, Gray, in Dieff. N. Zeal., vol. ii, 1843, p. 252.

Many valves.

69. Sanguinolaria (Soletellina) siliqua (Reeve).

Soletellina siliqua, Reeve, Conch. Icon., vol. x, 1857, fig. 10.

Two small valves.

70. Corbula zelandica (Quoy and Gaimard).

Voy. "Astrolabe," Zool., vol. iii, 1835, p. 511, pl. lxxxv, figs. 12–14.

A few valves.

71. Corbula macilenta, Hutton.

Cat. Tert. Moll., 1873, p. 18.

A number of valves.

72. Saxicava arctica (Linnæus).

Mya arctica, L., Syst. Nat., 10th ed., 1767, p. 1113.

A few small valves.

73. Thracia vitrea (Hutton).

Lyonsia vitrea, Hutt., Cat. Mar. Moll., 1873, p. 61.

Three valves.

74. Myodora striata (Quoy and Gaimard).

Pandora striata, Q. and G., Voy. "Astrolabe," Zool., vol. iii, 1835, p. 537, pl. lxxxiii, fig. 10.

One valve.

75. Myodora subrostrata, E. A. Smith.

M. ovata, Reeve, Hutton, Cat. Mar. Moll., 1873, p. 62 (not of Reeve). *M. subrostrata*, Smith, Proc. Zool. Soc., 1880, p. 584, pl. liii, fig. 6.

A few valves.

76. **Myodora novæ-zealandiæ**, E. A. Smith.

Proc. Zool. Soc., 1880, p. 584, pl. liii, fig. 5.

A number of right valves.

77. **Myodora antipodum**, E. A. Smith.

Proc. Zool. Soc., 1880, p. 585, pl. liii, fig. 7.

One right valve.

78. **Cuspidaria trailli** (Hutton).

Neœra trailli, Hutt., Cat. Mar. Moll., 1873, p. 62.

A few valves.

BRACHIOPODA.

Terebratella rubicunda, Sowerby.

Proc. Zool. Soc., 1846, p. 92.

One small specimen.

EXPLANATION OF PLATES XXVI, XXVII, AND XXX.

PLATE XXVI.

Figs. 1–2. *Xenophora neozelanica*, Suter. 68 mm. by 35 mm.

PLATE XXVII.

Fig. 3. *Rissoina cuvieriana*, Suter. 3·5 mm. by 5·8 mm.
Fig. 4. *Pyramidella* (*Syrnola*) *lurida*, Suter. 1·6 mm. by 6 mm.
Fig. 5. *Odostomia* (*Evalea*) *chordata*, Suter. 1·9 mm. by 3·8 mm.
Fig. 6. ,, (s. str.) *incidata*, Suter. 1·8 mm. by 4·5 mm.
Fig. 7. *Eulima oxyacme*, Suter. 1·8 mm. by 5·1 mm.
Fig. 8. *Vulpecula marginata*, Hutton. 2·5 mm. by 6·2 mm.
Fig. 9. *Daphnella chariessa*, Suter. 1·7 mm. by 4·5 mm.
Fig. 10. ,, *psila*, Suter. 2·6 mm. by 6 mm.
Fig. 11. *Dacrydium radians*, Suter. 3·5 mm. by 5·5 mm.
Fig. 12. *Rochefortia reniformis*, Suter. 7·2 mm. by 5 mm.

PLATE XXX.

Figs. 1–2. *Glycymeris velutina*, Suter. 24 mm. by 22 mm.

Art. XXXV.—*Descriptions of New Species of New Zealand* Mollusca.

By Henry Suter.

[*Read before the Wellington Philosophical Society, 2nd October, 1907.*]

Plates XXVIII–XXX.

1. Tonicia cuneata, n. sp. Plate XXVIII, figs. 1–2.

Shell oblong-ovate, rather small, valves much raised, the intermediate valves beaked, angled above, with cuneiform sculpture. Anterior valve with 4 low and smooth ridges with serrated margins, corresponding with the slits, anterior margin with the same number of slightly projecting lobes, posterior margin a little concave: sculpture between the riblets consisting of deeply engraved grooves and punctures, leaving numerous wedge-shaped patches of various size; the whole surface dotted with minute eyes. Of the intermediate valves, the first is notably larger than the following 5, all are sinuated on the latero-anterior sides and narrowed, convex in front and prominently beaked behind; dorsal area V-shaped, smooth, microscopically transversely finely striate; pleural tracts with a few narrow longitudinal and divergent serrated grooves; lateral areas not raised, with an anterior obtuse diagonal ridge, sculpture similar to that of the head-valve; the small, reddish eyes scattered over the whole surface. Posterior valve with a V-shaped dorsal area, its sides serrated, mucro at about the posterior fourth, posterior slope moderately concave, posterior margin slightly lobed, the lobes corresponding with the slits; sculpture beautifully wedge-shaped, with the postero-lateral ridges corresponding with the anterior slits; the whole surface covered with minute eyes. Girdle moderately broad, leathery, yellowish, almost naked, with very few silvery fine hairs near the margin. Colour a dirty-white; anterior valve with the riblets reddish-white, the grooves and punctures rusty; intermediate valves with the central area light-olive, bordered by white, ornamented with very fine longitudinal reddish lines; grooves on the pleural and lateral areas rusty, a few light-blue spots scattered over the areas; posterior valve having the central area coloured as the intermediate valves, the grooves rusty, the cuneiform nodules light-blue on the pleural tracts, white, with a few blue spots, posteriorly. Interior greenish-white, without any strong callosity. Anterior valve with 4 slits, the 2 central ones broader; intermediate valves with 1 slit on each side, and posterior valve with 7 inequidistant slits; all teeth of the first 7 valves finely pectinated and sharp, but those of the tail-valve are stout, deeply grooved, rather blunt-edged; all insertion plates are high. Sinus flat, finely denticulate; sutural laminæ angularly produced, rather thin; valve-callus not much raised.

Length, 22 mm.; breadth, 11 mm.; dry specimen. Divergence, 78°.

Animal with the gills extending nearly the whole length of the foot.

Type in my collection.

Hab.—Bay of Islands (J. C. Anderson).

Remarks.—This shell is distinguished by its peculiar cuneiform sculpture from all the species of the genus known to me; it adds another genus to the New Zealand fauna.

2. **Seila cochleata,** n. sp. Plate XXVIII, fig. 3.

Shell small, conical, solid, dark-brown. Sculpture consisting of flat cinguli, 3 on the two whorls suceeding the embryonic shell, 4 on the following four whorls, and 5 on the body-whorl, to which are added 2 narrow spirals on the base, the upper of which arises from the suture; all are of about the same strength, the interstices of the same width as the cinguli, ornamented with fine axial striæ; the intercalation of an additional spiral takes place between the first and second rib, and it is at first very thin, but gradually attains the same strength as the others. Colour chestnut-brown. Spire elevated-conic, much higher than the aperture; outlines faintly convex. Protoconch broken off in the only specimen I have. Whorls about 10, regularly increasing, flat; base somewhat excavated. Suture deep, canaliculated by the spiral sculpture. Aperture triangularly oval, angled above, produced below into a very short and open canal. Outer lip rather thick, denticulated on the outside by the spirals, angularly rounded on meeting the straight basal lip. Columella vertical, short, arcuate, thick and rounded, subtruncate below; inner lip narrowly and thinly spread over the columella and parietal wall.

Diameter, 3·8 mm.; height, about 10·5 mm.

Type in my collection.

Hab.—Bay of Islands (J. C. Anderson).

Remarks. — In sculpture this species equals the Pliocene *Bittium cinctum*, Hutton (which, however, is a *Seila*), but the fossil species has more whorls, is higher, and the outlines of the spire are perfectly straight.

3. **Aclis succincta**, n. sp. Plate XXVIII, fig. 4.

Shell very small, turreted, perforate, hyaline and somewhat shining. Sculpture consisting of spiral threads, one upon the middle of the shoulder, the second (most prominent of all) on the angle of the shoulder, the third (slightly finer) a little below the periphery, and the fourth just above the suture; base with a few additional spiral liræ; the whole crossed by oblique rather distant axial lines reticulating the interstices and extending over the base; the axial sculpture by far not so conspicuous as the spiral. Colour light-horny. Spire turriculate, much higher than the aperture; outlines straight. Protoconch small, obtuse, spirally sharply ridged. Whorls 6, regularly increasing, distinctly shouldered, and angularly narrowed again below the periphery; base convex. Suture distinct, margined above by the fourth spiral. Aperture subvertical, oval. Peristome discontinuous, sharp. Columella vertical, somewhat arcuate, a little broadened and subtruncate below. Perforation narrow, open. Operculum unknown.

Diameter, 1·1 mm.; height, 2·6 mm.

Type in my collection.

Hab.—Near the Snares Islands, in 50 fathoms (Captain Bollons). One specimen.

4. **Pyramidella (Eulimella) limbata**, n. sp. Plate XXVIII, fig. 5.

Shell small, subulate, imperforate, polished, with channelled suture. Sculpture consisting simply of straight growth-lines, slightly plicate on some of the whorls. Colour white. Spire subulate, much higher than the aperture; outlines straight. Protoconch heterostrophe, of 2 smooth whorls, the nucleus lateral. Whorls about 9, regularly increasing, flatly rounded; base convex. Suture very distinctly channelled. Aperture vertical, suboval, the sides subparallel, the base angularly effuse. Peristome solid, but not thickend, rather sharp; basal lip expanded. Columella straight, subtruncate below; inner lip not reflexed.

Diameter, 1·5 mm.; height, 5 mm.

Type in my collection.

Hab.—Bay of Islands, type; Takapuna Reef (H. S.).

5. **Odostomia (s. str.) bembix**, n. nov. Plate XXVIII, fig. 6.

Odostomia lactea, Angas, Hutton, Cat. Mar. Moll., 1873, p. 22, &c. (not of Angas nor of Dunker). *O. angasi*, Tryon, Index, p. 74 (not of Tryon).

Shell small, ovato-conic, subperforate, slightly polished, subdiaphanous, fairly solid. Sculpture consisting of irregularly spaced nearly straight growth-lines, crossed by fine, sometimes very indistinct, spiral striæ. Colour white, occasionally tinged with yellowish or pink. Spire conic, about 1½ times the height of the aperture; outlines straight. Protoconch very small, heterostrophe, of 1 smooth whorl. Whorls 8 in quite adult examples, but the shells usually obtained have 6 whorls; they increase regularly, are flatly convex, and the last whorl is usually distinctly angled at the periphery, but sometimes rounded. Suture impressed, submargined below. Outer lip sharp, slightly convex; basal lip acutely convex and expanded. Columella oblique, with a prominent oblique plait above, concave below; inner lip broadly reflected below, spreading as a very thin callus over the parietal wall. Base with a distinct umbilical fissure.

Diameter, 3·5 mm.; height, 7·5 mm. Specimen of 8 whorls.

Diameter, 3 mm.; height, 5 mm. Specimen of 6 whorls.

Type in the Dominion Museum, Wellington.

Hab.—Stewart Island, type; Lyttelton Harbour, in 2 fathoms (H. S.); Akaroa Harbour, in 6 fathoms (H. S.); Blind Bay; Narrow Neck Reef, Devonport (H. S.); near Channel Island, Hauraki Gulf, in 25 fathoms.

Fossil in the Pliocene.

Remarks.—The Australian *O. angasi*, Tryon (= *O. lactea*, Angas), is a much more slender, subulate species, which has the body-whorl rounded, never angled.

6. **Odostomia** (s. str.) **taumakiensis,** n. sp. Plate XXVIII, fig. 7.

Shell very small, elongately ovate, imperforate, smooth and polished, thin, translucent. Sculpture consisting occasionally of a few microscopic indistinct spiral striæ on the body-whorl, but very often absent; growth-lines fine, oblique. Colour white. Spire elevated-conic, about 1½ times the height of the aperture; outlines somewhat convex. Protoconch minute, heterostrophe, but slightly tilted, of 1 smooth whorl, globular. Whorls 5, regularly increasing, lightly convex; base flatly rounded. Suture impressed, margined below by a rather broad band. Aperture subvertical, oval, angled above, rounded and effuse below. Outer lip thin and sharp. Columella slightly oblique, arcuate, with a deeply situated and not very prominent plait above; inner lip but slightly expanded, forming a very thin and shining layer on the parietal wall.

Diameter, 1·5 mm.; height, 3·2 mm.

Type in my collection.

Hab.—Near Taumaki Island, west coast of the South Island, in 10 fathoms, type; near the Snares and Bounty Islands, in 50 fathoms (Captain Bollons).

Remarks.—From *O. proxima* this species is distinguished by being imperforate, having very faint or no spiral sculpture, the suture margined, and only 5 whorls; from *O. marginata* by the same characters, except the margined suture, and the body-whorl not being angled.

7. **Odostomia** (s. str.) **inornata,** n. sp. Plate XXVIII, fig. 8.

Shell small, subulate, imperforate, fairly solid, lightly polished, smooth. Sculpture consisting of straight and fine growth-lines only. Colour white. Spire broadly subulate, twice the height of the aperture; outlines straight. Protoconch heterostrophe, oblique, globular, of 1 whorl, smooth. Whorls 6, regularly increasing, the last rather high, but slightly convex, body-whorl sometimes faintly angled at the periphery; base flat. Suture impressed, narrowly and rather indistinctly margined below. Aperture subvertical, narrowly pyriform, rounded and produced below. Outer lip slightly convex, sharp. Columella somewhat oblique, arcuate, with a distinct oblique and deeply placed plait above; inner lip narrow above, but broadening toward the base, spread as a thin callus over the parietal wall. Sometimes there is a narrow umbilical chink present.

Diameter, 2·5 mm.; height, 6·1 mm.

Type in my collection.

Hab.—Near the Snares (type) and Bounty Islands, in 50 fathoms (Captain Bollons).

Remarks.—This species is apparently nearly allied to *O. hyphala*, Wats., but the whorls are not slightly scalar, the suture is less deep, the columellar plait stronger, &c.

8. **Odostomia** (s. str.) **denselirata,** n. sp. Plate XXVIII, fig. 9.

Shell minute, elongately oval, thin, semitransparent, slightly shining, imperforate. Sculpture: The protoconch and the succeeding whorl smooth, the others microscopically, densely, and distinctly spirally striate; growth-lines fine, vertical, and somewhat flexuous. Colour white. Spire conical, very little higher than the aperture; outlines moderately convex. Protoconch heterostrophe, of 2 whorls, smooth, polished, convex, nucleus lateral. Whorls 5, regularly increasing, flatly convex; base flat. Suture impressed. Aperture subvertical, ovate, high, angled above, narrowed and produced below. Outer lip regularly convex, thin and sharp. Columella vertical, arcuate, with a small plait above; inner lip extending very little beyond the pillar, but broadening towards the base.

Diameter, 1·25 mm.; height, 2·5 mm.

Type in my collection.

Hab.—Near Little Barrier Island, in 20 fathoms; type (R. H. Shakespear).

9. **Odostomia** (s. str.) **takapunaensis**, n. sp. Plate XXVIII, fig. 10.

Shell small, conical, narrowly umbilicate, smooth, fairly solid, shining. There is no sculpture. Colour white. Spire conic, about twice the height of the aperture; outlines straight. Protoconch heterostrophe, of 2 oblique whorls, nucleus lateral. Whorls 7, regularly increasing, flatly convex, the last regularly rounded at the periphery; base flat. Suture impressed. Aperture subvertical, oval, broadly angled above, effuse below. Outer lip slightly arcuate, sharp. Columella subvertical, arcuate, with a distinct oblique plait above; inner lip narrow, broadening a little below; thin over the parietal wall. Umbilicus narrow, but very distinct and quite open.

Diameter, 2·2 mm.; height, 4 mm.

Type in my collection.

Hab.—Takapuna Reef, in sand; type (H. S.).

10. **Odostomia** (s. str.) **dolichostoma**, n. sp. Plate XXIX, fig. 11.

Shell small, ovate, imperforate, faintly shining, opaque. Sculpture consisting of a few indistinct and distant spiral striæ on the body-whorl; growth-lines rather strong, oblique. Colour yellowish-white. Epidermis horny, very thin, easily wearing off. Spire conic, somewhat scalar, about the same height as the aperture; outlines almost straight. Protoconch of 1 smooth and polished whorl, heterostrophe, oblique. Whorls 4, the last very high, flatly convex, projecting out of the suture; base faintly rounded. Suture deep. Aperture vertical, pyriform, high, sharply angled above, broadly rounded and effuse below. Outer lip regularly arched, a little thickened inside, sharp. Columella subvertical, arcuate, with a feeble plait above, placed rather deep within; inner lip spreading a little beyond the pillar, having a sharp outer edge, broadening towards the base, and extending as a very thin glaze over the parietal wall. Operculum horny, inner margin very little indented.

Diameter, 2·1 mm.; height, 4·2 mm.

Type in my collection.

Hab.—Cheltenham Beach, near Auckland (H. S.).

11. **Odostomia** (s. str.) **cryptodon**, n. sp. Plate XXIX, fig. 12.

Shell very small, ovate, fairly solid, imperforate, smooth, slightly shining. There is no sculpture, except fine oblique growth-lines. Colour white, slightly yellowish. Spire conic, a little higher than the aperture; outlines but faintly convex. Protoconch heterostrophe, oblique, of 1 smooth and convex whorl. Whorls 4, regularly increasing, flatly rounded; base moderately convex. Suture impressed. Aperture a little oblique, oval, angled above, narrowly effuse below. Outer lip thin and sharp. Columella vertical, arcuate, with a small plait above, which is deep within the aperture; inner lip extending a little beyond the columella, with a sharp edge, slightly broadening below; not spreading over the parietal wall. Operculum normal.

Diameter, 1·6 mm.; height, 3 mm.

Type in my collection.

Hab.—Te Onepoto Bay, near Lyttelton, type (T. Iredale); Queen Charlotte Sound, in 16 fathoms (Captain Bollons).

12. **Odostomia** (s. str.) **acutangula,** n. sp. Plate XXIX, fig. 13.

Shell minute, elevated-conic, rimate, solid, polished. Sculpture consisting of a few microscopic spiral striæ, crossed by vertical flexuous fine growth-lines. Colour white. Spire elevated-conic, about twice the height of the aperture; outlines straight. Protoconch heterostrophe, oblique, small, and rounded, of 1 whorl. Whorls 5, regularly increasing, flatly convex, the last acutely angled at the periphery; base flat. Suture impressed between the upper whorls, channelled further down. Aperture subvertical, broadly oval, angled above and effuse below. Outer lip nearly straight, acutely rounded on meeting the basal lip, which is straight. Columella vertical, very little arcuate, with a feeble and deep-seated plait above; inner lip narrow. Umbilical chink very small.

Diameter, 1·4 mm.; height, 2·7 mm.

Type in my collection.

Hab.—Port Pegasus, Stewart Island, in 18 fathoms (Captain Bollons).

Remarks.—The only shell at my disposal is hardly adult.

13. **Odostomia** (s. str.) **pudica,** n. sp. Plate XXIX, fig. 14.

Shell small, elongate, imperforate, smooth, semitransparent, polished. There is no sculpture, except fine straight growth-lines. Colour white. Spire subulate, twice the height of the aperture; outlines straight. Protoconch of 1 small and smooth whorl, heterostrophe, oblique. Whorls 7, regularly increasing, flat, the lower ones angularly contracted above the suture, the angle continued on the periphery of the body-whorl; base flat. Suture canaliculate. Aperture oblique, pyriform, angled above and narrowly produced below. Outer lip flatly rounded, thin and sharp. Columella vertical, slightly concave, with a low oblique plait above; inner lip rather broadly expanded, spreading thinly over the parietal wall.

Diameter, 2·4 mm.; height, 5·6 mm.

Type in my collection.

Hab.—Bay of Islands (J. C. Anderson).

Remarks.—This species is evidently also near *O. hyphala*, Wats., but it is shorter, with the same number of whorls, and slightly more slender; the whorls are angled above the suture, the last whorl is slightly angled at the periphery; the suture is channelled and the whorls not projecting below it.

14. **Odostomia (Menestho) sabulosa**, n. sp. Plate XXIX, fig. 15.

Shell small, elevated, spirally striate, thin, faintly shining, imperforate. Sculpture consisting of flattish spiral cords, 7 on the penultimate whorl, and extending over the base; interstices slightly narrower than the cords, ornamented with numerous equidistant axial threads. Colour white. Spire narrowly conic, twice the height of the aperture; outlines straight. Protoconch heterostrophe, of 1 whorl, smooth, globular. Whorls 6, regularly increasing, but faintly convex; base flattish. Suture canaliculate, but not very deep. Aperture subvertical, oval, angled above, narrowly rounded and effuse below. Outer lip slightly convex. Columella vertical, almost straight, the columella plait small and deep within the aperture; inner lip narrow, not reflexed, forming a very thin glaze on the parietal wall.

Diameter, 1·8 mm.; height, 4·2 mm.

Type in my collection.

Hab.—Near the Bounty (type) and the Snares Islands, in 50 fathoms (Captain Bollons).

Remarks.—The axial sculpture is in the majority of the dredged and more or less worn specimens almost completely lost. The species is more slender than *O. impolita*, Hutt., the spiral cords more distinct and mostly with wider interspaces, and the latter are in well-preserved specimens reticulated by axial threads.

15. **Odostomia (Evalea) liricincta**, n. sp. Plate XXIX, fig. 16.

Shell very small, elongate-oval, imperforate, spirally lirate, slightly shining. Sculpture consisting of unequal flat spiral liræ, absent on the first 2 whorls, the interstices linear, the sculpture extending over the base; growth-lines dense, oblique, distinct. Colour white. Spire elevated-conic, about twice the height of the aperture; outlines straight. Protoconch minute, heterostrophe, globular. Whorls 5, regularly increasing, flatly convex, the last not angled; base flattish. Suture impressed. Aperture slightly oblique, angled above and narrowly produced below. Outer lip regularly rounded, thin and sharp. Columella subvertical, almost straight, with a minute plait above; inner lip extending a short distance beyond the pillar, and as a thin layer over the parietal wall.

Diameter, 1·5 mm.; height, 3·3 mm.

Type in my collection.

Hab.—Port Pegasus, Stewart Island, in 18 fathoms (Captain Bollons).

Remarks.—This species is nearest allied to *O. impolita*, Hutt., but it is smaller, more slender, and the spiral sculpture is much more distinct. The fossil *O. fasciata*, Hutt., is also very similar, but has a differently arranged sculpture and an open umbilicus. Hutton's name, dating of 1885, being preoccupied by Dunker, 1860, I propose the name *O. huttoni* for it.

16. Eulima truncata, n. sp. Plate XXIX, fig. 17.

Shell very small, subcylindrical, thin and polished, semi-transparent, straight. There is no sculpture and no varices. Colour white. Spire very narrowly conic, a little more than twice the height of the aperture; outlines straight. Protoconch high, obtusely rounded. Whorls 5, regularly increasing, flat; base flattish, elongated. Suture linear, superficial, false-margined below. Aperture subvertical, lanceolar, high and narrow, sharply angled above and acuminate below. Outer lip straight above, rounded towards the base, thin and sharp. Columella short, truncated at the base; parietal wall slightly concave.

Diameter, 1 mm.; height, 3 mm.

Type in my collection.

Hab.—Cape Maria van Diemen (Captain Bollons).

Remarks.—No doubt the specimen is not full grown.

17. Eulima titahica, n. sp. Plate XXIX, fig. 18.

Shell small, subulate, slightly curved, semitransparent, polished, with a few discontinuous and inconspicuous varices. Sculpture consisting of a few indistinct varices and faint growth-lines. Colour white. Spire somewhat curved to the right, narrowly conic, three times the height of the aperture. Protoconch globular, obtuse. Whorls 7, regularly increasing, flatly convex; base rounded. Suture linear, not much impressed, false-margined below. Aperture pyriform, angled above, slightly effuse below. Outer lip but slightly curved, thin and sharp; basal lip broadly convex. Columella vertical, indistinctly arcuate; parietal wall straight; inner lip very little expanded, with a sharp edge.

Diameter, 1·4 mm.; height, 4 mm.

Type in my collection.

Hab.—Titahi Bay, Cook Strait (Miss M. Mestayer).

18. **Latirus huttoni**, n. nov. Plate XXX, fig. 3.

Trophon dubius, Hutton, Journ. de Conch., vol. xxvi, 1878, p. 13.
Taron dubius, Hutton, Trans. N.Z. Inst., vol. xvi, p. 227.

The late Captain F. W. Hutton proposed the genus *Taron* for his *Trophon dubius* in 1883 (Trans. N.Z. Inst., vol. xv, p. 119), because the dentition proved the mollusc to belong to the *Fusidæ*, and, in his opinion, the operculum has not an apical, but subcentral, nucleus. This latter is not correct, as the growth-lines on the outer side of the operculum distinctly show the nucleus to be apical. Looking at the operculum held up against the light, however, one gets the impression that the nucleus is subcentral, and this has no doubt misled Captain Hutton. The dentition is that of *Latirus*, as already pointed out by J. C. Melvill in 1891 (Mem. and Proc. Manchester Lit. and Philos. Soc. (4), vol. iv, p. 12), and the shell has all the characters of that genus. *Taron*, therefore, must be reduced to a synonym of *Latirus*. The specific name of Hutton being preoccupied in the genus for a fossil shell by Beyrich, I propose the name as above.

19. **Euthria strebeli**, n. nov. Plate XXX, fig. 4.

E. antarctica, Reeve, Hutton, Man. N.Z. Moll., 52; Index, 73.
Pisania antarctica, Reeve, Hutton, Trans. N.Z. Inst., vol. xvi, p. 231 (not of Reeve).

Shell not large, fusiform, very solid, usually spirally ridged. Sculpture consisting of numerous narrow spiral ridges, much more prominent upon the base, the interstices with fine spiral threads; two or three whorls below the protoconch are axially costate; growth-lines oblique, fine. Colour whitish or cinereous, very often with light-brown spiral bands; aperture purplish-brown within, outer lip white or with a few brown patches. Sometimes the whole shell is covered by a blackish coating. Spire elevated-conic, height almost that of the aperture with canal; outlines but little convex. Protoconch minute, of 2 smooth and convex whorls. Whorls 8, first slowly increasing, the last high; they are very lightly convex, depressed below the suture, the base contracted. Suture not much impressed. Aperture very little oblique, narrowly oval, distinctly channelled above, produced below into a moderately long recurved and open canal, notched at the base. Outer lip flatly convex, sharp, much thickened inside, and distinctly toothed. Columella vertical, arcuate, with a number of tubercles at the base; inner lip rather narrow upon the pillar, extending over the parietal wall, which has a well-marked plait below the suture; the lip is narrowed below, forming the inner edge of the canal. Fasciole prominent, lamellate; a narrow groove between it and the edge of the canal. Operculum horny, yellowish, the nucleus apical.

Diameter, 15 mm.; height, 28 mm. Angle of spire, 47° to 50°.

Type in my collection.

Hab.—Dunedin Harbour, type (H. S.); Lyttelton Harbour (H. S.); Preservation Inlet; Auckland Islands.

Remarks.—This species is much more solid than *E. littorinoides*, Reeve; the spiral bands are inconspicuous, and the outer lip is not banded with brown within. When studying the exhaustive descriptions and very good figures of *E. fuscata*, Brug. (= *Bucc. antarcticum*, Reeve), published by Dr. H. Strebel (Zool. Jahrb., Abt. Systematik, vol. xxii, 1905, p. 611) I was more than doubtful about the identity of the New Zealand species, and I asked for Dr. Strebel's opinion on the subject. He most courteously informed me that our species was not *E. antarctica*, Reeve, at all, and that it seemed to him more nearly allied to *E. dira*, Reeve, from the west coast of North America. Our shell, however, in my opinion, is also quite distinct from this as well, but nearly allied to *E. vittata*, *littorinoides*, and *striata*. The four species so closely resemble one another that it is not always easy to separate them, their variability being so great. I have much pleasure in uniting the name of the distinguished conchologist, Dr. Hermann Strebel, with the species.

20. **Tritonidea (Cantharus) fuscozonatus**, n. sp. Plate XXX, fig. 5.

Shell ovato-fusiform, solid, spirally ridged and axially broadly costate. Sculpture consisting of regular spiral liræ of subequal strength, the interstices with 1 or several fine spiral threads, the liræ more prominent and further apart on the base; axial ornamentation formed by rather distant, elevated, and broadly rounded axial costæ, about 15 on a whorl, the spirals passing over them; they are getting obsolete on the base. Colour fulvous, the spiral riblets purple, sometimes a purple band above the suture and a second below the periphery of the body-whorl are present, also longitudinal streaks of light-brown; aperture whitish within. Spire conical, turreted, of the same height as the aperture with canal; outlines straight. Protoconch conical, axially striate. Whorls 6 to 7, the last high, concave on the shoulder, convex below it; base contracted. Suture not deep, undulating. Aperture somewhat oblique, narrowly channelled above, with an oblique narrowly open and slightly recurved canal below, its base notched. Outer lip thick, with a distinct varix outside, callous and denticulate within. Columella vertical, concave, with transverse ridges over the whole length; inner lip narrow, spreading over the concave parietal wall, which bears a tubercle above; narrowed below to a point. Some specimens have a distinct depression between the fasciole and the edge of the canal. Operculum unknown.

Diameter, 14 mm.; height, 26 mm. Type specimen.

Type in the Dominion Museum, Wellington.

Hab.—East Cape Lighthouse, type; Foveaux Strait.

Remarks.—This species is very variable in size; my largest specimen, of 7 whorls, measures 17 mm. by 32 mm., the smallest also of 7 whorls, 10·5 mm. by 21 mm., but numerous intermediate forms occur.

21. **Tritonidea** (s. str.) **colensoi**, n. sp. Plate XXX, fig. 6.

Shell small, ovate, solid, distinctly broadly spirally lirate, and more or less distinctly axially costate on the spire-whorls. Sculpture consisting of broad and flattish spiral liræ, 3 on the penultimate, 9 to 10 on the body whorl, the interstices narrow, linear; they are crossed on the spire-whorls by flatly rounded axial ribs, about 12 on a whorl, which usually cut up the spirals into squarish nodules. Colour white, the spiral grooves purplish-brown, a few longitudinal narrow light-brown bands passing over the body-whorl and across the interstices of the axial ribs; aperture purple within, outer lip and columella white. Spire short, conic, about the same height as the aperture; outlines faintly convex. Protoconch very small, convex, of $1\frac{1}{2}$ smooth whorls. Whorls 5, the last high, flattish; base lightly contracted. Suture not deep, uneven. Aperture somewhat oblique, narrowly channelled above, produced below into a short oblique and narrowly open canal, its base notched. Outer lip very thick, with a blunt edge and a broad varix on the outside; inside callous, denticulate-lirate. Columella vertical, lightly concave, with several ridges at its base; inner lip narrow, not distinctly bounded, extending over the concave parietal wall, which has one or two tubercular plaits above; at the base the lip is narrowed towards the canal. Operculum unknown.

Diameter, 10 mm.; height, 18 mm.

Type in the Dominion Museum, Wellington.

Hab.—East Cape Lighthouse.

Remarks.—This shell was first shown to me by Mr. Howard Hill, of Napier, who told me that the examples in his possession were collected by the late Rev. W. Colenso, the exact locality being unknown. It may well be that the species ranges from the East Cape down to Hawke's Bay.

22. **Cuspidaria fairchildi**, n. sp. Plate XXIX, fig. 19.

Shell small, thin and fragile, ovate, with a long and straight posterior rostrum, concentrically finely striate, almost equivalve, inequilateral. Beaks small, sharply pointed, directed forwards, situated a little in front of half the length; prodissoconch small, roundly ovate, smooth. Anterior end narrowly rounded, the dorsal margin slowly descending, straight; posterior end produced into a long straight rostrum, gaping at its end; basal margin broadly rounded, slightly concave on approaching the rostrum. Lunular area very little excavated. Sculpture consisting of very fine and dense concentric striæ, with but little stronger inequidistant marks of rest; the rostrum finely concentrically lamellate, without radial sculpture. Colour white, lightly iridescent in some places. Interior white, shining, finely radially striate; margins smooth. Hinge-plate very narrow, slightly buttressed posteriorly, with a small resilifer below the beaks; right and left valve with a very small posterior lateral tooth. Ligament very small, linear. Muscle-scars rather large; pallial sinus not deep, broadly rounded.

Length, 13 mm.; height, 6 mm.; diameter, 4·4 mm.

Type in the Dominion Museum, Wellington.

Hab.—Dredged in the "sixties" by the late Captain Fairchild off Flat Point, in 75 fathoms. One perfect specimen and one left valve.

Remarks.—At once distinguished from *C. trailli*, Hutt., by the absence of concentric sharp laminæ and radial ridges on the rostrum; Hutton's species has a very distinct anterior and posterior lateral tooth in the right valve.

EXPLANATION OF PLATES XXVIII–XXX.

Plate XXVIII.

Figs. 1–2. *Tonicia cuneata*, Suter. 22 mm. by 11 mm.
Fig. 3. *Seila cochleata*, Suter. 3·8 mm. by 10·5 mm.
Fig. 4. *Aclis succincta*, Suter. 1·1 mm. by 2·6 mm.
Fig. 5. *Pyramidella (Eulimella) limbata*, Suter. 1·5 mm. by 5 mm.
Fig. 6. *Odostomia bembix*, Suter. 3 mm. by 5 mm.
Fig. 7. „ *taumakiensis*, Suter. 1·5 mm. by 3·2 mm.
Fig. 8. „ *inornata*, Suter. 2·5 mm. by 6·1 mm.
Fig. 9. „ *denselirata*, Suter. 1·25 mm. by 2·5 mm.
Fig. 10. „ *takapunaensis*, Suter. 2·2 mm. by 4 mm.

PLATE XXIX.

Fig. 11. *Odostomia dolichostoma*, Suter. 2·1 mm. by 4·2 mm.
Fig. 12. ,, *cryptodon*, Suter. 1·6 mm. by 3 mm.
Fig. 13. ,, *acutangula*, Suter. 1·4 mm. by 2·7 mm.
Fig. 14. ,, *pudica*, Suter. 2·4 mm. by 5·6 mm.
Fig. 15. ,, (*Menestho*) *sabulosa*, Suter. 1·8 mm. by 4·2 mm.
Fig. 16. ,, (*Evalea*) *liricincta*, Suter. 1·5 mm. by 3·3 mm.
Fig. 17. *Eulima truncata*, Suter. 1 mm. by 3 mm.
Fig. 18. ,, *titahica*, Suter. 1·4 mm. by 4 mm.
Fig. 19. *Cuspidaria fairchildi*, Suter. 13 mm. by 6 mm.

PLATE XXX.

Fig. 3. *Latirus huttoni*, Suter. 10·5 mm. by 18 mm.
Fig. 4. *Euthria strebeli*, Suter. 15 mm. by 28 mm.
Fig. 5. *Tritonidea* (*Cantharus*) *fuscozonatus*, Suter. 14 mm. by 26 mm.
Fig. 6. *Cantharus colensoi*, Suter. 10 mm. by 18 mm.

ART. XXXVI.—*Notes on some New Zealand Marine Molluscs.*

By TOM IREDALE.

[*Read before the Philosophical Institute of Canterbury, 6th November*, 1907.]

Plate XXXI.

THESE unconnected notes are presented in their present unfinished state for the sole reason that I will be, myself, unable to further my studies in connection with them in the near future. They relate chiefly to *Chitons*, limpets, and *Acmœas*, which have been my favourites whilst collecting. Notes referring to other species are here incorporated on account of interest attaching to them. I hope by publishing these fragmentary articles to draw attention to the molluscs noticed, and thereby get the problems propounded solved.

I intend further investigating some of the South Island queries, but would like to see those which also relate to the North Island taken up by the conchologists resident in the North Island.

Ischnochiton fulvus, Suter.

Ischnochiton fulvus, Suter, Journ. Malac., vol. xii, p. 66, 1905.

That the *Ischnochitons* of the South Island of New Zealand have been neglected by collectors this species would apparently prove: that this is due to the variation in colour of *I. longicymba*, Q. and G., is certain. I first met with this species as a red-brown shell dredged in shallow water in Purau Bay, Lyttelton Harbour. I then found a pure-white shell at Sandfly Bay, Otago Peninsula.

The small size and constant coloration induced me to separate these shells from *I. longicymba*, Q. and G. At that time I did not know of the existence of *I. fulvus*, Suter, and consequently these specimens remained unnamed in my collection.

At Shag Point, Otago, and all round the Otago Peninsula this species is abundant. It usually lives on clean smooth stones, unassociated with *I. longicymba*, Q. and G. When the two occur on the same stone, *I. fulvus*, Suter, is on the clean edge, whilst *I. longicymba*, Q. and G., is on the muddy side underneath.

I. fulvus, Suter, is as variable as regards colour as almost any other *Chiton*, but is almost always unicoloured; it runs through all the shades from pure-white through pale-yellow to fulvous and red-brown. The most striking shell, however, is a deep-green, with a green-and-white girdle.

I might here point out that very probably two or three species are doing duty in New Zealand collections for *I. longicymba*, Q. and G.

Whilst closely searching for *Chiton stangeri*, Reeve, I obtained a small-keeled *Ischnochiton* which I have not again found. I have, however, found another species of *Ischnochiton* which I have not been able to identify with any Australian species. This is a low-keeled species, with the lateral areas sculptured like *I. divergens*, Reeve, and a peculiar pattern of coloration.

Callochiton platessa (Gould).

Callochiton platessa (Gould), Suter, Proc. Mal. Soc., vol. ii, p. 184, 1897.

This quotation gives full references, and is the only record of this Australian species in New Zealand. The specimen there referred to is of unknown habitat, and was obtained prior to 1872.

The refinding of this species is, therefore, worthy of record. Collecting at Shag Point, Otago, with Mr. W. R. Brook Oliver, he found one specimen, and afterwards I obtained two more. These were obtained from under stones at the bottom of a deep rock-pool. I identified these from specimens from Port Jackson, New South Wales.

This makes the third species of *Callochiton* I have obtained whilst littoral collecting—a curious circumstance when it is remembered that all the previous records of this restricted genus in New Zealand refer to dredged specimens.

In the same pool that contained the *C. platessa* was found a single specimen of a new species of *Acanthochites*. This species is too well characterized to be the second species of *Acanthochites* mentioned by Pilsbry (Man. Conch., ser. i, vol. xv, p. 16).

Plaxiphora ovata (Hutton).

Plaxiphora ovata (Hutton), Suter, Proc. Mal. Soc., vol. ii, p. 191, 1897.

References are given in this paper, where Suter writes, "This handsome but rare mollusc is found mostly in roots of *D'Urvillea*." I have never yet found it on any other station, and, searching for specimens at Sandfly Bay, Otago Peninsula, my friend Mr. W. R. Brook Oliver obtained a lovely specimen with six valves only.

In the succeeding note, written previously to this find, the rarity of this find is shown. As this is the first occurrence in New Zealand of such an abnormal specimen, I am giving an illustration of it (Plate XXXI, fig. 1). In this specimen it will be noticed that the last valve is of unusual size for this species, the shape of the last valve in normal specimens being one of the chief characters of the subgenus *Fremblya*, which includes only one other species, *P. egregia*, H. Adams, of New South Wales.

Chiton pellis-serpentis, Quoy and Gaimard.

Chiton pellis-serpentis, Q. and G., Suter, Proc. Mal. Soc., vol. ii, p. 195, 1897.

In the paper quoted, Suter gives full references. I have to record the occurrence of a specimen of this species having five valves only, and herewith give an illustration from a photograph (Plate XXXI, fig. 2). This specimen is, as far as I can trace, unique.

Pilsbry wrote (Man. Conch., vol. xiv, p. xiii, 1894), "The occurrence of 6- and 7-valved *Chitons* has been noted as early as the time of Linnæus. It is likely that the 6-valved were artificial fabrications, although a certain number may perhaps be traced to incorrect drawings." Since the publication of Pilsbry's monograph increased interest in the collecting of *Chitons* has caused undoubted instances to be put on record.

In the Proc. Mal. Soc, vol. ii, p. 154, 1897, Bednall records the occurrence of a 6-valved specimen of *Plaxiphora conspersa* (Ad. and Ang.). Sykes, in his presidential address on "Variation in Recent Mollusca" (Proc. Mal. Soc., vol. vi, p. 268, 1905), mentioned that 6-valved specimens of *Trachydermon ruber*, Linné, and *Ischnochiton conspicuus*, Cpr., had recently been noted elsewhere, and that he himself had met with a 3-valved specimen of *Ischnochiton contractus*, Reeve, which is preserved in the British Museum.

Chiton æreus, Reeve.

Chiton æreus, Reeve, Suter, Proc. Mal. Soc., vol. ii, p. 195, 1897.

Suter's references refer to this species, though his letterpress does not, as has since been pointed out by himself. The following year Suter queried New Zealand as the habitat of this species (Trans. N.Z. Inst., vol. xxxi, p. 63, 1898 [1899]), yet on the east coast of the South Island this species cannot be considered rare. I can get specimens any day I wish in Lyttelton Harbour, and have obtained specimens at every other locality I have visited on Banks Peninsula. It is common at Shag Point, Otago, and all round the Otago Peninsula.

The normal colouring of this *Chiton* is a bluish-green, sometimes with the girdle marked with white. Yellow-green occurs in some localities; pure-lemon-yellow, yellowish-white, pure-white, puce-coloured, and bright-red-brown specimens are also rarely met with. In Otago, however, shells occur which I call albinos. So far I have obtained five distinct types. The general appearance of the shell is white: first, in which the whole is splashed with greenish-black; then, the valves are pure-white, with the girdle blackish-brown; next, the shell is pure-white with a greenish tinge, the girdle green-and-white; a fourth has the valves speckled with green and suffused with yellow, the girdle green-and-white; lastly, the valves suffused with greenish and the girdle pink.

Acmæa rubiginosa (Hutton).

Acmæa rubiginosa (Hutton), Suter, Proc. Mal. Soc., vol. vii, p. 315, 1907.

Upon shells of *Haliotis iris*, Martyn, at Lyttelton occur *Acmæas*. I separated them as *lacunosa* (= *rubiginosa*) and *cingulata*. Upon reading Suter's paper I re-examined my specimens, comparing them with undoubted specimens of *A. rubiginosa*, Hutton, from the Chathams, with the result that I consider my shells identical. At Shag Point, Otago, I first found dead shells and then live ones on *Haliotis iris* again. The dead shells are inseparable from the dead shells from the Chathams.

Acmæa cantharus (Reeve).

Acmæa cantharus (Reeve), Suter, Proc. Mal. Soc., vol. vii, p. 320, 1907.

In the paper quoted Suter restricts *A. cantharus*, Reeve, to New Zealand. As in that paper he does not discuss the relationships of the shells listed in Australia under that name, I here do so. That this is necessary for the understanding of this species is shown by the following: Pritchard and Gatliff (Proc. Roy. Soc., vol. xv (n.s.), p. 195, 1903), in their list of Victorian shells, believed *A. cantharus*, Reeve, was a Victorian shell, but could not give it specific rank, citing it as a synonym of *A. septiformis*, Q. and G. I have examined shells sent by Mr. Gatliff in support of this classification, and I quite agree that the shell so classed is a variant of *A. septiformis*, Q. and G., but it is certainly not the New Zealand shell called *A. cantharus*, Reeve.

Tate and May, in the "Revised Census of the Marine Mollusca of Tasmania" (Proc. Linn. Soc. N.S.W., vol. xxvi, p. 412, 1901), consider *A. cantharus*, Reeve, as a distinct Tasmanian species. Mr. May sent me shells identified as above, but they are not *A. cantharus*, Reeve. They may be an extreme form of *A. septiformis*, Q. and G., but that point must be settled by a study of the shells in their environment.

In the Trans. Roy. Soc. S. Aust., vol. xxx, p. 215, 1906 (1907), Dr. Verco identifies a South Australian shell as *A. cantharus*, Reeve. He treats fully of the shell so named, and has since expressed the opinion that the South Australian shell is identical with the New Zealand shell. The specimens he sent me, though very similar, I do not consider conspecific with ours. They are much eroded, whereas the New Zealand shell is very rarely so; the general coloration, as shown by the literature and these specimens, is the exception among New Zealand shells. I, however, think the South Australian shells worthy of a name, but they should not be called *A. cantharus*, Reeve. I therefore conclude, as Suter already has done, that *A. cantharus*, Reeve, does not occur in Australia.

Let us now consider the specific rank of *A. cantharus*, Reeve, in New Zealand. Suter gives it full specific rank, but the study of South Island shells does not warrant this. The characters Suter uses for separating the two I have found to be of very little value.

The size of the shells depends a great deal upon their station. A shell living in a secluded cavity, free from the action of rain, may attain a large size, and does not suffer from erosion. In the same locality shells living on boulders exposed to rain are small and much eroded. These exposed shells never attain a large size. I have *cantharus* much larger than Suter's measurements—viz., 26 by 20 by 9 mm., 25 by 19 by 9 mm., and 24 by 18 by 10 mm.

The prominence of the radial striation is an inconstant character, undoubted *pileopsis* having radial sculpture almost microscopic. As eroded shells occur, this character could only be used in conjunction with others.

No stress can be laid upon the position of the apex, as under *A. pileopsis,* Q. and G., Suter writes, "The situation of the apex is also variable, but in the majority of shells it is marginal."

The inside coloration varies much; it may be brown, yellowish-brown, yellowish-white, pale-blue, or bluish-white. This last colour, which Suter mentions as typical of *A. pileopsis,* Q. and G., is the usual colour of the inside, between the marginal band and the spatula, of very large shells.

Dark shells, sparsely blotched with white, and very distinctly striated, were collected at Lyttelton. Many of these shells show a colour-pattern of a very peculiar character—viz., from the apex to about half-way down the margin of each side runs a series of white blotches; when the shell is held up to the light and viewed from the inside these blotches are clearly seen, though other blotches visible on the outer surface are not.

Shells tessellated with white, apparently smooth, undoubtedly referable to *cantharus* were collected at Shag Point, Otago. No signs of this colour-pattern were apparent on the outer surface, yet when the shells were held up to the light these blotches were the only ones visible from the inside. This unexpected find was, to me, convincing evidence of the specific identity of the two shells.

I am therefore compelled to reduce *A. cantharus,* Reeve, to an absolute synonym of *A. pileopsis,* Q. and G.

The specimens which furnished the material for this review were collected at Waipara Rocks, North Canterbury; Taylor's Mistake Bay, near Sumner; Lyttelton Harbour; south coast of Banks Peninsula; Shag Point; near Cape Saunders; and at Sandfly Bay, Otago Peninsula.

An analysis of the habitats of *A. pileopsis,* Q. and G., and *A. cantharus,* Reeve, as recorded by Suter, gives: *A. pileopsis,* Q. and G.—North Island; South Island as far south as Lyttelton; Snares Islands; Auckland Islands; Campbell Island. *A. cantharus,* Reeve—West coast of South Island; east coast of South Island, from Oamaru down; Macquarie Island.

Therefore, instead, we now have—*Acmæa pileopsis,* Q. and G. (synonym, *Acmæa cantharus,* Reeve, Suter, Proc. Mal. Soc., vol. vii, p. 320, 1907): Both islands of New Zealand; all the subantarctic islands.

Acmæa parviconoidea, Suter.

Acmæa parviconoidea, Suter, Proc. Mal. Soc., vol. vii, p. 321, 1907.

To the localities mentioned by Suter I can add, near Cape Saunders, Otago Peninsula. This is the furthest-south locality yet recorded.

Acmæa parviconoidea leucoma, Suter.

Acmæa parviconoidea, var. *leucoma*, Suter, Proc. Mal. Soc., vol. vii, p. 322, 1907.

Shells answering to this description occur under stones in Dunedin Harbour; they agree with shells collected in Heathcote Estuary. I should consider this variety better placed under *A. septiformis*, Q. and G.

Acmæa dædala, Suter.

Acmæa dædala, Suter, Proc. Mal. Soc., vol. vii, p. 323, 1907.

The commonest form of this species is a pale-green shell, tessellated as the type. It is common at Shag Point, Otago, and near Cape Saunders, Otago Peninsula. Associated with it at these two localities is the subspecies *subtilis*, Suter. When alive this subspecies is very pale green, the colour fading to greenish-white when the animal is dead. With these two, at Shag Point, Otago, occurs a third variety: this is dark-brown, unicoloured, agreeing with the type in everything save coloration.

Shells dredged on dead shells in Lyttelton Harbour which may be referable to this species have a very different coloration. The sculpture is very similar, and they are transparent. They are whitish, with green thick radiating rays, about 7 to 9 in number. Others are whitish dotted with red, the border margined with red lines.

Acmæa scapha, Suter.

Acmæa scapha, Suter, Proc. Mal. Soc., vol. vii, p. 324, 1907.

I have this shell from shell-sand collected at Blind Bay, Nelson.

Acmæa pseudocorticata, n. sp.

Shell small, conical, elongate-oval, sides almost parallel, closely ribbed, greenish, with brownish markings between the ribs, margin almost entire. The sculpture consists of about 17 ribs in the young shell up to 30 in the older shell, due to divarication. Apex situated at about the anterior third to subcentral; almost always eroded, so that the sculpture is only distinct on the lower half of the older shells. Margin entire or feebly denticulate; very irregular in some specimens, due to their station. The coloration of the outside is constantly greenish, the interstices between the ribs brownish. The spatula is distinctly marked, of a pinkish colour; below is a darker shade of pink; the margin is white, marked with bluish-black lines corresponding to the interstices between the ribs. This coloration is almost constant: in some the spatula is whitish or yellowish-white or rarely spotted with black; below is rarely spotted with black.

Measurements of a fair specimen are: Length, 13 mm.; breadth, 9 mm; height, 6 mm.

Hab.—On rocks, almost at high-tide mark: Lyttelton Harbour (type); Taylor's Mistake Bay; Shag Point, Otago; Otago Peninsula.

Type to be presented to the Canterbury Museum, Christchurch.

This species is closely allied to *A. stella*, Lesson, and *A. stella corticata*, Hutton, with which species it would appear to have been previously confounded. It differs from the latter in shape, being elongately parallel-sided: the ribs are lower and more regular; the margin is almost entire. It is a much thinner shell, the inside coloration is fairly constant, and I have met with no specimens covered with nullipores.

I have specimens of some more *Acmæas* which I cannot assign to any known species, even allowing for the variability of members of this genus. These I hope to work out later on.

Helcioniscus stelliferus (Gmelin).

Helcioniscus stelliferus (Gmelin), Suter, Proc. Mal. Soc., vol. vi, p. 350, 1905.

Having found live young specimens of this species, I may add that the live shell is, as would be naturally supposed, very different in coloration from the dead shell. Living on the rocks at low water, constantly exposed to heavy swells, these specimens were very depressed, and difficult to detach.

They are blackish on the outside, and bluish-black, iridescent, inside. Upon holding them up to the light they are seen to show blood-red, as the dead shells do.

Helcioniscus tramosericus (Martyn).

Helcioniscus tramosericus (Martyn), Suter, Proc. Mal. Soc., vol. vi, p. 346, 1905.

In my list of molluscs collected in Otago I have included this species with a (?) after it. The specimens referred to were collected as a variety of *radians* showing the coloration of *tramosericus*. Owing to the hot weather, no animals were preserved.

Upon comparing the shells with New South Wales specimens of *tramosericus* it was seen that these shells could not be differentiated from conchological characters alone. As my shells may be either *radians* or *tramosericus*, it would tend to show that unless the animals are examined New Zealand records of *tramosericus* must still remain doubtful.

Schismope brevis (Hedley).

Schismope brevis, Hedley, Rec. Austr. Museum, vol. v, p. 90, fig. 16 in text, 1904.

This species was described from dead shells from Lyall Bay, near Wellington, New Zealand. The colour was given as white, and the figures show a turbinate strongly sculptured shell.

Live shells from Lyttelton Harbour are cream-coloured, young ones very commonly brownish. The sculpture is weaker than in typical examples, the spirals being almost as prominent as the longitudinal ribs.

Schismope brevis levigata, n. subsp.

This subspecies differs from the type in the degree of sculpture. At first sight this would appear a very different shell, but when closely examined the sculpture is seen to be the same: the longitudinal ribs have greatly deteriorated in strength, whilst the spirals have gained: the last whorl descends much more rapidly than in typical *brevis*, whilst the earlier whorls are smaller. This combination gives an entirely different appearance to the shell, which is further strengthened by the fact that the fasciole is very little longer than the foramen. Operculum thin, horny, multispiral. Colour cream; dead shells pure-white.

Measurement of a large specimen the same as the type of *S. brevis*, Hedley.

Type to be presented to the Canterbury Museum, Christchurch.

Hab.—Sandfly Bay, Otago Peninsula (type); Lyall Bay, near Wellington (dead shells).

Incisura lytteltonensis (E. A. Smith).

Scissurella lytteltonensis, Smith, Proc. Mal. Soc., vol. i, p. 57, pl. vii, figs. 1–2, 1894. *Incisura lytteltonensis* (Smith), Hedley, Rec. Austr. Museum, vol. v, p. 91, fig. 18 in text, 1904.

These two papers cover all that is on record about this species, and as these are at variance, though both accurate, it is best to at once reconcile them. Smith noted as a peculiarity the presence of colour in the shell. Hedley wrote, "None of a considerable series of *Incisura lytteltonensis*, Smith, before me present any trace of colour. The character" (rosea vel albida) "attributed to that species in the original description was, perhaps, derived from examples of *S. rosea.*"

Smith was correct in noting the coloration of the shell, as he was studying *live* shells: these show distinctly rose-coloured. Dead shells, which, I believe, were all Hedley had, are just as constantly colourless. *Scissurella rosea*, Hedley, which Hedley surmised Smith might have confused with *I. lytteltonensis*, Smith, does not occur in Lyttelton Harbour, where the latter is common, and whence it was described. Hedley further writes, "From the shell-characters of *Incisura* I deduce it to be, if not sessile, yet of sluggish habits."

This species lives on a species of *Cystophora*, and is certainly neither sessile nor sluggish. Three specimens I had under observation moved about very rapidly, being as active as any mollusc I have noted.

Photinula decepta, n. sp.

Shell small, globosely conoidal, imperforate, thin, fragile, whorls 5, spire very short, last whorl very large, rapidly descending, apparently smooth. Sculpture: Very finely spirally striated, 30 striations being counted on the penultimate whorl, obscured on last whorl by growth-lines. Colour variable; typical; the two apical whorls white or pinkish-white; on the third whorl 2 purplish bands equidistant from the sutures arise; the fourth whorl is wholly purplish-black, as is the last whorl. In some shells these bands persist on to the last 2 whorls, additional bands arising so that on the last whorl 5 distinct bands can be counted; rarely additional minute bands can be seen between these principal bands. In some cases the purple on the last whorl breaks up into irregular dashes.

The Shag Point shells are mostly light-coloured: some have almost a white ground-colour, with 5 separate distant bands; others have a pinkish ground-colour, with darker markings between the principal bands; whilst in some the bands on the last whorl are broken up into dots. Sutures distinctly marked. Columella subvertical, semicurved, expanding as a callus over the umbilicus. Aperture large, round, outer lip thin, edged with a thin band of white, inside iridescent.

Altitude, 13 mm.; diameter, 12 mm. Altitude, 11 mm.; diameter, 11 mm.

Type to be presented to the Canterbury Museum, Christchurch.

Hab.—Sandfly Bay, Otago Peninsula (type); near Cape Saunders, Otago Peninsula (syntype); Shag Point, Otago (syntype).

Cyclostrema corulum (Hutton).

Scalaria corulum, Hutton, Trans. N.Z. Inst., vol. xvii, p. 322, 1884 (1885); Pliocene Mollusca of N.Z., in Macleay Mem.

Vol., p. 67, pl. viii, fig. 72, 1893. *Scala corulum*, Hutton, Suter, Trans. N.Z. Inst., vol. xxxix, p. 267, 1906 (1907).

I have found this species not uncommon in shell-sand from Lyall Bay, near Wellington; Titahi Bay shell-sand also showed it; whilst I have one specimen from seaweed-washings from Taylor's Mistake Bay, near Sumner. It is a very fragile shell, and the majority of the specimens noted are imperfect. Having carefully compared specimens, there is no doubt it is congeneric with *Cyclostrema angeli*, Ten.-Woods, and for the present the best location is in the genus *Cyclostrema*.

Rissoa emarginata, Hutton.

Rissoa emarginata, Hutton, Trans. N.Z. Inst., vol. xvii, p. 320, 1884 (1885); Pliocene Mollusca of N.Z., in Macleay Mem. Vol., 1893, p. 65, pl. viii, fig. 68.

This peculiar little shell is an addition to the list of Pliocene fossils found recently. I have found it in shell-sand from Purau, Lyttelton Harbour; in shell-sand from Lyall Bay, near Wellington; and Queen Charlotte Sound, 30 fathoms. From the description and figure, the shell recently described as *Rissoina parvilirata*, Suter (Trans. N.Z. Inst., vol. xxxix, p. 257, pl. ix, fig. 5, 1906 [1907]) would appear to be its nearest ally, if not identical.

Cominella costata (Quoy and Gaimard).

Buccinum costatum, Quoy and Gaimard, Voy. "Astrolabe," Zool., vol. ii, p. 417, pl. xxx, figs. 17–20 (1833).

This species has only recently been re-recorded from New Zealand; locality unknown: Suter, Trans. N.Z. Inst., vol. xxxviii, p. 330, 1905 (1906). Collecting at Shag Point, Otago, I found a dead specimen of this shell.

Siphonalia valedicta (Watson).

Fusus valedictus, Watson, Rep. Scient. Results "Challenger," Zool., vol. xv, p. 201, pl. xvii, fig. 7, 1886. *Siphonalia mandarina*, Duclos, var. *valedicta*, Watson, Index Faunæ N.Z., p. 72, 1904.

The type specimen was dredged in 275 fathoms, 200 miles west of Cape Farewell, New Zealand. I do not know whether it has been since found. If it has not, the finding of a dead shell on the south coast of Otago Peninsula must be of interest. My specimen has the apical whorls missing, and the outer lip is broken. Having collected numbers of *S. mandarina*, Duclos, in all stages of growth, it appears to me that this shell is worthy of full specific rank, as Watson gave it.

Cæcum digitulum, Hedley.

Cæcum digitulum, Hedley, Rec. Austr. Museum, vol. v, p. 94, fig. 21 in text, 1904.

It may be of interest to record the station of this species, especially as all the records I can trace of this genus refer either to dredged specimens or dead shells from shell-sand.

In Lyttelton Harbour, under stones at high-water mark, this species is common. Associated with it is *Leuconopsis obsoleta*, Hutton. There lives also a small bivalve which I have not yet satisfactorily identified. The apparent reason of these shells having been previously overlooked is their minute size. These shells rarely occur in shell-sand, perhaps on account of their station being almost beyond the limit of the force of the tides. If this conclusion be correct, may not *Cæcum amputatum*, Hedley, and *Cæcum lilianum*, Hedley, perhaps live on a similar station?

Specimens of *Cæcum digitulum*, Hedley, occur almost half as long again as typical examples, and these specimens are much more curved. Upon microscopic examination the length appears to be due to a new growth of shell, owing to a fracture. The majority of shells, also, do not taper as rapidly as Hedley's description would imply, nor as his figure shows.

Trophon pusillus, Suter.

Trophon pusillus, Suter, Trans. N.Z. Inst., vol. xxxix, p. 253, 1906 (1907).

In shell-sand in Lyttelton Harbour there occurs not uncommonly a small *Trophon*. I could not reconcile it with *Trophon curta*, Murdoch, the only New Zealand *Trophon* of similar size. It was therefore with pleasure that I read the description of the shell as above. The majority of dead shells have the apical whorls missing and the sculpture worn, so that the axial striation is almost unrecognisable. However, I had also found live shells under stones, and these answered perfectly to Suter's figure and details. As the outer lip of his specimens is stated to have been broken, I may add that in the adult shell there are half a dozen well-developed teeth inside the outer lip.

Limacina australis (Eydoux and Souleyet).

Spiralis australis, Eydoux and Souleyet, "Description sommaire de quelques Pteropodes nouveaux ou imparfaitement connus," "Revue Zoologique," t. iii, p. 237, 1840. *Limacina australis* (Eydoux and Souleyet), Pelseneer, Rep. Results "Challenger," Zool., vol. xxiii, p. 25, pl. i, fig. 6, 1888.

From shell-sand from Lyall Bay, near Wellington, I sorted out a minute mollusc, which Mr. Hedley has identified for me as above, with the remark, "This is a most important discovery."

This record adds a genus as well as a species to the New Zealand molluscan fauna.

Pyrene paxillus (Murdoch).

Columbella paxillus, Murdoch, Trans. N.Z. Inst., vol. xxxvii, p. 224, 1904 (1905).

This shell is not uncommon alive under dirty stones in Lyttelton Harbour. I had differentiated it from the dark form of *Pyrene choava*, Reeve, by means of its operculum before I read Murdoch's description. It is furnished with a large operculum, and as *Pyrene transitans*, Murdoch, and *Pyrene huttoni*, Suter, are closely allied conchologically, they most probably also possess such an appendage.

Under dirty stones in Lyttelton Harbour there occurs another *Pyrene*. This I had intended to describe, but I have just received Hedley's "Mollusca of Masthead Reef, Capricorn Group, Queensland" (Proc. Linn. Soc. N.S.W., vol. xxxii, p. 510). In it he describes a shell as *Pyrene lurida*, Hedley. My shell agrees very well with the description and figure, but without comparison of specimens it would be unwise to attach the New Zealand shell to that species.

Recently I have found specimens of *Pyrene choava*, Reeve, paired, and in each instance a dark shell was mated with a light one. It may be that the change of coloration in this species is a sexual characteristic.

Since writing the preceding I have found numbers of *Pyrene huttoni*, Suter, at Shag Point, Otago, and on the Otago Peninsula, and note that this species is possessed of an operculum similar to that of *P. paxillus*, Murdoch.

Leuconopsis obsoleta (Hutton).

Leuconia obsoleta, Hutton, Journ. de Conch., vol. xxvi, p. 42, 1878; Man. N.Z. Moll., p. 34, 1880. *Leuconopsis obsoleta*, Hutton, Trans. N.Z. Inst., vol. xvi, p. 213, 1883 (1884); Hedley, Proc. Linn. Soc. N.S.W., vol. xxv, pl. xlviii, fig. 16, 1900.

This shell would appear to be rare; from north of Auckland and Auckland are the only published records of its occurrence. The finding of a species of *Leuconopsis* under stones at high-water mark in Lyttelton Harbour was therefore interesting, but had been anticipated by the occurrence of odd shells in seaweed-washings. These shells did not fully agree with the diagnoses and drawings of *L. obsoleta*, Hutton, nor with one Auckland shell of that species I examined. As Webster (Trans.

N.Z. Inst., vol. xxxvii, p. 280, 1904 [1905]) had recorded *L. inermis*, Hedley, from Takapuna, I sent one of my shells to Mr. Hedley for his determination. His answer was, "Not *inermis*, but perhaps a variant of *obsoleta*."

In order to settle the specific identity, I collected a good number of shells from different parts of Lyttelton Harbour. A critical examination of this series results as follows: The shell is very variable in size and shape, some shells being almost globular, with the spire-whorls very compressed; others are elongated and narrow, with the spire-whorls lengthened. The spiral striation may be very distinct, indistinct, or almost indistinguishable on account of the abrasions to which this shell is very subject. The apex of the shell may appear either on the left or on the right, or almost central. The teeth on the inner lip may both be very prominent, or the anterior one may be almost suppressed.

My conclusion is that only one species of *Leuconopsis* should be recognised, and that that should be *L. obsoleta*, Hutton. I feel certain the examination of a larger series from Takapuna will induce Webster to withdraw his record of *L. inermis*, Hedley. The improbability of a Sydney species of a genus such as the one in question occurring in New Zealand certainly demands a reinvestigation of this record. In view of my experience of the extreme variability of *L. obsoleta*, Hutton, it is very possible that the two species described by Gatliff (Vict. Naturalist, vol. xxii, pp. 12–13, 1905) would be united were a longer series studied. I have found the position of the apex, which Gatliff lays stress upon, very inconstant in the New Zealand shell.

Collecting at Shag Point, Otago, I made a special search for *L. obsoleta*, Hutton, and was rewarded by finding it as abundantly as in Lyttelton Harbour, and as variable. That the species is commonly distributed throughout New Zealand the additional localities whence I have dead shells from shell-sand would show—Blind Bay, Nelson; Titahi Bay, near Wellington; and Lyall Bay, near Wellington. From practical knowledge I can assert that this species could be very easily collected alive at any of these localities.

Modiolarca pusilla (Gould).

Modiolarca pusilla (Gould), E. A. Smith, Proc. Mal. Soc., vol. iii, p. 24, 1898.

In the paper quoted, this species was first recorded as a New Zealand shell. As, however, the specimens referred to Macquarie Island, the farthermost limit of the New Zealand region, the occurrence of this shell on the New Zealand mainland is notable.

Last Christmas (1906), collecting on the south side of Cape Saunders, Otago Peninsula, I obtained numerous specimens of a *Modiolarca* on a species of *Cystophora*, in a rock-pool. These have been named for me as above by Mr. Suter.

This is the first record of any species of this genus from the mainland of New Zealand.

Modiolarca minutissima, n. sp.

Shell very small for the genus, thin, fragile, subtriangular, almost equilateral, equivalve, ventricose. Colour uniform brownish-red. Sculpture: None save growth-lines. Anterior margin rounded; posterior obtusely angled; ventral margin curved. Lunule slightly excavate. Umbones central, very prominent. There appear to be two small teeth in each valve.

Length, 2 mm.; height, 2 mm.; depth of conjoined valves, 1·5 mm.

Hab.—Near Cape Saunders, Otago Peninsula.

Type to be presented to the Canterbury Museum, Christchurch.

This first occurred as odd specimens among stones between tide-marks. It was later on found in thousands on seaweed-stalks, almost at low tide. It is very easily separated from the other species of this genus by its small size and shape.

EXPLANATION OF PLATE XXXI.

Fig. 1. Six-valved *Plaxiphora ovata*, Hutton.
Fig. 2. Five-valved *Chiton pellis-serpentis*, Q. and G.

ART. XXXVII.—*A Preliminary List of the Marine* Mollusca *of Banks Peninsula, New Zealand.*

By TOM IREDALE.

[*Read before the Philosophical Institute of Canterbury, 6th November*, 1907.]

AT present the "Manual of the New Zealand ***Mollusca***," by Captain Hutton, published in 1880, is the only complete catalogue of the New Zealand ***Mollusca*** in existence. In the introduction to the Manual Captain Hutton wrote, "Much still remains to be done towards working out the geographical distribution of the species; and lists would be particularly valuable from Napier, Taranaki, Wellington, Nelson, Hokitika, and Banks Peninsula." Up to the present no one has taken that advice to heart as regards the locality under notice. As the

Government has now authorised the preparation of a new Manual, I feel it incumbent upon me to endeavour to fill this lack, even in an imperfect manner.

Between 1880 and 1886 Captain Hutton wrote a good deal upon the New Zealand *Mollusca*, and, living in Christchurch, some of his work relates to Banks Peninsula molluscs. Since then Mr. Suter has recorded some species from this locality. I can trace no other recent workers.

Upon looking at the map, Banks Peninsula can be seen as a compact rocky peninsula bounded both on the north and south by extensive sandy beaches. It is cut into by deep bays, which are very possibly rich in marine molluscs. These bays, however, are very difficult of access from Christchurch.

As a matter of fact, the bulk of these records refer to Lyttelton Harbour and Taylor's Mistake Bay; inasmuch, however, as on the few occasions on which I have collected at other places on the peninsula molluscs that had previously occurred to me very rarely turned up commonly, I have deemed it best to cover the ground by using the more comprehensive title. It may be as well to note that I have included records from the New Brighton Beach: though, strictly speaking, this may not be termed a part of Banks Peninsula, as it is most accessible from Christchurch it has been most thoroughly searched. It is tolerably certain, however, that every species that has been found on the New Brighton Beach could be found on the other beaches of the peninsula, were they as carefully searched.

Some few molluscs have been recorded from this locality which, at the time of writing, I had not been fortunate in finding. In order to make this contribution as useful as possible, I have incorporated these records, in each instance acknowledging the authority. I have also included molluscs known as estuarine, and which some malacologists dissociate from marine lists. As, however, these are found whilst searching for marine forms, and occur under the same stone as undoubted marine molluscs, I consider this is the correct place to record them.

Against each mollusc I have noted the station where I have commonly found it living. These remarks, of course, give only a general idea of the station frequented by the mollusc. The majority of molluscs being active creatures, specimens are often found on stations foreign to their general habits.

I have adopted Pelseneer's classification, as laid down in vol. v of "A Treatise on Zoology," because the new Manual now in preparation by Mr. Suter is following that plan. Having compiled this catalogue with a view to economy of space, consistent with thoroughness, I have noted orders and their families only, except in the case of the order *Opisthobranchia*, where I have differentiated between the suborders *Tectibranchia* and *Nudibranchia*—for the reason that of the latter I have collected at least twenty distinct species, but, as they have not yet been thoroughly studied, I have only included ten identifications already on record, and noted the remaining as "ten other distinct species."

As regards specific nomenclature, I have followed the "Index Faunæ Novæ-Zealandiæ," such corrections by Hedley and Suter as have come under my notice having been included.

As author of this paper, I have used throughout the singular pronoun. I wish here to acknowledge, however, in justice to my friend Mr. W. R. Brook Oliver, that many of the rarest finds have been made by him. As he usually accompanied me on my collecting trips, it was mere chance to whose lot happened the find.

Class AMPHINEURA.

Order POLYPLACOPHORA.

Fam. LEPIDOPLEURIDÆ.

Lepidopleurus inquinatus, Reeve.

Rarely met with in the littoral zone; dredged in numbers in shallow water on *Turritella rosea*, Q. and G.

Fam. ISCHNOCHITONIDÆ.

Ischnochiton longicymba, Q. and G.

Abundant under stones between tide-marks.

Ischnochiton fulvus, Suter.

Dredged with *L. inquinatus*, Reeve.

Fam. MOPALIIDÆ.

Plaxiphora biramosa, Q. and G.

Not uncommon on kelp-covered rocks at low-water mark.

Plaxiphora cœlata, Reeve.

Common on rocks between tide-marks, also in roots of kelp.

Plaxiphora suteri, Pilsbry.

With *P. biramosa*, Q. and G., but much more plentiful.

Plaxiphora ovata, Hutton.

Have only met with this *Chiton* in the roots of *Durvillea utilis*, where it is not uncommon.

Fam. ACANTHOCHITIDÆ.

Acanthochites porosus, Burrow.

Not uncommon on rocks about low-water mark.

Acanthochites zelandicus, Q. and G.

Common anywhere between tide-marks, under stones.

Fam. Chitonidæ.

Chiton pellis-serpentis, Q. and G.
Abundant anywhere on rocks between tide-marks.

Chiton sinclairi, Gray.
Under stones and on rocks near low water.

Chiton quoyi, Deshayes.
Abundant under stones between tide-marks

Chiton ærcus, Reeve.
Not uncommon under stones in deep rock-pools, also under stones below low water.

Chiton stangeri, Reeve.
Mr. Suter found one specimen; I have found two in rock-pools. A very rare *Chiton*.

Eudoxochiton nobilis, Gray.
Rare; on rocks below low-water mark.

Eudoxochiton huttoni, Pilsbry.
Only one specimen has been as yet found.

Onithochiton undulatus, Q. and G.
Not uncommon on rocks at low water; common in kelp-roots.

Class GASTROPODA.

Order ASPIDOBRANCHIA.

Fam. Acmæidæ.

Acmæa fragilis, Chemnitz.
On stones between tide-marks; very local.

Acmæa pileopsis, Q. and G.
Rare; only met with above high-water mark.

Acmæa cingulata, Hutton.
rubiginosa, Hutton.
Associated together on shells of *Haliotis iris*, Martyn.

Acmæa stella, Lesson.
stella corticata, Hutton.
Commonly met with on rocks between tide-marks.

Acmæa pseudocorticata, Iredale.
Not uncommon on rocks about high-water mark.

Acmæa septiformis, Q. and G.
Under stones in Heathcote Estuary.

Acmæa dædala, Suter.
Common; the green tessellated shell most frequent.

Acmæa parviconoidea, Suter.
Common on rocks near high-water mark.

Acmæa parviconoidea leucoma, Suter
Under stones in Heathcote Estuary; rare.

Acmæa parviconoidea nigrostella, Suter.
Dead shells in shell-sand; rarely met with alive in seaweed-washings.

Fam. Patellidæ.

Helcioniscus radians, Gmel.
radians argentea, Q. and G.
radians decora, Philippi.
radians earlii, Reeve.
radians affinis, Reeve.
radians olivacea, Hutton.
These all occur, the various subspecies being of local distribution.

Helcioniscus stelliferus, Gmelin.
stelliferus phymatia, Suter.
Dead shells not uncommon. I have found live shells of the former on rocks below low-water mark.

Helcioniscus ornatus, Dillwyn.
ornatus inconspicuus, Gray.
Abundant on rocks.

Helcioniscus redimiculum, Reeve.
strigilis, Hombr. and Jacq.
Our rarest limpets, in my experience.

Fam. Pleurotomariidæ.

Scissurella rosea, Hedley.
I have only as yet met with three dead shells—two in shell-sand, one in seaweed-washings.

Schismope brevis, Hedley.
Live shells not uncommon in seaweed-washings.

Fam. Haliotidæ.

Haliotis iris, Martyn.
Common about low-water mark.

Haliotis australis, Gmelin.
Lives in deeper water than *iris*, consequently more rarely met with

Haliotis virginea, Gmelin.
Have as yet only met with two specimens, in a deep rock-pool.

Fam. Fissurellidæ.

Emarginula striatula, Quoy and Gaimard.
Suter records this in Trans. N.Z. Inst., vol. xxx, p. 326.

Subemarginula intermedia, Reeve
Dead shells in shell-sand.

Incisura lytteltonensis, E. A. Smith.
Not uncommon in seaweed-washings. Lives on *Cystophora*, sp.

Scutum ambiguum, Chemnitz.
Common at low-water mark.

Fam. Trochidæ.

Trochus viridis, Gmelin.
tiaratus, Quoy and Gaimard.
Not uncommon on rocks; more plentiful in summer; *tiaratus* scarcer than *viridis*.

Trochus oppressus, Hutton.
Very rare; under stones in deep rock-pools.

Monodonta æthiops, Gmelin.
atrovirens, Philippi.
nigerrima, Gmelin.
morio, Troschel.
coracina, Troschel.
lugubris, Gmelin.
Abundant; some species local; on and under stones between tide-marks.

Monodonta corrosa, A. Adams.
corrosa undulosa, A. Adams.
corrosa plumbea, Hutton.
Live together on mud-flats.

Cantharidus purpuratus, Martyn.
purpuratus texturatus, Gould.
Rarely met with; stragglers on rocks at low water.

Cantharidus tenebrosus, A. Adams.
tenebrosus huttoni, E. A. Smith.
Abundant on seaweeds; the latter on *Zostera* beds.

Cantharidus pupillus, Hutton.
dilatatus, Sowerby.
On seaweeds in rock-pools; the latter scarcer; the former also found in roots of *Durvillea*.

Gibbula nitida, Adams and Angas.
suteri, E. A. Smith.
On seaweeds in rock-pools; the latter much the commoner; both rarer than the two preceding.

Calliostoma punctulatum, Martyn.
In crevices of rocks just above low-water mark.

Ethalia zelandica, Hombron and Jacquinot.
Dead shells on sandy beaches.

Fam. LIOTIIDÆ.

Liotia polypleura, Hedley.
Not uncommon in seaweed-washings; live shells.

Fam. CYCLOSTREMATIDÆ.

Cyclostrema corulum, Hutton.
lissa, Suter.

Fam. TURBINIDÆ.

Turbo smaragdus, Martyn.
smaragdus tricostatus, Hutton.
Common on rocky shores, between tide-marks.

Turbo granosus, Martyn.
One specimen in Canterbury Museum, from Lyttelton.

Astralium sulcatum, Martyn.
Not common alive on rocks; dead shells on beaches adjacent.

Astralium su'catum davisii, Stowe.
Have only met with two dead shells.

Astralium heliotropium, Martyn.
One very young specimen from shell-sand.

Order PECTINIBRANCHIA.

Fam. LITORINIDÆ.

Litorina mauritiana, Lamarck.
cincta, Quoy and Gaimard.
Common on rocks above low tide and also above high water.

Risellopsis varia, Hutton.
varia carinata, Kesteven.
Common; associated with *Litorina*, spp.

Fam. RISSOIDÆ.

Rissoa hamiltoni, Suter.
incidata, Frauenfeld.
fumata, Suter.
zosterophila, Webster.
zosterophila minor, Suter.
cheilostoma, Ten.-Woods.
cheilostoma lyalliana, Suter.
microstriata, Murdoch.
All these were found alive in seaweed-washings.

Rissoa insculpta, Murdoch.
foveauxiana, Suter.
subfusca, Hutton.
subfusca micronema, Suter.
neozelanica, Suter.
emarginata, Hutton.

I have only met with dead shells of these species.

Rissoina rugulosa, Hutton.
agrestis, Webster.

Eatoniella olivacea, Hutton.
olivacea annulata, Hutton.
limbata, Hutton.

I have obtained live shells of all of these from seaweed-washings.

Fam. HYDROBIIDÆ.

Potamopyrgus antipodum, Gray.
spelæus pupoides, Hutton.

Living under stones in brackish water; dead specimens rarely found in shell-sand.

Fam. CERITHIIDÆ.

Cerithiopsis sarissa, Murdoch.

Live shells under dirty stones; also met with in seaweed-washings.

Potamides subcarinatus, Sowerby.

Common in shallow pools at high-water mark.

Potamides bicarinatus, Gray.

In Canterbury Museum, from Lyttelton.

Fam. CÆCIDÆ.

Cæcum digitulum, Hedley.

Common under stones at high-water mark.

Fam. TURRITELLIDÆ.

Turritella rosea, Quoy and Gaimard.
kanieriensis, Harris.

Dead shells common on sandy bays; dredged alive in shallow water.

Fam. STRUTHIOLARIIDÆ.

Struthiolaria papulosa, Martyn.

Dead shells only, on sandy beaches.

Fam. CALYPTRÆIDÆ.

Calyptræa novæ-zelandiæ, Lesson.
Common under dirty stones.

Calyptræa scutum, Lesson.
Only dredged on shells in shallow water.

Crepidula crepidula, Linné.
Have only met with a few young specimens, on shells washed up.

Fam. IANTHINIDÆ.

Ianthina exigua, Lamarck.
One shell, from shell-sand off a sandy beach.

Fam. PYRAMIDELLIDÆ.

Odostomia impolita, Hutton.
vestalis, Murdoch.
proxima, Murdoch.
marginata, Murdoch and Suter.
(Two other species.)

Pyrgulina rugata, Hutton.

Turbonilla zealandica, Hutton.
sp. nov.

Eulimella deplexa, Hutton.
cœna, Webster.

Occurring in shell-sand and dredgings. Live specimens of *Odostomia impolita*, Hutton, and *Turbonilla zealandica*, Hutton, found under dirty stones.

Fam. MITRIDÆ.

Vulpecula rubiginosa, Hutton.
Live shells not uncommon under dirty stones, dead shells in shell-sand.

Fam. BUCCINIDÆ.

Siphonalia mandarina, Duclos.
Not uncommon in shallow water; live shells rarely met with above low water, in crevices of rocks.

Siphonalia nodosa, Martyn.
Have only met with dead shells so far.

Cominella maculosa, Martyn.
Common on rocky shores, between tide-marks.

Cominella lurida, Philippi.
Common on mud-flats.

Euthria lineata, Martyn.
lineata pertinax, Von Martens.
vittata, Quoy and Gaimard.
antarctica, Reeve.
littorinoides, Reeve.
striata, Hutton.

All occur under stones between tide-marks; some of local distribution.

Fam. Muricidæ.

Trophon ambiguus, Philippi.

Common in shallow water in Purau Bay; very rarely found otherwise.

Kalydon duodecimus, Gray.
plebeius, Hutton.
paivæ, Crosse.
inferus, Hutton.
pusillus, Suter.

Under stones in rock-pools; under dirty stones below low-tide mark: all of local distribution.

Fam. Purpuridæ.

Thais haustrum, Martyn.

Common on rocky shores.

Thais striata, Martyn.
striata squamata, Hutton.

Common under stones near low-water mark.

Thais scobina albomarginata, Deshayes.
scobina rutila, Suter.

Common on rocks about high-tide mark; *rutila* very local.

Fam. Columbellidæ.

Pyrene choava, Reeve.
paxillus, Murdoch.

Live shells not uncommon under dirty stones.

Fam. Volutidæ.

Scaphella arabica, Martyn.
arabica elongata, Swainson.

Live shells in shallow water; dead shells on sandy beaches.

Fam. Olividæ.

Ancilla australis, Sowerby.

Specimens in Canterbury Museum from Lyttelton.

Ancilla rubiginosa, Swainson.
Suter records this from near Sumner (Trans. N.Z. Inst., vol. xxxviii, p. 332).

Ancilla depressa, Sowerby.
One dead shell, which agrees exactly with specimens from the North Island.

Fam. PLEUROTOMATIDÆ.

Mangilia sinclairi. E. A. Smith.
Live shells dredged in shallow water.

(Three other species.)
Young specimens from shell-sand.

Fam. TEREBRIDÆ.

Terebra tristis, Deshayes.
Have only met with dead shells so far.

Order OPISTHOBRANCHIA.

Suborder TECTIBRANCHIA.

Fam. PHILINIDÆ.

Philine aperta, Linné.
One shell, dredged in shallow water; muddy bottom.

Fam. APLYSIIDÆ.

Tethys venosa, Hutton.
Specimen in Canterbury Museum from Sumner.

Suborder NUDIBRANCHIA.

Doris longula, Abraham.
Canterbury Museum.

Archidoris wellingtonensis, Abraham.
Canterbury Museum.

Alloiodoris lanuginata, Abraham.
Canterbury Museum.

Cratena corfei, Hutton.
Trans. N.Z. Inst., vol. xiii, p. 203.

Stiliger felinus, Hutton.
Trans. N.Z. Inst., vol. xv, p. 133.

Æolis leptosoma, Hutton.
Trans. N.Z. Inst., vol. xvi, p. 213.

Goniodoris punctata, Bergh.
Proc. Mal. Soc., vol. vii, p. 349.

Fiona marina, Forskal.
Trans. N.Z. Inst., vol. xxx, p. 326.

Æolis gracilis, T. W. Kirk.
Trans. N.Z. Inst., vol. xv, p. 217.

Chromodoris aureomarginata, Cheeseman.
Trans. N.Z. Inst., vol. xiii, p. 203.

(Ten other distinct species.)

Order PULMONATA.

Fam. Auriculidæ.

Marinula filholi, Hutton.
One dead shell from shell-sand.

Leuconopsis obsoleta, Hutton.
Common under stones at high water.

Fam. Amphibolidæ.

Amphibola crenata, Martyn.
Abundant on mud-flats.

Fam. Siphonariidæ.

Siphonaria obliquata, Sowerby.
On rocks about high-water mark; abundant.

Siphonaria australis, Quoy and Gaimard.
zealandica, Quoy and Gaimard.
Both species common; on rocks between tide-marks and on seaweeds in rock-pools.

Fam. Gadiniidæ.

Gadinia nivea, Hutton.
On rocks about high-water mark; rare.

Fam. Oncidiidæ.

Onchidella patelloides, Quoy and Gaimard.
nigricans, Quoy and Gaimard.
Common on rocks about high-water mark.

Class LAMELLIBRANCHIA.

Order PROTOBRANCHIA.

Fam. Solenomyidæ.

Solenomya parkinsoni, E. A. Smith.
Have only met with dead shells.

Fam. Nuculidæ.

Nucula nitidula, A. Adams.
lacunosa, Hutton.
Have dredged live shells in shallow water.

Order FILIBRANCHIA.

Fam. ARCIDÆ.

Philobrya costata, Bernard.
Commonly occurring in seaweed - washings : in clusters under dirty stones between tide-marks.

Philobrya filholi, Bernard.
One specimen in seaweed-washings.

Philobrya meleagrina, Bernard.
Valves in shell-sand.

Hochstetteria trapezina, Bernard.
Not uncommon in seaweed-washings.

Fam. MYTILIDÆ.

Mytilus edulis, Linné.
canaliculus, Martyn.
magellanicus, Chemnitz.
All common between tide-marks ; the last named scarce.

Modiolus australis, Gray.
Have only met with one live specimen, washed up after a storm.

Modiolus ater, Frauenfeld.
Abundant between tide-marks.

Modiolaria impacta, Hermannsen.
Not uncommon ; in crevices of rocks, and commensal with *Ascidians*.

Lithophaga truncata, Gray.
Have only met with dead shells.

Fam. PECTINIDÆ.

Pecten medius, Lamarck.
Dead shells on beaches only as yet.

Chlamys radiatus, Hutton.
One valve found on a sandy beach.

Chlamys zelandiæ, Gray.
gemmulatus, Reeve.
Valves on beaches ; young live specimens attached by a byssus to stones in rock-pools.

Order EULAMELLIBRANCHIA.

Fam. OSTREIDÆ.

Ostræa angasi, Sowerby.
Live shells sometimes met with cast up after storms.

Ostræa reniformis, Sowerby.
Common on rocks about low-tide mark.

Ostræa purpurea, Hanley.
Specimen in Canterbury Museum from Lyttelton.

Fam. PINNIDÆ.

Pinna zelandica, Gray.
Live shells dredged in shallow water; dead shells on beaches.

Fam. CARDITIDÆ.

Cardita calyculata, Linné.
Young specimens in seaweed-washings and roots of *Durvillea*.

Verticipronus mytilus, Hedley.
Valves in seaweed-washings.

Fam. CONDYLOCARDIIDÆ.

Condylocardia crassicosta, Bernard.
One live specimen from seaweed-washings.

Fam. LUCINIDÆ.

Divaricella cumingi, Adams and Augas.
cumingi huttoni, Vanatta.
Dead shells very rarely met with on beaches.

Fam. UNGULINIDÆ.

Diplodonta globularis, Lamarck
zelandica, Gray.
striata, Hutton.
Have only met with dead shells so far.

Fam. LEPTONIDÆ.

Kellia suborbicularis, Montagu.
Have only met with dead shells.

Lasea miliaris, Philippi.
Common in seaweed-washings.

Fam. CYCLADIDÆ.

Corneocyclas aucklandica, Suter.
Common under stones in brackish water.

Fam. TELLINIDÆ.

Tellina alba, Quoy and Gaimard.
Shells not uncommon on sandy beaches.

Tellina lactea, Q. and G.
Dead shells not uncommon; lives on a muddy bottom; live specimens common.

Tellina glabrella, Deshayes.
Dredged valves; muddy bottom.

Tellina disculus, Deshayes.
Dead shells washed up.

Tellina spenceri, Suter.
Dead shells met with after storms; sandy beaches.

Tellina huttoni, E. A. Smith.
Dredged in shallow water; muddy bottom.

Leptomya lintea, Hutton.
Dead shells dredged in shallow water; muddy bottom.

Macoma suteri, E. A. Smith.
Dredged with *T. huttoni*, E. A. Smith.

Fam. MESODESMATIDÆ.

Mesodesma australis, Gmelin.
Atactodea subtriangulata, Gray
Abundant; the former on mud, the latter sand; our commonest bivalves.

Fam. MACTRIDÆ.

Mactra discors, Gray.
æquilatera, Deshayes.
Common; lives below low-water mark on sandy beaches.

Mactra ordinaria, E. A. Smith.
Dredged with *Tellina huttoni*, E. A. Smith.

Standella ovata, Gray.
Dead shells abundant on muddy bottom; have not found live shells.

Resania lanceolata, Gray.

Zenatia acinaces, Quoy and Gaimard.
Lives below low-water mark on sandy beaches; dead shells common.

Fam. VENERIDÆ.

Dosinia subrosea, Gray.
australis, Gray.
Lives with the two preceding.

Dosinia grayi, Zittel.
Have only met with single valves; very rare.

Chione ob'onga, Hanley.
Dead shells rarely met with; one live specimen in a rock-pool.

Chione stutchburyi, Gray.
Abundant on muddy bottom.

Chione costata, Quoy and Gaimard.
Common; lives in sand among stones between tide-marks.

Chione crassa, Quoy and Gaimard.
Have only met with dead shells.

Anaitis yatei, Gray
Live shells washed up on sandy beaches after storms.

Tapes intermedia, Quoy and Gaimard.
Associated with *Chione costata*, Q. and G., but much rarer.

Venerupis siliqua, Deshayes.
reflexa, Gray.
Sp.
Have only met with dead shells.

Fam. CARDIIDÆ.

Protocardia pulchella, Gray.
Specimens in Canterbury Museum marked "Banks Peninsula."

Fam. PSAMMOBIIDÆ.

Psammobia lineolata, Gray.
stangeri, Gray.

Solenotellina siliqua, Reeve.
nitida, Gray.
incerta, Reeve.
May be met with on sandy beaches after heavy seas.

Fam. CORBULIDÆ.

Corbula haastiana, Hutton.
The type-locality is Lyttelton.

Corbula zealandica, Quoy and Gaimard.
Two valves from shell-sand.

Fam. SAXICAVIDÆ.

Saxicava arctica, Linné.
Common; boring in sponges and under roots of *Durvillea*, sp.

Panopæa zelandica, Quoy and Gaimard.
Very rare; dead shells washed up on sandy beaches.

Fam. PHOLADIDÆ.

Barnea similis, Gray.
Have only met with valves so far.

Fam. PERIPLOMIDÆ.

Cochlodesma angasi, Crosse and Fischer.
Rare; live shells sometimes washed up after storms.

Fam. MYOCHANIDÆ.

Myodora striata, Quoy and Gaimard.
Valves dredged in shallow water; rarely met with on sandy beaches.

Myodora pandoriformis, Stutchbury.
Two valves on sandy beaches.

Myodora novæ-zelandiæ, E. A. Smith.
One specimen dredged in shallow water.

Class CEPHALOPODA.

Order DIBRANCHIA.

Fam. SPIRULIDÆ.

Spirula spirula, Linné.
Shells found on sandy beaches.

Fam. OMMATOSTREPHIDÆ.

Todarodes sloanii, Gray.
Specimen from Lyttelton in Canterbury Museum.

Fam. SEPIIDÆ.

Sepia apama, Gray.
In Canterbury Museum.

Fam. OCTOPODIDÆ.

Polypus maorum, Hutton.
Specimen from Lyttelton in Canterbury Museum; not very rare.

Art. XXXVIII.—*List of Marine Molluscs collected in Otago.*

By Tom Iredale.

[*Read before the Philosophical Institute of Canterbury, 11th December,* 1907.]

When I was preparing my list of marine *Mollusca* of Banks Peninsula I thought it would be interesting to compare that fauna with the recorded marine *Mollusca* of Otago. The only compilation I could trace was one prepared by the late Captain Hutton, and included in the "Geology of Otago" by Hutton and Ulrich, published as long ago as 1875. As, owing to nomenclatorial changes, as well as different ideas of specific values, that list is now of little value, I, with my friend Mr. W. R. Brook Oliver, determined to investigate the marine molluscan fauna of Otago Peninsula. The chief reason that prompted us to choose that locality was ease of access. At that time there was no intention of making up a list, but we found the fauna so different, and unexpected molluscs kept turning up to such an extent that I have felt it imperative to record them. We worked up the harbour from Dunedin to Port Chalmers; then at two localities near Cape Saunders—one north of the cape, the other south; thence at Sandfly Bay and the coast between that bay and Ocean Beach. Later on we collected at Shag Point, Otago, with the result that we found the fauna almost identical with that observed on the south coast of Otago Peninsula.

Our collecting was entirely in the littoral zone, and was done very hurriedly; consequently this list can only be regarded as a contribution towards a complete list of this very interesting fauna. One feature especially noticeable is the lack of many certainly common species. To remedy this in some degree I have noted in an addenda to this list such species from Dunedin as are represented in the Otago Museum, together with recent records of rare species I did not meet with. Two species in the Otago Museum I have not included—viz., *Subemarginula rugosa*, Q. and G., and *Monodonta subrostrata*, Gray. I was unable to examine these, but they appear to be doubtful identifications.

The outstanding features of our collecting were the finding of two species of *Modiolarca* and a species of *Photinula;* the abundance of *Chiton æreus*, Reeve; the occurrence of *Callochiton platessa*, Gould; and the refinding of *Cominella costata*, Q. and G., and *Siphonalia valedicta*, Watson.

As in my Banks Peninsula list, I have followed Pelseneer's classification, for the purposes laid down in the preface to that list.

As the collecting was done on the Otago Peninsula and at Shag Point, Otago, I have after each species put "1" or "2," the "1" meaning collected on the Otago Peninsula, and the "2" standing for Shag Point. By this means this list will prove more useful to students of the geographical distribution of the marine *Mollusca* of New Zealand.

In my Banks Peninsula list I have noted the stations whence I obtained living specimens of the molluscs there enumerated. In Otago I collected some molluscs which I had not met with alive on Banks Peninsula.

Some very interesting finds I have elsewhere recorded in detail. Herewith are given details of the stations of some molluscs which appear to be rare alive in the littoral zone:—

Acanthochites violaceus, Q. and G.
Under clean stones in very deep rock-pools only.

Emarginula striatula, Q. and G.
Under dirty stones, with above.

Trochus oppressus, Hutton.
Not uncommon under stones in rock-pools.

Cantharidus opalus, Martyn.
One specimen alive on seaweed in rock-pool.

Turbo granosus, Martyn.
Among seaweed on reef uncovered at very low tide.

Trichotropis inornata, Hutton.
Under dirty stones between tide-marks.

Gyrineum argus, Gmelin.
Eight live specimens in a deep rock-pool.

Barbatia decussata, Sowerby.
One specimen under a dirty stone with preceding.

All the other species I found frequenting the same station as at Banks Peninsula.

Lepidopleurus inquinatus, Reeve. 1, 2.
Ischnochiton longicymba, Q. and G. 1, 2.
fulvus, Suter. 1, 2.
Callochiton platessa, Gould. 2.
Plaxiphora biramosa, Q. and G. 1.
cœlata, Reeve. 1, 2.
suteri, Pilsbry. 1.
ovata, Hutton. 1, 2.

Acanthochites porosus, Burrow. 1, 2.
violaceus, Q. and G. 1, 2.
zelandicus, Q. and G. 1, 2.
Chiton pellis-serpentis, Q. and G. 1, 2.
sinclairi, Gray. 1, 2.
quoyi, Deshayes. 1, 2.
æreus, Reeve. 1, 2.
Onithochiton undulatus, Q. and G. 1, 2.
Acmæa fragilis, Chemnitz. 1, 2.
pileopsis, Q. and G. 1, 2.
septiformis, Q. and G. 1, 2.
cingulata, Hutton. 1, 2.
rubiginosa, Hutton. 2.
stella, Lesson. 1, 2.
stella corticata, Hutton. 1, 2.
dædala, Suter. 1, 2.
dædala subtilis, Suter. 1, 2.
dædala, Suter, var. 2.
parviconoidea, Suter. 1.
parviconoidea leucoma, Suter. 1.
pseudocorticata, Iredale. 1, 2.
Helcioniscus radians, Gmelin. 1, 2.
radians affinis, Reeve. 1, 2.
radians decora, Philippi. 1, 2.
radians olivacea, Hutton. 1, 2.
radians argentea, Q. and G. 1, 2.
tramosericus, Martyn (?). 1, 2.
redimiculum, Reeve. 1, 2.
strigilis, H. and J. 1.
ornatus, Dillwyn. 1, 2.
ornatus inconspicua, Gray. 1, 2.
Schismope brevis levigata, Iredale. 1.
Haliotis iris, Martyn. 1, 2.
australis, Gmelin. 1, 2.
virginea, Gmelin. 1, 2.
Emarginula striatula, Q. and G. 1, 2.
Incisura lyttletonensis, Smith. 2.
Scutum ambiguum, Chemnitz. 1, 2.
Trochus viridis, Gmelin. 1, 2.
tiaratus, Q. and G. 1, 2.
oppressus, Hutton. 2.
Monodonta æthiops, Gmelin. 1, 2.
atrovirens, Philippi. 2.
nigerrima, Gmelin. 1, 2.
coracina, Troschel. 1, 2.
morio, Troschel. 1, 2.

Monodonta lugubris, Gmelin. 1, 2.
corrosa, A. Adams. 1.
corrosa undulosa, A. Adams. 1
Cantharidus purpuratus, Martyn. 1.
opalus, Martyn. 2.
pupillus, Hutton. 1, 2.
rufozonus, A. Adams. 2.
sanguineus, Gray. 2.
tenebrosus, A. Adams. 1, 2.
tenebrosus huttoni, Smith. 1.
Photinula decepta, Iredale. 1, 2.
Gibbula nitida, Adams and Angas. 1, 2.
scamnata, Fischer. 1.
Calliostoma punctulatum, Martyn. 1.
Ethalia zelandica, H. and J. 1.
Liotia polypleura, Hedley. 2.
Turbo smaragdus, Martyn. 1, 2.
smaragdus tricostatus, Hutton. 1, 2.
granosus, Martyn. 2.
Astralium sulcatum, Martyn. 2.
Litorina mauritiana, Lamarck. 1, 2.
cincta, Q. and G. 1, 2.
Risellopsis varia, Hutton. 1, 2.
varia carinata, Kesteven. 1, 2.
Rissoa zosterophila, Webster. 2.
cheilostoma, Ten.-Woods. 2.
foveauxiana, Suter. 1, 2.
insculpta, Murdoch. 2.
rubriglobosa, Iredale. 1.
sinulabrum, Iredale. 1, 2.
inopinata, Iredale. 1, 2.
zosterophila, Webster, var. 2.
Rissoina rugulosa, Hutton. 2.
Eatoniella olivacea, Hutton. 1, 2.
olivacea annulata, Hutton. 1.
Turritella rosea, Q. and G. 1.
kanieriensis, Harris. 1.
Crepidula crepidula, Linné. 2.
Calyptræa novæ-zealandiæ, Lesson. 1, 2.
scutum, Lesson. 1.
Natica zelandica, Q. and G. 1.
Trichotropis inornata, Hutton. 1.
Gyrineum argus, Gmelin. 1.
Odostomia vestalis, Murdoch. 2.
Turbonilla zealandica, Hutton. 1.
Vulpecula rubiginosa, Hutton. 2.

Siphonalia valedicta, Watson. 1.
Cominella maculosa, Martyn. 2.
lurida, Philippi. 1.
costata, Q. and G. 2.
Euthria lineata, Martyn. 1, 2.
vittata, Q. and G. 1, 2.
antarctica, Reeve. 1.
littorinoides, Reeve. 1.
flavescens, Hutton. 1.
Trophon ambiguus, Philippi. 2.
patens, H. and J. 1.
sp. indet. 1.
Kalydon duodecimus, Hutton. 1, 2.
paivæ, Crosse. 1, 2.
plebeius, Hutton. 1.
pusillus, Suter. 1.
Thais striata, Martyn. 1, 2.
striata squamata, Hutton. 1, 2.
scobina albomarginata, Deshayes. 1, 2.
Pyrene choava, Reeve. 1.
transitans, Murdoch. 1.
huttoni, Suter. 1, 2.
Mangilia sinclairi, E. A. Smith. 1, 2.
Marinula filholi, Hutton. 1.
Leuconopsis obsoleta, Hutton. 2.
Amphibola crenata, Martyn. 1.
Siphonaria obliquata, Sowerby. 1, 2.
australis, Q. and G. 1, 2.
zelandica, Q. and G. 1, 2.
Gadinea nivea, Hutton. 1, 2.
Onchidella nigricans, Q. and G. 1, 2.
patelloides, Q. and G. 1, 2.
Nucula lacunosa, Hutton. 1.
Pectunculus striatularis, Lamarck. 1.
Barbatia decussata, Sowerby. 1, 2.
Philobrya costata, Bernard. 1.
Hochstetteria trapezina, Bernard. 1, 2.
Mytilus edulis, Linné. 1.
canaliculus, Martyn. 1.
magellanicus, Chemnitz. 1.
Modiolus australis, Gray. 1.
ater, Frauenfeld. 1.
Modiolaria impacta, Hermannsen. 1.
Chlamys zelandiæ, Gray. 1.
Ostræa angasi, Sowerby. 1.
reniformis, Sowerby. 1.

Modiolarca pusilla, Gould. 1.
minutissima, Iredale. 1.
Cardita calyculata, Linné. 1.
Verticipronus mytilus, Hedley. 1.
Lasea miliaris, Philippi. 1.
Corneocyclas aucklandica, Suter. 1.
Tellina lactea, Q. and G. 1.
alba, Q. and G. 1.
disculus, Deshayes. 1.
Mesodesma australis, Gmelin. 1.
Atactodea subtriangulata, Gray. 1.
Mactra discors, Gray. 1.
æquilatera, Deshayes. 1.
scalpellum, Reeve. 1.
Standella ovata, Gray. 1.
Chione stutchburyi, Gray. 1.
costata, Q. and G. 1, 2.
crassa, Q. and G. 1.
Tapes intermedia, Q. and G. 1, 2.
Venerupis reflexa, Gray. 1, 2.
siliqua, Deshayes. 2.
elegans, Deshayes. 2.
insignis, Deshayes. 2.
Saxicarva arctica, Linné. 1, 2.
Panopea zelandica, Q. and G. 1.
Pholadidea tridens, Gray. 2.
Barnea similis, Gray. 2.
Polypus maorum, Hutton. 1, 2.

In addition, we collected six distinct species of Nudibranchs which have not yet been studied.

ADDENDA.

Chiton huttoni, Suter.
canaliculatus, Q. and G.
Eudoxochiton huttoni, Pilsbry.
Acmæa scapha, Suter.
Trochus oppressus dunedinensis, Suter.
Monodonta corrosa plumbea, Hutton.
Monilea egena, Gould.
Calliostoma selectum, Chemnitz.
Astralium heliotropium, Martyn.
Rissoina parvilirata, Suter.
Turritella pagoda, Reeve.
Struthiolaria papulosa, Martyn.
Seila terebelloides, v. Martens.
Potamides subcarinatus, Sowerby.

Pyrene inconstans, Suter.
Scaphella arabica, Martyn.
Thais haustrum, Martyn.
Trophon stangeri, Gray.
Terebra tristis, Deshayes.
Melanopsis trifasciata, Gray.
Marsenia cerebroides, Hutton.
Tethys brunnea, Hutton.
Solenomya parkinsoni, E. A. Smith.
Modiolus fluviatilis, Hutton.
Venericardia bollonsi, Suter.
Resania lanceolata, Gray.
Solenotellina nitida, Gray.
Neolepton antipodum, Filhol.

Art. XXXIX.—*List of Marine* Mollusca *from Lyall Bay, near Wellington, New Zealand.*

By Tom Iredale and M. K. Mestayer.

[*Read before the Philosophical Institute of Canterbury, 11th December,* 1907.]

The authorship of this list requires explanation. All the larger shells were collected by Miss Mestayer, whilst the minute forms were sorted and identified by Tom Iredale from shell-sand and seaweed-washings collected by Miss Mestayer. Therefore, whilst all the credit for this list is due to Miss Mestayer, all the blame must be undertaken by Tom Iredale, who holds himself responsible for all identifications and errors of nomenclature.

This paper has been prepared with a view to furthering our knowledge of the geographical distribution of the marine *Mollusca* of New Zealand, which at the present time is very imperfect. This is chiefly due to the extent of coast-line and the scarcity of workers.

We have no new records of large shells, as the locality under notice has probably been collected more thoroughly than any other in New Zealand, save, perhaps, some Auckland collecting-ground. The shell-sand, however, is very rich, and has provided a number of new species, though the most interesting find is not a new shell: we refer to the occurrence of *Limacina australis*, Eydoux and Souleyet, details of which are given in another place. Further diligent search in shell-sand will doubtless add many species to this record.

This list is imperfect, inasmuch as we have no Cephalopods nor Nudibranchs to enumerate. It only records species which have occurred in the littoral zone. Nevertheless, we feel it will be a useful contribution, and will act as a basis upon which to work.

The most recent list in existence dealing with the marine *Mollusca* of the Wellington district dates back to 1880.

In order to add to the value of this list, we have noted in an addenda some species on record which we have not yet been fortunate enough to find. As regards classification, we have followed Pelseneer, and as to specific nomenclature we have used the "Index Faunæ Novæ-Zealandiæ," with such later alterations as have come under our notice.

Lepidopleurus inquinatus, Reeve.
Ischnochiton longicymba, Q. and G.
Plaxiphora biramosa, Q. and G.
    cœlata, Reeve.
    suteri, Pilsbry.
    ovata, Hutton.
Acanthochites porosus, Burrow.
    zelandicus, Q. and G.
    violaceus, Q. and G.
Chiton pellis-serpentis, Q. and G.
    sinclairi, Gray.
    quoyi, Deshayes
    quoyi limosa, Suter.
    æreus, Reeve.
    huttoni, Suter.
Eudoxochiton nobilis, Gray.
    huttoni, Pilsbry.
Onithochiton undulatus, Q. and G.
Acmæa cingulata, Hutton.
    fragilis, Chemnitz.
    dædala, Suter.
    stella, Lesson.
    stella corticata, Hutton.
    parviconoidea, Suter.
    parviconoidea nigrostella, Suter.
Helcioniscus radians, Gmelin.
    radians argentea, Q. and G.
    radians earlii, Reeve.
    radians flava, Hutton.
    radians affinis, Reeve.
    denticulatus, Martyn.
    stelliferus, Gmelin.
    ornatus, Dillwyn.
    ornatus inconspicua, Gray.

Scissurella rosea, Hedley.
Schismope brevis, Hedley.
beddomei, Petterd.
Haliotis iris, Martyn.
australis, Gmelin.
virginea, Gmelin.
Emarginula striatula, Q. and G.
Subemarginula intermedia, Reeve.
parmophoidea, Q. and G.
Incisura lytteltonensis, E. A. Smith.
Trochus viridis, Gmelin.
tiaratus, Q. and G.
Monodonta æthiops, Gmelin.
nigerrima, Gmelin.
coracina, Troschel.
lugubris, Gmelin.
Cantharidus purpuratus, Martyn.
opalus, Martyn.
dilatatus, Sowerby.
Gibbula nitida, Adams and Angas.
suteri, E. A. Smith.
Calliostoma tigris, Martyn.
punctulatum, Martyn.
selectum, Chemnitz.
Monilea egena, Gould.
Euchelus bellus, Hutton.
bellus iricolor, T. W. Kirk.
Ethalia zelandica, H. and J.
Liotia polypleura, Hedley.
Cyclostrema corulum, Hutton.
Orbitestella exquisita, Iredale.
Turbo smaragdus, Martyn.
smaragdus tricostatus, Hutton.
granosus, Martyn.
Astralium sulcatum, Martyn.
heliotropium, Martyn.
Litorina mauritiana, Lamarck.
cincta, Q. and G.
Couthouyia corrugata, Hedley.
Rissoia hamiltoni, Suter.
subfusca, Hutton.
subfusca micronema, Suter.
foveauxiana, Suter.
fumata, Suter.
insculpta, Murdoch.
cheilostoma, Ten.-Woods.

Rissoia chcilostoma lyalliana, Suter.
microstriata, Murdoch.
zosterophila, Webster.
zosterophila minor, Suter.
incidata, Frauenfeld.
emarginata, Hutton.
neozelanica, Suter.
Rissoina agrestis, Webster.
rugulosa, Hutton.
Eatoniella olivacea, Hutton.
olivacea annulata, Hutton.
limbata, Hutton.
rosea, Hutton.
Cerithiopsis sarissa, Murdoch.
Potamides subcarinatus, Sowerby.
Cæcum digitulum, Hedley.
Turritella rosea, Q. and G.
Struthiolaria papulosa, Martyn.
Calyptræa novæ-zealandiæ, Lesson.
scutum, Lesson.
Crepidula crepidula, Linné.
Natica zelandica, Q. and G.
Gyrineum argus, Gmelin.
Epitonium philippinarum, Forbes.
Pyrgulina rugata, Hutton.
Turbonilla zealandica, Hutton.
Leiostraca murdochi, Hedley.
Siphonalia nodosa, Martyn.
mandarina, Duclos.
Cominella maculata, Martyn.
maculosa, Martyn.
Euthria lineata, Martyn.
lineata traversi, Hutton.
antarctica, Reeve.
Trophon ambiguus, Phillipi.
Kalydon duodecimus, Hutton.
(*Purpura*) *Thais succinta*, Martyn.
striata, Martyn.
scobina, Q. and G.
scobina albomarginata, Deshayes.
haustrum, Martyn.
Pyrene choava, Reeve.
huttoni, Suter.
Marginella turbinata, Sowerby.
Ancilla australis, Sowerby.
mucronata, Sowerby.

Ancilla pyramidalis, Reeve.
rubiginosa, Swainson.
depressa, Sowerby.
Mangilia sinclairi, E. A. Smith.
epentroma, Murdoch.
Terebra tristis, Deshayes.
Limacina australis, Eydoux and Souleyet.
Pleurobranchus ornatus, Cheeseman.
Marinula filholi, Hutton.
Leuconopsis obsoleta, Hutton.
Siphonaria obliquata, Sowerby.
zelandica, Q. and G.
Gadinia nivea, Hutton.
Solenomya parkinsoni, E. A. Smith.
Nucula lacunosa, Hutton.
Pectunculus laticostata, Q. and G.
striatularis, Lamarck.
Barbatia decussata, Sowerby.
Philobrya meleagrina, Bernard.
costata, Bernard.
filholi, Bernard.
Hochstetteria trapezina, Bernard.
Mytilus edulis, Linné.
canaliculus, Martyn.
magellanicus, Chemnitz.
Modiolus ater, Frauenfeld.
Modiolaria impacta, Hermannsen.
barbata, Reeve.
(*Pecten*) *Chlamys zelandiæ*, Gray.
gemmulatus, Reeve.
Lima bullata, Born.
Ostræa glomerata, Gould.
Pinna zelandica, Gray.
Cardita calyculata, Linné.
Verticipronus mytilus, Hedley.
Kellya suborbicularis, Montagu.
Lasea miliaris, Philippi.
Mylitta stowei, Hutton.
Erycina parva, Deshayes.
Tellina alba, Q. and G.
lactea, Q. and G.
disculus, Deshayes.
Mesodesma australis, Gmelin.
Atactodea subtriangulata, Gray.
Mactra discors, Gray.
æquilatera, Deshayes.

Dosinia subrosea, Gray.
australis, Gray.
Chione oblonga, Hanley.
stutchburyi, Gray.
costata, Q. and G.
crassa, Q. and G.
Tapes intermedia, Q. and G.
fabagella, Deshayes.
Venerupis reflexa, Gray.
Psammobia stangeri, Gray.
lineolata, Gray.
Solenotellina nitida, Gray.
Corbula macilenta, Hutton.
Saxicava arctica, Linné.
Myodora striata, Q. and G.
novæ-zealandiæ. E. A. Smith

ADDENDA.

Trochus oppressus, Hutton.
Monodonta atrovirens, Phillipi.
Cantharidus sanguineus elongata, Suter.
Gibbula tasmanica, Petterd.
Cyclostrema subtatei, Suter.
Drillia lyallensis, Murdoch.
Mitromorpha subabnormis, Suter.
Mangilia dictyota, Hutton.
nodicincta, Suter.
Dosinia cœrulea, Reeve.

Art. XL.—*Captain Dumont D'Urville's Exploration of Tasman Bay in* 1827.

Translated from the French* by S. Percy Smith, F.R.G.S.

[*Read before the Auckland Institute, 28th August,* 1907.]

So far as I am aware, no translation of the voyage of the "Astrolabe," under the command of the celebrated French explorer, Dumont D'Urville, has ever appeared in English, though it has been briefly summarised more than once. Hence it will prove of interest to New-Zealanders to see what was accomplished in the way of geographical exploration in Tasman Bay, the "Astrolabe" being the first ship, so far as is known, to actually enter that bay since the time of Tasman in 1642.

It is proposed to follow this by a translation of the proceedings during the visit of the corvette to Tologa Bay, and to the Wai-te-mata, where Auckland now stands.

Captain D'Urville made a subsequent visit to New Zealand in 1840, during his long voyage in the same ship, the "Astrolabe," an account of which is published in his "Voyage au Pole Sud et dans l'Océanie," Paris, 1841. But he did not live to see the completion of the publication, for he, his wife, and son were killed in a railway accident in Paris on the 8th May, 1842, whilst the later volumes were passing through the press. He had been appointed a Rear-Admiral not long previous to his death.

I have added a few notes to the translation; they are enclosed in brackets, thus: [ ].

The "Astrolabe" left Port Jackson on the 19th December, 1826, bound for New Zealand. Captain Dumont D'Urville, in the second volume of his history of the voyage, expresses the feelings of pleasure with which he anticipates renewing his acquaintance with a country which he had previously visited in the same frigate, but then called "La Coquille," in 1824. On this occasion the corvette's course was directed towards the south-west coast of the Middle Island, with the intention of visiting Chalky Inlet, near the south-west cape; but the passage across the Tasman Sea was so tempestuous, and the wind so contrary, that the commander had to abandon his

* Voyage de la corvette L'Astrolabe, exécuté par ordre du Roi, pendant les années 1826, 1827, 1828, 1829, sous le commandement de M. T. Dumont D'Urville. Paris, 1833.

design for lack of time to accomplish it, and consequently directed his course to the northwards, with a view of entering and exploring those parts of Cook Strait which had not been closely inspected by the great navigator after whom the strait is named.

The history of the voyage (vol. ii, p. 9) may now be given in detail :—

These tempestuous times finally determined me, on the 8th January, 1827, at 8 a.m., to steer to the E.N.E. in order to approach more nearly the coast. We were already in about lat. 43° south, and, no doubt, with a little more perseverance, it had been possible to have attained the southern region of New Zealand : but I could not neglect the other objects of my mission, and time was already pressing.

10th January, 1827.—The weather was still very bad, and we experienced frequent squalls of rain, with a heavy sea from the S.W. ; whilst the presence of clouds of black-and-white petrels, and, still more, of some terns, announced to us the proximity of the land. In fact, at 7 o'clock I clearly distinguished it to the E.S.E. and S.E. As we were at that time from thirty to forty miles distant at least, that to the S.E. showed like a high island notched on the top. As we approached, it extended more and more ; but the summit was still toothed like a saw, with sharp teeth inclined towards the north, in a uniform and singular manner, whilst it seemed to be separated from the land on the left, so much so as to cause suspicion that the intermediate space was occupied by the entrance to a port. [The range referred to was no doubt the Paparoa Range of mountains, and the apparent entrance to a port was the valley of the Grey River.]

We now steered right for that part of the coast, and at noon were not more than four leagues distant. It was then easy for us to convince ourselves that the coast was continuous, and that our illusion had been caused by its sensible decrease in height in the space where we supposed a bay to exist. The geographical work was at once put in hand, and M. Gressian was charged with the survey of all the extent of New Zealand comprised from the most southerly land in view, situated in lat. 42° 28′ S., up to Cape Farewell. The soundings indicated 100 fathoms, sand and fine mud, whilst the temperature, 16·2° in the air, 17·2° at the surface, and not more than 13·2° at that depth.

Each of us, at the view of this wild coast, those lofty mountains battered by the furious winds of the Antarctic, rejoiced to be at last, after so much fatigue, at the end of his wishes, on a theatre worthy of his researches. Proud to follow the tracks of Tasman, Cook, and Marion, we hoped to add to science new documents on these countries still so little known, and to study as closely as possible the various kingdoms of nature ; but, above all, to scrupulously observe the bizarre customs and extraordinary institutions which tend here to give the human species a character so particular.

As soon as the midday station was complete we bore away to the N.E. and N.N.E., with an uncertain wind and cloudy sky, in order to follow the coast at five or six miles distant. The dense fog which enveloped the summits of the mountains generally prevented our distinguishing the details. We were only able to ascertain that the shore is very uniform, and elevated in steep, inaccessible, wooded ridges, and dominated in the interior by mountains of a considerable height, of which many summits were divided into sharp peaks. One of them, remarkable for its five points, imitated the fingers of an open hand, and received the name of the Central Five Fingers, to distinguish it from the Five Fingers of Cook, near Dusky Bay.

At half-past 3 and at 5 p.m. we found 50 and 40 fathoms, fine sand and mud, at least four miles from the coast. At ten minutes after 5 the wind fell, and left us at the mercy of a heavy swell from the S.W., and facing a fearful coast, where the sea broke with unexampled fury. Already I had serious reflections on our situation, when at 7 a fresh breeze up from the N.W. permitted us to draw off from the coast.

At the moment when we made our tack outwards, the mountains of the coast were seen to be interrupted by a wide and profound ravine, probably occupied by a river, or at least by some remarkable torrent [probably the Fox River, on which is the township of Brighton]. At three or four miles from that ravine, and more than three miles from the sea, the peak Five Fingers rises, whilst at fifteen miles N.N.E. we perceived a low point which projected some distance into the sea [Cape Foulwind].

All night the wind blew from the N.W. in heavy squalls, with rain, and an obscured sky of the most sinister appearance. Beyond that, the swell from the S.W., which we met right ahead, caused us much heavy pitching. Our position, already sufficiently critical on this iron coast, became more disquieting towards 4 a.m. At that time the sky was charged with clouds in all parts, and the rain fell in veritable torrents, whilst the wind blew very fresh, with heavy squalls, from the N.W. to the W.N.W. It became necessary to reef the mizzen and the smaller topsails, whilst we lay as near the wind as possible, but it was impossible to save them. During some hours I felt extreme anxiety, for if the wind had changed to the W.S.W. and S.W., and blew with the same force and as long as we had had it a few days previously, it would have made an end of the corvette. Forced by the tempest to become embayed by degrees on the coast, she would have finished by being cast ashore and broken into a thousand bits.

11th January.—But, to my great satisfaction, at 7.30 a.m. the fury of the tempest decreased, and at 10 a.m. the wind became manageable, and varied to the W., which enabled us to steer N.N.E. At 12.30 p.m. we saw the land with the saw-tooth peaks about forty miles distant, which proved that, notwithstanding the wind and sea, we had gained to windward of the land during the night. At 4.30 p.m. we were on the parallel, and about twelve miles distant from the ravine or depression remarked the preceding evening; and at 7 p.m. Cape Foulwind bore N.E. ½ N. at twelve or thirteen miles distant, appearing as a low point which projected far to the west, and terminating in a flat hillock; beyond that point the coast decreases much in height, although the interior chain of mountains remained quite imposing.

We continued to run six or eight miles until 11.15 p.m., when we tacked to port, having there found 65 fathoms, sand and mud, and being at the time five or six miles off Cape Foulwind. The sky, fine up to that moment, became again obscured, and rain fell almost continuously until daylight, with a slight N.N.W. breeze.

12th January.—At 4 a.m. Cape Foulwind showed itself bearing E.N.E., and our course was laid so as to pass it within three or four miles. When we got near we recognised that the point which distinguishes it was low land covered with beautiful forest, and projecting two or three leagues seaward. At a mile and a half off its northern extremity are situated three bare rocks, isolated, and about from 60 ft. to 80 ft. high. We gave these the name of "Trois-Clochers" (the Three Steeples) [so called still], from the appearance they present from a certain distance. As soon as we found ourselves opposite to them, at 9.22 a.m., and at least a league off, the corvette sailed through muddy water, with scattered trunks of trees, leaves, and *débris* of vegetation. This continued until 4 p.m., over the space of about nineteen miles, without our being able to perceive the limits of this discoloured water. As to the cause, there is reason to believe that it was due to the presence of a river or strong torrent which falls into the sea to the north of the valley which forms Cape Foulwind. We saw a depression in lat. 41° 16′ S. which might well be the mouth of that river, and from whence came the numerous *débris* of vegetation and the muddy waters carried out by the current in consequence of the late rains. [This was, of course, the Buller River.]

During this time the soundings were successively 80, 53, 35, and even 30 fathoms, sand and mud. Without doubt, on all that part of the coast vessels might anchor in shelter as long as the winds were easterly. But to do this with certainty it would be necessary to acquire local knowledge of the direction of the winds and the indications which would announce their duration and changes. Until then it would be very imprudent to hazard such an anchorage, for all the experience I have acquired during three months' stay on these tempestuous coasts has taught me never to count on the finest weather and the most favourable wind from appearances.

Moreover, it is probable that if the human species has found means to penetrate to this inhospitable coast, it is sure to have established itself near Cape Foulwind; and the telescope allowed us to perceive agreeable and beautiful sites susceptible of cultivation. Nevertheless, our close attention failed to discover either house or trace of inhabitants, nor even any fires. [There must, however, have been inhabitants thereabouts at that time, for D'Urville's visit was prior to Niho's raid, in 1828, which drove most of the West Coast, or Poutini Ngai-Tahu, to the mountains and secret fastnesses inland.]

Beyond the promontory the coast rises suddenly in escarped ridges from the seaside, and offers not the least appearance of low coast (*lisiere*) practicable to the foot of man. [No doubt, the very low stretch of land bordering the sea north of the Buller, and along which the Ngakawau Railway now runs, would not be visible a few miles at sea in the thick weather D'Urville refers to.] A little before night we passed before a place where the coast, on the contrary, seemed lower, and covered with fine trees; but the thick mists which covered that part very shortly after hid the place from our eyes. . . . At night the wind fell, and this was followed by showers. During a sudden and fresh squall at 12.15 the wind shifted to the N.E., shortly after returning to the N.W., where it remained, uncertain and irregular. We passed the night in making short tacks.

13th January.—This morning was again little favourable to our operations; the sky was charged in all parts, and with sudden squalls, sufficiently violent, from the W.N.W. and N.W., which succeeded one another without interruption from 4 a.m. to 11 a.m., with much rain and a heavy sea.

Nevertheless, we made all sail to double the Point of Rocks, which is a high steep cape with some rocks at its base near the coast. For some miles to the south of the cape the coast is very steep, high, and covered with trees, without any appearance of a port or inhabitants. At the point itself [Rocks Point, twenty-eight miles south of West Whanganui, six miles south of Kahurangi Point] is a white streak, which contrasts with the sombre hue of the land, and indicates the presence of a cascade, the waters of which precipitate themselves vertically into those of the ocean.

We had passed beyond it some miles, when at the "station," at 3.30 p.m., the soundings were 60 fathoms, heavy sand, at a league and a half from the shore. Subsequently, driven by a fine breeze from the west, we sailed rapidly along the coast, of which the aspect became more and more agreeable as we approached the straits. The mountains retired towards the interior, and the parts near the sea showed up in more easy slopes; here and there we distinguished beautiful spots, with pretty clumps of wood, but no trace of inhabitants. . . .

Towards 6 p.m. we believed we could see on the coast a vast basin capable of offering a good anchorage, and I had great hope of being able to enter it next morning to examine that part of New Zealand. In consequence, I approached the coast closely, to reconnoitre the place. We passed at less than two miles; and at that moment M. Gressian mounted on the cross-trees to obtain a more exact view. He assured me that the basin was very extensive, but, unfortunately, communicated with the sea only by a narrow channel, completely barred by breakers. I was consequently obliged to renounce my hopes of entering. We gave it the name of "Harbour-barred." [This is West Whanganui Harbour, only available occasionally for small craft.]

At 7 p.m. we were on the parallel of Cape Farewell, and three or four miles off it. The land is of moderate elevation, and falls rapidly to the coast, and here our watches gave us an enormous difference with the position of Cook. . . .

The weather had decidedly improved; the night was tranquil, and we passed it in making short tacks, with a nice westerly wind.

14th January.—At 3 a.m. I steered in the direction where I presumed Cape Farewell lay; but at daylight I perceived that the current during the night had carried us far to the E.N.E., and we were already considerably within the straits. I hastened to pick up the coast, and very soon, favoured by charming weather and a nice breeze from the west, our corvette glided lightly over a most tranquil sea at less than a mile from the coast. The soundings were 8, 10, and 12 fathoms. It was easily seen from the tops that the land which we were following was nothing but a narrow tongue, with small round sand-dunes and a few tufts of shrubs here and there [Cape Farewell Spit]. Beyond that (to the south) was a vast basin bordered by high mountains, of which the most distant were snow-clad. [Massacre or Golden Bay.] That coast extends between twelve and fifteen miles east and west, and terminates in a low narrow point. Just as I had decided to steer south, to pass close to the point into Tasman Bay, we perceived breakers extending off the point for more than five miles. Nearly at the same moment the breeze changed to the south and ended in a dead calm. Without doubt the turn of the tide changes daily the direction of the current, and in two hours' time we lost three or four miles to the west. Our proximity to the coast, and the impossibility of steering the ship, commenced to cause some anxiety; and I had decided to anchor off the coast, when at 11 a.m., the breeze having returned to the north, allowed us to resume our route with full sail. Having rounded the breakers at a mile distant, we directed our course south into the bay which Cook in his second voyage had named "Tasman Bay."

The visit of that celebrated navigator having procured an extensive knowledge of Admiralty Bay and Queen Charlotte's Sound, I judged that we might render greater service to geography by guiding the corvette to an anchorage in Tasman Bay, which hitherto no expedition had made known to us.

Since the morning M. Guilbert had succeeded M. Gressian in the hydrographic work, and was charged with the survey of all these parts of Cook's Straits. We may remark here that the task of the geographical officer is an extremely arduous one. From daylight until night closes in he remains close to the compass, in order that no useful detail may escape his notice, and to increase his observations and render them of the greatest utility possible. Rarely does he quit his post except to take a hasty meal, whilst violent squalls alone cause him to temporarily leave his post. Then, when he has completed the portion of the coast which has been assigned to him, up to the time when his turn comes again, every instant which the service allows him is devoted to charting his observations, a species of work which, though less fatiguing, is not less delicate or less engrossing.

As we advanced towards the south, we saw that the vast bay comprised between the land of Cape Farewell on the one part and that of Cape Stephen on the other, and which Cook in his first voyage named "Blind Bay," is divided into two basins very distinct by a remarkable point which I named "Separation Point." [This point separates Tasman from Golden Bay.] The western basin, which Cook named "Massacre Bay," is somewhat vaguely traced on our chart, because at the distance at which we passed it we could but ascertain the outline.

On the contrary, the southern basin, to which I have conserved the name of "Tasman's Bay," following Cook in his second voyage, became more particularly the object of our attention, and it is this bay we now have to do with.

We continued our route to the south until 4 p.m., when the wind suddenly changed to the S.S.E., with the appearance of bad weather. Not wishing to beat against a contrary wind, I profited by a good bottom of soft mud to anchor in 26 fathoms to pass the night.

15th January.—The night was fine, and to the calm, which lasted till 1 a.m., succeeded a slight breeze from the south, which gradually augmented, and was blowing quite strong enough at daylight.

From our anchorage an imposing view extended round us. Two elevated coasts bordered the bay right to its head; and that to the west, which was much nearer, offered to us agreeable forests and a pleasing verdure. The head of the bay seemed to be occupied by low land, barely visible, dominated in the distance by mountains, whitened by perpetual snow.

As the wind did not permit me to advance further towards the head of the bay, and because I was desirous of procuring for M. Guilbert the means of making a station on Point Separation (from which we were only distant two leagues), at 6 a.m. I sent that officer away in the whaleboat with MM. Quoy, Gaimard, and Dudemaine. The breeze off the land ceased at 10 a.m.; an interval of calm ensued, and at 11.30 the wind off shore set it. Impatient to profit by it, I fired a gun to recall the boat. Shortly after we saw it leave the point we got under sail, and the "Astrolabe" sailed slowly along the coast to give them time to join us, which they did at 3 p.m.

M. Guilbert had much trouble to climb the ridge to make his station, and lost not a single moment of the time he had at his disposal. The sailors, in rambling about the vicinity, discovered some abandoned huts, from which they had taken many objects used by the Natives. I addressed strong reproofs to them on that subject, and menaced them with severe punishment, as well as those who permitted suchlike license. One cannot at all doubt that the greater number of serious quarrels which arise between savages and Europeans have their origin in causes of that nature. As it was impossible for me to send these objects ashore, I ordered them to be placed with others which will form part of the King's collection.

We proceeded along a good part of the west side of the bay at two miles distant, and with regularly decreasing soundings from 25 to 10 fathoms, always with muddy bottom. After having passed two islands situated under the land, the coast decreases in height, and leaves a large margin of much lower land, on which we noticed some cabins, a fire, and a group of Natives moving about. At half a league to the south of the village rose a massive group of enormous trees, with long straight stems and foliage of sombre hue [probably kahikatea trees, of which there used to be several in that locality], and which I suspect belong to the genus *Podocarpus*. Already the valley appeared of very large extent, and M. Dudemaine, on the look-out on the crosstrees, distinguished clearly, at a mile or more from the forest, a narrow channel which penetrated the land [probably the Motueka River]. I would have been delighted to find a safe anchorage for the corvette, but the soundings gave only 7 fathoms. In consequence, I laid to, and sent M. Lottin to sound in that direction. At less than a mile from the corvette he found only 4½ fathoms. I then made signal to him to return on board, and continued to follow the coast towards the S.E. in the direction of a perpendicular white cape, of not much elevation.

I have no doubt that the channel seen from the tops, entering for some distance into the land, was the course of a river of considerable size, fed by the snows of the interior summits. The night approaching, I was desirous of finding a depth of water convenient for anchorage, the more so as the soundings were now from 6 to 7 fathoms, rocky instead of a muddy bottom, which offered to us little safety for the night. In consequence, I put about, and at 7.10 p.m., having 27 ft. of water (mud and gravel), I anchored with the starboard anchor with 20 fathoms of cable. Shortly after the wind fell, and the night was fine. The obscurity prevented us from ascertaining the depth of this gulf; nevertheless, we had come 27 miles since our last station. Thus, that bay, shown on Cook's chart as a slight embayment of a few miles of depth and width, seemed to take on a great development. This unexpected discovery caused us the greatest satisfaction, and we congratulated ourselves in being the first to give more exact notions on these coasts until now unknown. [The position of D'Urville's anchorage was about three miles N.E. of Moutere Bluff.]

16th January.—In looking around the corvette as soon as the light allowed me to distinguish objects, I was surprised to see that we had in reality attained the head of the bay, which terminated to the south in low-lying lands, often bare, and in appearance marshy. The depth was wanting at a considerable distance from the shore, and no part announced a sure anchorage for the "Astrolabe." In consequence, directly the "station" had been made, the anchor was lifted, and we ran across to the opposite [*i.e.*, east] coast to within three miles and a half of the shore. The land near here arose in elevated escarped bluffs, fairly well wooded. [This was Mackay's Bluff, seven miles north of Nelson.] Two canoes, from the head of the bay, were approaching us, and as the wind was very light they were not long in arriving near us. I laid to, and hailed them in their language to come on board; but these Natives rested a long time on their paddles, with an air of distrust. From time to time one of them addressed us in a short harangue, to which my sole response was each time, "*Aire mai ki te pahi, e oa ana matou.*" (Come to the vessel; we are friends.)* Tired at last to see my efforts inutile, I bore away, when they came alongside, and soon after climbed on board without distrust. One of the canoes carried ten Natives and the other nine. Half of these people seemed of a superior rank, to judge by their tattooing, their fine forms, and distinguished expression of their faces; the others, without tattoo, and features common and insignificant, were slaves, or belonging to the lower classes, and might easily have been taken for men of another race, so much they seemed to differ from the chiefs at the first glance.

These savages appeared to know of the effect of firearms, but very little of iron, or instruments made of that metal, for they attached no value to anything but cloth. They brought with them no kinds of arms, and their mats were all made of rushes or the thick *mouka* [*muka*] (*Phormium tenax*) [pl. xli], one only excepted, of a fine and silky texture, which its possessor gave up in exchange for an indifferent shirt of blue cloth, after having refused to exchange it for a fine axe, or even a sword.

After some trials I soon recognised that the language of these islanders was, radically, the same as that of the Bay of Islands, with some little differences, which were more in pronunciation than the nature of the words. Thus I was able to understand fairly well what they said by means of the words I had learnt from the vocabulary of the missionaries. During four hours the calm permitted them to pass with us they ceased not to comport themselves with the greatest probity, and an admirable reserve for a people as warlike and as advantageously treated by nature in the way of physique.

At 11 a.m. the breeze increased a little from the N.N.E., and the Natives, finding themselves already two leagues from their village, which they showed to us on the borders of the

* I have before remarked the facility with which D'Urville seemed to pick up the Maori language. The above sentence is good Maori, except that *Aire* should be *haere*; *e* should be *he*; and *oa*, *hoa*.—(TRANSLATOR.)

sea in an agreeable site, and which they named "Skoi-Tehai,"* they gave us to understand that they were about to leave us, but that they would return the following day to the anchorage with their women. So they departed in their canoes, but four chiefs demanded of me to remain on board, to which I consented with much pleasure, astonished at this proof of their hardihood and the entire confidence with which we had inspired them.

I did not dream otherwise than to direct our course towards the anchorage, which I hoped to find on the west coast, between the shore and the two islets near which we had passed the previous evening. The wind having freshened from the N.N.E., it was necessary to make some tacks, with a constant depth of 10 to 15 fathoms. At 5.30 p.m. arrived within a mile of Adèle Island. I sent M. Lottin on ahead to clear up our route. At 6 p.m. I doubled, at less than half a cable's length, the N.E. point of the island, and a few minutes after let go the anchor in a bay [pl. xxxvii], which received the name of our ship, in 5 fathoms of water. This time our two chains served to moor us in that port, and we found them hold well. . . .

With what pleasure we enjoyed again the calm and repose after the torments which we had suffered in the channel of New Zealand [Tasman Sea], and the inquietude inseparable from the difficult navigation we had had for eight days along those dangerous and mostly unknown coasts! The basin where our corvette reposed, sheltered in all parts, offered to the eye a *coup d'œil* the most picturesque, and promised to our eager regards all sorts of discoveries. A land agreeably broken, although generally mountainous; of fresh and sombre forests; of spaces more open, covered only with high fern; of beautiful beaches of sand, occupied all our attention, and we lamented that we had to await to-morrow to satisfy our ardent curiosity.

On their side, our guests continued to be well satisfied with us, nor manifested any regrets or fear of our intentions towards them. Notwithstanding, everything about them caused us to believe that they had never had any relations with Europeans before, but only had confused notions conveyed to them by their neighbours, or perhaps by the warriors of their tribe, who had encountered some during their voyages. They frequently repeated that their canoes would return in the morning with women, as if that were a powerful interest to us. They explained to us that some neighbours armed with guns came often from the N.W. to pillage and exterminate them, and they feared

* Judge Mackay, who knows this part well, cannot recognise this name, nor does he know of an old settlement in that part. It may have been a temporary camp.—(Translator.)

them singularly. Often they asked if we would not go and kill and eat them, openly testifying the pleasure they would experience. They cultivated the potato, but had no pigs, which they only knew of by name—*pouaka* [*poaka*]. For bed I gave them a sail, in which they enveloped themselves, and slept well in one of the boats.

17th January.—At an early hour in the morning all the work commenced at the same time. MM. Jacquinot and Lottin went to establish their observatory on a little sandy beach near where were found abandoned houses; MM. Guilbert and Dudemaine commenced the plan of Astrolabe Bay; and a party was sent to the woods. About 8 a.m. three canoes came alongside, containing about forty persons. Two of these canoes were those we had seen the previous evening; the third contained new faces. The savages brought this time only three women, who remained hidden under some mats whilst the canoes remained alongside, and who, on shore, fled into the fern if one wished to approach them. These islanders remained some time near the corvette, occupied in exchanging mats, hemp of their country, and divers other objects for European bagatelles. In general they manifested much gentleness and good faith in their bargains, and one could only praise their conduct. When they had finished they went to the beach where was the observatory, hauling up their canoes, and establishing themselves in the adjacent huts [pl. xxxviii]. It was very agreeable to me to see them fix themselves near us: nothing could better demonstrate to us their confidence, and the sincerity of their intentions; but, thus placed under the range of our cannon, the least outrage on their part could be followed by a punishment prompt and severe.

After I had assured myself of the pacific disposition of the Natives, and having also otherwise prepared if they testified differently, I went ashore at 9.30 a.m., followed by M. Lesson and the sailor Simonet. I landed at the beach named in our chart "the watering-place" [pl. xxxix]. The first thing I remarked with joy was a pretty stream of water, very limpid, that twisted and turned down through the sand to the sea, and where our long-boat could, at high water, obtain all our water with the greatest facility.

The land around was very broken, mountainous, and difficult to climb. At first I was struck with the *rôle* played in the vegetation of a climate so far distant from the line, by the ferns of all descriptions, identical with those of the tropics, or, at least, perfectly analogous. The ligneous and also the arborescent species inhabit in crowds the humid ravines, whilst the slopes are entirely occupied by that kind of which the root furnishes an alimentary substance to the inhabitants of these regions. The Phanerogams are little varied compared to the ferns; the season was too advanced, few of them offering either flowers or fruit. It is the same with the trees, many of which are remarkable for the elegance of their forms and the beauty and solidity of the wood. Amongst the parasites I observed the beautiful *Epidendrum*, or *Dendrobium*; but no root of *Phormium* was seen. No species of coleopterous insects, except the *Cicindèle sabulicole*; no butterflies animated the scene. There are, nevertheless, a number of birds; I shot seven or eight species, and saw many others I could not get. It is worthy of remark that they are all wild, with the exception of a *moucherolle* [? black robin], which is excessively familiar. Directly one stops in any part of the forest, one is sure to see appear at least one or two of these birds around one. They look at you in silence and with curiosity; if you remain quiet they push their confidence so far as to alight on the barrel of your gun. The beautiful *merle à cravate* (*Ceathia circinata* of Forster) [tui] is common in the woods. A rat was the only species of quadruped I saw.

The sky became overcast at 4 p.m., and soon the rain fell, and continued until midnight.

18th January.—The weather continued overcast, and rain recommenced at daylight, and continued until noon.

Another canoe arrived, and those on board united with the others. They came on board from time to time to continue their barter, as peacefully as usual, and returned to their huts as the rain came on.

Although it still continued to rain heavily, at 7.30 a.m. I landed on the beach that is beyond the observatory to the south, and, accompanied only by Simonet, I walked towards the interior. After having followed a stream for some distance, which runs in the bottom of a ravine occupied by fine ferns and beautiful trees, I climbed, with much trouble, the bluff which dominates the coast. As soon as one arrives at 50 or 60 fathoms above the level of the sea the soil is very dry, and almost completely covered with the edible fern, of which the interlaced branches formed thickets often 5 ft. or 6 ft. high, and almost impenetrable. Some *Lepstospermum* and two or three other species of shrubs are seen here and there in these parts. No birds, no insects, or reptiles: that absence of all animated species, that profound silence has something of solemnity and sadness. In walking over these solitary bluffs one believes one's-self transported to that age of the world where nature, after having produced the vegetable kingdom, waited the Eternal command to bring forth the animated races. To complete the illusion, one does not encounter any human traces on these heights.

Without doubt, the Natives are not anxious to quit the food-producing coasts to wander in these sad and sterile deserts.

In spite of the bad weather, and the fatigue I experienced in traversing a country so broken, after having attained the summit of a hillock that faces towards the S.W. of the anchorage I was well recompensed for my trouble by a complete view of Tasman Bay, and by the discovery of a second basin situated beneath my feet, and which appeared to offer an anchorage not less secure than Astrolabe Bay, from which it is separated by an isthmus of 500 or 600 fathoms in width only [Torrent Bay]. Three fine torrents discharge themselves there, and a pretty margin to some level land occupied part of its extent, and in the south a corner completely closed to the swell from outside announced a harbour most commodious for small vessels. Besides, an immense forest of fine trees, of which many would be useful in construction, occupied the depths of the ravines down which the streams came. I at once promised myself to explore and make a plan of this fine basin, to ascertain if it really possessed the advantages that it promised.

My eyes, running successively over all the details of Tasman Bay, could, from the prominent station where I was placed, assure me that in all the southern part it offered no chance of any bay suitable as shelter to vessels. I recognised the clump of *Podocarpus* near the village to the west, named by the Natives "Mai-Tehai." [This seems very like "Maitai," the name of the river falling into Nelson Haven, near the town of that name; but it is shown on the chart as lying to the west of Astrolabe Bay, about the Motueka Valley.] Beyond, the opening discovered by M. Dudemaine, clearly seen in the form of a river-bed well inland; at the same time, its brown waters communicated their colour to that of the bay as far as four or five miles from the coast. [This, no doubt, was Motueka River.] To the S.E. an island (Isle Pepin), situated on the coast, announced a channel, and perhaps shelter, between the island and the main. More to the north, and on the coast directly opposite to that on which I found myself, a deep opening made me already suspect a communication between Tasman Bay and that of Admiralty. [The French Pass.] Lastly, to the N.E. the land is composed of abrupt mountains, which terminate in the cape called "Stephens" by Cook.

After having wandered nearly eight hours across these wild slopes, and having entirely gone round the crest of the mountain, I descended to the coast through the wood above the watering-place, and returned on board about 4 p.m., enriched with many new specimens of plants and birds. Among the latter were two of the brown parrakeet of New Zealand (*Psittacus nestor*), a curious and rare bird, even in its own country.

The long-boat had made during the morning three consecutive trips to the watering-place, which work was executed with such ease and celerity that the water we were in want of had been completed. The weather was still rainy in the evening; at night it cleared up, and the following morning it was more passable.

19th January.—At 8 a.m. I started in the whaleboat to visit the bay of which I have already spoken, and which henceforth I will refer to under the name of "Bay of Torrents." I followed the coast northwards from our anchorage; it offers from 5 to 8 fathoms of water at a ship's length from the shore. But it is necessary to avoid an isolated reef distant two cables or more from the point N.E. of the entrance, and on which M. Guilbert found only 10 ft. of water at high tide. . . . After having followed the coast for a mile we found ourselves off the south point of Torrents Bay, which is formed by a narrow ridge of rocks that extend about 200 fathoms from the land. A similar extension seems to take place at the N.E. point; it follows that the entrance to the basin is thereby reduced to at least half a mile in width, and the interior is thus the better sheltered. Also, the sea is perfectly calm inside. I found, and M. Guilbert after me, a good bottom of mud, diminishing from 45 ft. to 25 ft. from the entrance up to the little bluff above the interior peninsula. Close to the shore, nearly everywhere, not less than from 20 ft. to 25 ft. of water is found. I recommend above all the southern bay, where ships of our dimension or less will find one of the best anchorages in the world, with 18 ft. to 20 ft. of water, and in front of a fine beach, from which rises a gentle slope.

Beyond the interior peninsula there is a kind of interior bay, which at high water forms a large basin of 200 or 300 fathoms in diameter, but which dries mostly at low water, so that only a channel of 4 ft. or 5 ft. of water is left, formed by the union of the three torrents which there discharge. I went up the course of two of these streams for a distance of one or two miles, and, although neither was deep, the water there was as abundant as at their mouths. But, like all the streams of the Oceanic isles, the courses of the streams become confined, the slope rapid, and with enormous rocks which at each instant encumber their beds, preventing the progress of the most determined traveller.

On the shore are found trees of an admirable height and dimensions, which would be easy to work. The little margin of flat land which runs along the beach, and which has evidently been formed by the streams, seems of a prodigious fertility, and probably the adjacent slope would be susceptible of culture. It is not to be doubted that this place would be convenient for a small establishment. Plantations of a larger size could only be placed on the banks of the River Mai-Tehai (Motueka) and the surrounding plains.

MM. Quoy and Lottin, who came to Torrents Bay overland by crossing the isthmus which separates that harbour from Astrolabe Bay, joined us about 11 a.m. We visited together the little valley of which I have spoken, and we found some houses where the Natives had left some of their utensils, and near them some potato plantations. No doubt these are places where the inhabitants of Mai-Tehai or Skoi-Tehai establish themselves for a time when occupied in fishing, or to pass the time at the harvesting of their crops of potatoes. We all returned on board at 4.30 p.m.

MM. Guilbert and Dudemaine finished this morning the detailed plan of Astrolabe Bay, and the numerous soundings on it leave nothing to be desired.

20th January.—The weather remained cloudy, with feeble breezes. From 5 to 10 a.m. it rained, and then became fine. I had not many days to devote to this anchorage, and did not wish to lose an instant. At 9 a.m. I was ashore with M. Lesson and Simonet on the large beach to the south of the anchorage. This is the most agreeable place, and more rich in birds than any part of the coast. A narrow and sandy flat, covered only with herbaceous plants, occupies the edge of the sea; it is surrounded by an immense and profound forest of easy access; a fine stream traverses it, running over a bed of granite; in many parts of its course it has pretty waterfalls. The fresh and delicious shade echoes with the songs of various birds, and that scene so full of life contrasts with the funereal silence which I had observed on the ridge near, barely two or three miles distant. The nature of these places, the aspect of the streams and forests, perfectly recalled to me many similar sights in New Guinea, near Dorei, and the surprising resemblance of the ferns struck me more and more. The almost complete absence of insects recalled to me the coasts of Tavai-Pounamou [Te Wai-pounamu = South Island, New Zealand]; indeed, in all my visit I did not remark more than one, coloured red, which I could not catch, but which I took to be a *Hymenoptère*. I do not count some small and insignificant species of locusts, crickets, and cicadas inhabiting the plants of the shore. Simonet and I made a successful chase after birds, of which we brought back more than forty individuals, of many sorts, amongst others a large pigeon with brilliant reflections, two *Glaucopis* with pendant drops, and many fine *philédon à cravate* [? tui].

I had sent back the boat, thinking I could easily proceed by land to a point opposite the corvette in following the coast; but when we came to return we found only too well why the Natives so seldom visit these rough shores. The sea, in rising, had nearly covered the narrow and rocky space which was dry in the morning; so we had to cross, with great trouble, the ravines and steep hills, covered with scrub, which alternately succeeded one another. Halfway we crossed an advanced point by passing under a natural vault more than 100 paces long, which passes right through the point; but the slopes beyond caused us fresh difficulties, for we had to climb a nearly perpendicular face; we crawled, holding by feeble shrubs or fragile stalks of fern, and ran each moment the risk of being precipitated on to the sharp points of the rocks below if these frail supports had given way. Lastly, after excessive fatigue and veritable dangers, we arrived at the beach of the observatory, where we found a boat, which carried us on board the corvette.

21st January.—Soon after midnight the rain commenced to fall in torrents, and continued up to 2 a.m. At the anchorage we had only slight breezes from the S.E., and more often calm; but the sea had risen, and even in our bay, so well sheltered, we had some swell and surf on the shore. I concluded that a gale prevailed at that moment in the straits, and I esteemed myself happy to have escaped it. This decided me to postpone our departure to the morrow, the more so as M. Lottin had still an observation to make to complete the comparison of our watches.

No doubt our stay here will seem short; it appeared so to myself. If I had only to consult the wishes of the naturalists, whose collections were enriched each day by most interesting material—if I could have listened to my own desires, I would have traversed those plains at the head of the bay [Waimea Plains], to which my thoughts returned involuntarily, and visited the Natives in their own village; but I could not forget my instructions. The hydrographic work was finished, our water, our wood had been completed, and other parts of New Zealand equally claimed our attention. A longer stay could not be justified, and would have nullified our future operations.

At 2 p.m., the sky having somewhat cleared, I went, with several officers, to take a last walk on the larger beach; but, the rain having driven the birds to their retreats, we were only able to secure a few; and also, the underscrub, still charged with the rain it had received, completely wetted those who wished to penetrate into the woods. Hence we returned early on board to make our preparations for departure.

The Natives had continued to visit us from time to time, and their conduct had always been without reproach. Their chiefs often offered me their women, and they appeared surprised at my refusal. It is true that, more gallant or more courageous, three of our young officers braved the vermin, the stench, and the dirt, and retired each evening to their homes to pass the night with *la belle Zélandaises*, who conceded to the wishes, or rather the presents, of their adorers.

These Natives are incontestably very inferior in industry, as in intellect, to those of the North Island, of whom they are probably only colonies. A soil more ungracious, a climate more rigorous, and greater privations have prevented the human species from taking on here the same development, and to form themselves into powerful tribes as are found in Te Ika-na-Maui [North Island]. They appeared to me to be ignorant of the national chant called *pihe*, and other songs given in Mr. Kendal's grammar. Their pronunciation is also more defective, for they rarely articulate the "r" in their words; * thus they say *koeo* for *korero*, to speak; *tainga* for *taringa*, the ear, &c.; often it is the same with the "d," which brings them nearer to the language of the Tahitians. [In the early missionary writings the "d" is often found instead of the "r."]

The anchorage of Astrolabe Bay, in Tasman Bay, is, without contradiction, one of the best in these parts, owing to the security that a vessel may enjoy, its ease of access and departure, the resources that it offers for wood and water, and, lastly, for the excellent fish which it can furnish each day. We quitted the place well satisfied, completely revictualled and enriched with an unbelievable quantity of new objects.

I have already observed that Torrents Bay is not inferior to it in any respect, and also offers space on the shore more open and better suited to the works that have to be executed during a long stay, or in consequence of accidents that have to be repaired.

We know that it was the Dutch navigator Abel Tasman that discovered New Zealand, and that on the 18th December, 1642, he anchored in the great bay bearing his name. The morning after his arrival the savages killed four men of the crew in one of his boats, which induced him to quit the place, leaving the name of Bay of Murderers. In casting the eye over our chart it is difficult to assign exactly the place where Tasman anchored. If his latitude 40° 50′ S. was exact, it would be, as I have indicated, opposite a little stream four miles south of Separation Point. It may be that the vessels of Tasman had doubled that point, and were, in fact, brought up in the bay that we have

* This dropping of the letter "r" is characteristic of the old Ngati-Tu-mata-kokiri Tribe of Tasman Bay, and also of the Ngati-Rakai of South Canterbury. In this they are like the Marquesans.—(TRANSLATOR.)

continued to call, after Cook, Massacre Bay. That basin demands a further exploration, and one might think that it offers better anchorage, because the seas from outside cannot enter from any side.

It results from the observations of M. Jacquinot that our observatory in Astrolabe Bay was situated—40° 58′ 22″ lat. S., 170° 35′ 25″ long. E. (of Paris), 14° 25′ variation N.E.

(End of Chapter XII.)

[With regard to the Natives met with by Captain D'Urville in Tasman Bay, they belonged to the Ngati-Apa-ki-te-ra-to Tribe (or Western Ngati-Apa), a branch of the tribe of that name which have occupied Rangi-tikei, Turakina, &c., on the North Island, for many centuries. These people, about the end of the seventeenth century, migrated from the North Island, and conquered the original inhabitants of Tasman Bay, known as Ngati-Tu-mata-kokiri. Most of the men were killed and the women taken as slaves. Those people who, D'Urville remarks, appeared to be slaves were in all probability some of the descendants of the conquered tribe, still in a state of vassalage. When these people mentioned the fact of their having suffered through the tribes from the N.W., who were armed with muskets, they refer to Ngati-Toa, of Kawhia, and Ngati-Awa, of Taranaki, who occupied Kapiti Island and the adjacent shores in 1822. But it was not until 1828, the year after D'Urville's visit, that Tasman's Bay was conquered by Niho, Takerei, Te Puohu, and others of Ngati-Toa and Ngati-Awa. Therefore, the collisions these people referred to must have been when they, together with all the other tribes of Cook's Straits, attacked Te Rauparaha at Kapiti Island, and at the battle of Wakapaetai suffered a very severe defeat at the hands of the Ngati-Toa chief. This was in 1824. For full particulars of these times see "History and Traditions of the Taranaki Coast," by the translator hereof.]

Chapter XIII.—Traverse from Astrolabe Bay to Houahoua* Bay.

22nd January, 1827.—A good part of the night the wind blew with force, with squalls and rain. At 2 a.m. the wind suddenly ceased, but rain continued until 5 a.m., when the wind set in from the south. Immediately the stern anchor was raised, and the corvette got under way. Seeing our preparations for departure, all the Natives embarked in one of their canoes with their women and children, to the number of thirty, to pay us a last visit and obtain a few more trifles from us. Their per-

* Houahoua is the nearest D'Urville could get to Uawa (or Tologa) Bay.

petual cries deafened us, and their presence was much in the way of the sailors, and interfered with working the ship. I endured their presence, however, importunate as they were, up till the last, in order to leave a good impression of the character of their guests. Happily, as the rain ceased we were deprived of their presence, as we lay becalmed at two miles from the shore. The Natives profited by that circumstance to make a short demonstration alongside about noon. Lastly, by aid of a light breeze from the N. and N.N.W. I made the best of my way towards the opening that I had observed on the east coast of the bay. At 3.45 p.m., and at the distance of fifteen miles about, that opening presented the appearance of a deep bay, so I steered N.E. ½ E. towards another opening much more prominent. Nevertheless, an hour afterwards the first embayment took on another aspect, and M. Guilbert believing he could see a channel, I steered right for it, in order to approach and spare myself any after-regrets. At 7.40 p.m. we were opposite that bay, and at less than a league's distance from the two points. From there we convinced ourselves that it did not offer any channel practicable by our ship. At the same time that bay, which I named "Croiselles Bay," should offer a large and good anchorage in all winds from south, the east, and even north-west, because of some islets situated near the north point, and which perfectly shelter that side. Near to us the coast was very steep everywhere, and the depth was constantly 25 fathoms. It was too late to look for a suitable anchorage; in consequence, I steered off the land to pass the night; but hardly had we shifted the sheets when it fell dead calm, leaving us at the mercy of the current and a somewhat heavy swell. So we passed the entire night less than three miles from the land, a prey to the most lively inquietude, and dreading to be carried, in spite of ourselves, on to the coast. The lead cast every half-hour showed 25 fathoms constantly, with a muddy bottom; but I refrained from anchoring lest obliged to do so, for I feared to be surprised at anchor by a strong N.W. wind, which would have left us without any resource.

23rd January.—Towards 4 a.m. we recognised that we had, in spite or our care, much approached the land, and were not more than half a league off it. Vainly I had out the oars of the gallery [? galley, boat], and manœuvred to profit by the least puff of wind; the swell continued to carry us nearer and nearer to the shore, and at 8.10 a.m., in spite of my repugnance and all our efforts, there remained nothing for it but to anchor in 20 fathoms. We were at that time not more than 500 fathoms from the rocks on the shore, on which the sea was breaking heavily. [According to the chart, the anchorage was about a couple of miles south of Cape Soucis, the south head of Croiselles Harbour.]

There exists an astonishing difference between the west coast of Tasman Bay and that of the east. The latter, battered by the gales from the west, only offers an escarped land, often bare, and nearly everywhere without landing. It recalled to us, by its sad and monotonous aspect, that which we had followed from Cape Five Fingers up to Rocks Point; also, the swell from the west appeared almost permanent, and thus renders the navigation as dangerous as the coast opposite is safe.

Between 8 and 9 a.m. a canoe manned by two Natives appeared at the mouth of Croiselles Harbour, but disappeared again. We were so anxious about our position that we gave but slight attention to them.

At 9.45 a.m. I profited by a fresh breeze from the N.W. to get under way in haste, and to conduct the ship towards the channel I had observed the previous evening in the N.N.E., and which seemed to me to establish a communication between Tasman and Admiralty Bay. We followed the coast at less than two miles distance, although the breeze was uncertain, and frequently threatened to leave us at the mercy of the swell. At 4.15 p.m. we had arrived opposite to the channel, and I stood for it with all sail, when the look-out on the crosstrees announced that the pass was barred by breakers, from which we were distant not more than three or four cable-lengths. In an instant M. Guilbert flew up to the crosstrees and confirmed the report. There was not a moment to lose; instantly all the sails were lowered, and the starboard anchor let go in 26 fathoms in mid-channel, and at about a mile or more from each of the two points. The wind threatened to freshen from the N.W., and the swell had much increased, so I at once paid out 50 fathoms of cable.

MM. Lottin and Gressian were sent away in two boats to follow each of the two sides of the channel, to search for dangers and to find out if the pass would, in effect, conduct us to Admiralty Bay. They were nearly four hours absent, and on their return informed me that, with th exception of the breakers that extended for a considerable distance from the N.W. point, the channel appeared to them quite safe right through. They could not, nevertheless, make sure that the channel was practicable in its narrowest part, where it debouched into Admiralty Bay. M. Lottin, who approached that part nearest, found it almost barred by rocks barely above the surface, and there prevailed there a very violent current, accompanied by eddies and whirlpools, which had nearly carried his boat into the breakers, and it was only with extreme difficulty he had been able to withdraw from this perilous position. That pass was distant a league and a half from our anchorage. In returning, the current had caused great trouble to these two officers, whilst the crews were extremely fatigued.

I expected to see the wind fall at night as usual. It did not do so; on the contrary, it freshened rapidly from the N.W. At 9 p.m., when the boats returned, it was already so strong, and had raised such a sea, that they had great trouble in hoisting in the boats without breaking them. From 10 to 11 p.m. the wind blew very hard, and the sea had become very heavy. The corvette pitched with great violence, causing a great strain on the cable, and in the strongest gusts the waves came right over the ship, covering entirely the forecastle. We ran the risk of foundering. At 11 p.m. I paid out 70 fathoms of cable, and some minutes after, having drifted sensibly, we let go the port anchor with the heavy chain, purchased at Port Jackson, giving 20 fathoms more on the other cable. Our position was extremely critical, for if the chain and the cable did not hold the corvette would have smashed up on an iron coast, from which we were only distant three or four cable-lengths. The sea was breaking with such fury that to reduce the "Astrolabe" into fragments would have been an affair of some minutes only. It was very certain not one of the crew would have escaped from such a catastrophe; it is even doubtful if any vestige would have been preserved on the coast, so complete would have been the destruction of the ship.

Great as our anxiety already was, it became much more so when, at 2.45 a.m., we found ourselves again dragging, and ascertained that the starboard cable had parted. We immediately paid out 60 fathoms of chain, which had now become our only resource, and made fast another cable to an old anchor on the port side ready for use in case of want. But the single chain held us, and at the same time the wind decreased suddenly, the sea went down, and the sky cleared as by enchantment. Whoever has found themselves in a similar situation will understand what a burden had been removed.

Hardly had the day broken when we commenced to haul in the end of the broken cable; it had been cut at 12 fathoms from the hawse-hole, and was much frayed in other parts. This proved that the bottom was covered with sharp rocks, and we felicitated ourselves that the accident had not taken place at the worst of the weather.

The large boat carried out small cables, and attached them to the buoy-rope of the anchor, in order to save the latter. At 8 a.m. we hauled on the chain, and when the anchor came to the surface of the water we recognised, with as much surprise as regret, that one of its flukes was broken, which no doubt was occasioned by the nature of the bottom. Thus, during many hours the safety of the " Astrolabe " had depended upon nothing but a thread, as it were.

We then hauled on the broken cable, having care to strengthen the buoy-rope with a solid *mailon.* That precaution was useful, for hardly had the anchor approached the surface when the buoy-rope broke, and without the *mailon* the anchor had been lost.

At 9.10 a.m. we got under way with a little sail to enter the channel of communication between the two bays; we passed to starboard two rocks under water, very dangerous, and shortly found ourselves in a basin of calm water, and which presented no appearance of currents. As the breeze still held in the west, I followed the east side at about 200 fathoms distance to hold the wind. Our navigation in that narrow channel, between two chains of elevated mountains, had something imposing in it: on one side thick forests, on the other copses, or nothing but tall fern; behind us Tasman Bay, losing itself in the horizon; before us the islands and islets of Admiralty Bay, appearing through the pass as in a telescope, and gradually increasing in size to the eye. Such was the extraordinary spectacle, which we could have enjoyed if care of the vessel had not prevented us.

Arrived about 400 fathoms within the pass, I saw that it was almost completely barred by rocks just showing above water, and I was obliged to send M. Gressian to take a nearer view, while I advanced slowly under very little sail. After having taken some soundings, and examined the pass, that officer returned and reported that it was practicable, though very confined, and that the greatest depth was on the east side; but that the current had commenced to enter, and that without a strong breeze it would be difficult to contend with. Nevertheless, I decided to try it, and made more sail. When the corvette was not more than a cable's length from the pass the bar all at once became covered with boiling foam, and the water came rushing through in whirlpools of an unbelievable violence. On the instant the corvette obeyed the action of the currents, which carried her back rapidly into the bay of currents [Current Basin], making her turn round several times.

I was better pleased to see her resting in the basin than carried on to the breakers in the pass, but I was disappointed as much as surprised to find the current, instead of following the middle of the channel, directing itself straight to the coast on to a point [Point Tourbillons—Whirlpool Point] which was immediately to the south of us. Thus, in two or three minutes, before the anchors could be let go, the bow of the vessel was not more than a few fathoms off the rocks of the coast. She was rushing on to the point with all the swiftness of the current. To deaden the violence of the blow, I sent the long-boat with a tow-line, and at the same instant the anchor was let go. Although the anchor was apeak, it held us afloat; but it could not protect the ship from grazing if the whirlpool in which she was had again made her turn right round twice or thrice, with the depth of 7 or 8 fathoms, at not many feet from the rocks. It was now noon; M. Jacquinot had gone ashore in the long-boat to observe the sun, and all these movements had been so rapidly made that that officer had not observed them till all were terminated. The lesser anchor was immediately placed in the long-boat, and carried outside to the distance of a short cable; but, although strongly manned, and towed by the yawl, the boat, carried by the current, could only with difficulty carry it out some 30 or 40 fathoms. However, as soon as we had the end of the cable we hauled on it, dragging after us the large anchor, which by good luck had not held. Towards an hour after noon we found ourselves nearly apeak over the small anchor and at 20 fathoms from the coast.

Anxious to give to each of our collaborators the means of utilising his time, I at once sent to the neighbouring shore the naturalists and the artist of the expedition, also MM. Guilbert and Pâris. These two latter each climbed the summit of a hill which overlooked both Tasman and Admiralty Bays, in order to obtain an exact view of their details, and make observations useful for the geography of the strait. In thus acting I had a double end in view—that of utilising the zeal of persons whose presence aboard was of no use in the manœuvres we had to make, and, above all, to impress the crew with the fact that, notwithstanding the dangers we were incurring, the work was carried on as if we were under the happiest circumstances in our navigation. It was the course I constantly followed, and I believe it to be indispensable, especially with individuals so pusillanimous as were most of our crew.

Whilst our companions were usefully occupied ashore, on board we redoubled our efforts to place the corvette in safety. The long-boat, having taken on board two short cables and a stream-anchor, departed to place it as far out as possible, but, always mastered by the current, which carried them towards Tasman Bay, they could not take it further than a cable's length from the shore. We hauled on it, at the same time slacking out on the other, but the current caused it to become entangled with the large anchor, which was dragging. The cables, the short cables, and the buoy-ropes were so thoroughly twisted that it took some time to clear them. Lastly, at 4 p.m. all was ready, and we let go the smaller anchor with the little chain in 21 fathoms, gravel and shells, at a good cable's length from the shore; afterwards the stream-anchor was lifted.

It was not until then that the crew, which had worked hard ever since 4 a.m., and had only had a quarter of an hour's respite for breakfast, could take their dinner. On that occasion I remarked that the sailors, naturally idle and grumblers in ordinary bad times, showed themselves active, submissive, and even resigned in the dangers we had seen. That observation gave me great pleasure, as showing what they were capable of in decisive moments.

In the evening we occupied ourselves in clearing up the poop, which was more encumbered with chains and warps than it had ever been before, and in preparing for the manœuvres which remained to be executed to take us into Current Basin.

During that time, accompanied by M. Guilbert, who had returned from his excursion, I embarked in the whaleboat to visit the pass. What I ascertained this time convinced me that it would be very imprudent to risk the passage before being well acquainted with it, as well as the part of the sea beyond, in Admiralty Bay, and it was at that moment impossible to sound either one or the other. The current had turned, and now ran toward Admiralty Bay, but its action was too irregular, and the sea boiled in whirlpools in a frightful manner. The N.W. point was continued in a chain of rocks just showing, and which, by closing three-fourths of the pass, stopped the waters in their course, and formed a bar almost continuous in the only open part. The effect of this contraction of the mass of water was felt in our basin, and its surface was more elevated than that of the water of Admiralty Bay. With the whaleboat it required all the force of six men to pull against the current outside the main stream, so one may judge of its impetuosity in its true sphere of action. There was reason to believe that low water would be the most favourable time to attempt the passage; but at that time the current was contrary, and the help of a favourable and constant breeze would be indispensable. Almost touching the bar, and opposite the east point, I found 20, 25, up to 40 fathoms depth. A crowd of cormorants, perched on the bushes on the opposite shore, were the sole guardians of this basin.*

* In reference to these cormorants or shags, it is interesting to read the Maori account of the (mythical) formation of the French Pass by a cormorant named Te Kawau-a-Toru. See "Journal, Polynesian Society," vol. ii, p. 53 *et seq.* The Maori name of the pass is "Te Aumiti." — (TRANSLATOR.)

We passed the night with the smaller anchor down, with 42 fathoms of chain. It was calm up to midnight, after which time the sky became overcast, and squalls came on from the N.W. with rain, which lasted some hours.

25th January.—M. Guilbert employed the whole morning in making a plan of the basin in which we were, and it resulted from his explorations that the soundings are regular from 20 to 25 fathoms, gravel and shells, right up to the shore.

I left at 10 a.m., with M. Gressian, to again examine the pass, or at least its sides. The tide was nearly low, and I found with pleasure that the sea only broke feebly on the rocks, in spite of the whirlpools which were there. I sounded in the very middle of the channel and found a great depth, whilst, without our perceiving it, the current carried us rapidly towards Admiralty Bay. For the moment I was somewhat anxious as to the manner by which we should return to Current Basin, because of the redoubtable bar which the back current always established. Lastly I decided, certain that we could always return by land over the peninsula, and, after all, it would only mean the sacrifice of the boat.

Hence I advanced with confidence for half a mile into Admiralty Bay, the basin of which appeared quite safe, and the entrance much less obstructed by islands and islets than Cook had shown. On the shore we observed some Native villages, and a canoe at sea, which I would willingly have waited for, but it was essential not to lose precious time for the object which I proposed. I therefore hastened back to the pass, where I found the sea perfectly calm. It was the very moment when the current was absent, and during our stay there we observed that this calm rarely lasted more than a quarter of an hour. It was to us altogether an extraordinary event to be able to move in that space which we had seen occupied by impetuous whirlpools and a menacing bar. I profited by it to sound it with care. I recognised that all the N.W. part of the pass was effectively barred by rocks just at the surface, at that time quite uncovered, and also that some isolated rocks 8 ft. or 10 ft. under water prolonged the chain. Thus the only part of the pass practicable is reduced to 30 or 40 fathoms in width near the S.E. point; that point is as accessible as a quay, and might be closely approached without any danger.

From that moment I decided to take the "Astrolabe" through the pass with the first favourable wind, from the double consideration that this would save us a long and disagreeable round, and at the same time procure us the means of delineating properly the coasts of Admiralty Bay. I called to M.

Guilbert, whom I saw at some distance going on board, and asked him to hasten to the pass, and profit by the calm to make some soundings. But already the current commenced to turn into our basin, and it became impossible for him to approach the pass, in spite of all his and his crew's efforts.

From there I went to a beach on the isle, not far from the pass, where I remained an hour walking over it and collecting plants. Again I was struck with the resemblance that exists in general terms between the vegetation of this part of the world and that of Polynesia. On the other hand, one discovers that New Zealand possesses plenty of Australian species, notwithstanding the differences that at first present themselves between the floras of the two countries. That double observation conducts naturally to the thought that New Zealand, in spite of its high latitude, presents a system of vegetation intermediate between that of Polynesia and that of New Holland—a sort of transition from one to the other.

That spot offered me many bunches of *Phormium*, and, although its favourite station is on the banks of streams, I have seen it grow with vigour on the almost bare maritime rocks [pl. xliii]. Near the shore a pretty cascade rolls its waters over the rocks and *débris* which have succumbed to the action of the winds, or of centuries of storms, and would furnish easily the wants of a fleet.

On returning on board about 1 p.m. I sent the long-boat to place a stream-anchor two cable-lengths outside, towards the middle of the channel; we afterwards hauled up to it, after having heaved up the lesser anchor, with which we proceeded to replace the other, when the wind began to rise from the N.W., with squalls charged with rain, which caused us to drift. Fifty fathoms of chain were paid out, and the corvette held at about a cable-length from the shore. Thus our whole day's work was wasted, and we found ourselves not more advanced than before. During the night the wind increased, and blew very fresh, with squalls, rain, thunder, and lightning. To spare the small chain, which worked a good deal, and to prevent our dragging on to the shore, it became necessary to let go another anchor, with the great chain of which we paid out 30 fathoms.

26th January. The wind decreased at midnight, and at daylight work was again commenced. The large and the small anchors were both lifted, and then we hauled on to a stream-anchor placed at three cables' length to windward in 21 fathoms of water. We remained with 84 fathoms of the small cable, awaiting a favourable moment to get under way. At 9 a.m. a nice breeze from the W.S.W. arose, and seemed to hold. The anchor was quickly hauled in, the mizzen and the top sails set at the same moment; but hardly had we fallen off on our course when the wind fell, and came round to the north. Just then the current took us broadside on, and carried us again within half a cable's length of the unfortunate Whirlpool Point. A stream-anchor could not hold us, and it became necessary to add the smaller anchor and chain.

We then towed off shore with three hawsers, which, with difficulty, took us a cable-length off the land. This movement was repeated, but we were so contraried by difficulties that at 5 p.m. we had to content ourselves with anchoring about a cable-length and a half from the shore. We had been engaged thirteen hours in this continued and hard labour, removing, mooring, and lifting a number of anchors and cables, and were still less far advanced than in the morning. Hardly had the boats, laden with anchors and cables, reached a short distance from the ship when the current would sweep them away to the southward with irresistible violence, and the longest tow-line was thus reduced to a half-cable or more. In this fatal basin the punishment of the Danaids was renewed for us, and it seemed as if some evil genius wished each day to destroy in an instant the fruit of our greatest efforts.

For several days I had suffered from pains in my side, and the successive fatigue of the day had not contributed to lessen them. All night long a strong wind from the N.W. and W.N.W. prevailed with squalls, but a clear sky. Our chain, now well tried, assured our position, otherwise it would not have been without inquietude.

27th January.—At 7.30 a.m. I went in the yawl to look for a spot to place a stream-anchor at four cables' length to windward of the ship, in order that we might haul towards the other side of the bay, where we should be in a position to get under way with the prevailing wind. To my great surprise, in sounding at 200 or 300 fathoms from the pass I found all that space occupied by a sand-bank covered with only 15 ft., 12 ft., and even 11 ft. of water at low tide. Beyond that the depth suddenly returned to 22 and 24 fathoms, and formed a narrow channel along the island. The presence of that sand-bank proved to me that the pass was even more dangerous than I had thought for a ship drawing so much water as ours; but, on the other hand, I was pleased with the discovery, because it offered a point of safe support for the stream-anchors which I wished to place there.

Directly I returned on board I sent the long-boat to place a stream-anchor towards the sand-bank, and it returned with the end of the three hawsers with which it was furnished. At the same time I sent the whaleboat with two other hawsers to join on to those of the other boat whilst we hauled on our anchor: but by a new fatality, at the moment when the two boats approached one another, the current, which up to that time had been quite moderate, returned with violence towards Tasman Bay, and rapidly carried the boats away, each on its own side. All attempts for the moment became useless. Thus we remained with the anchor apeak; the whaleboat was hauled to the ship with its hawser; and I gave the order to the long-boat to remain at anchor.

At 11.30 a.m. the current still ran with the same force, and, fearing that the time of high water would be too short to execute our movements, I sent M. Lottin towards the long-boat with orders to haul up the stream-anchor, and to let it go near the corvette, so that the end of the three hawsers could be brought on board. This was carried out with success. At 1.30 p.m. we had hold of the end of the hawsers; the great anchor was lifted, and we hauled on the stream-anchor.

At 3 p.m. we let go another anchor in 5½ fathoms of water, on the edge of the sand-bank, and at 500 fathoms from either side of the channel. We now found ourselves in position to get under way at the first favourable wind.

In the evening, accompanied by several of the officers, I again visited the shores of the island [D'Urville Island]. I wished to penetrate into the interior, but the thickets and the steep slopes of the hills soon stopped me. From Reef Point I again attentively examined the pass, and promised myself to accomplish the passage the day following, if the weather permitted. In returning on board, our boat was surrounded by the foaming whirlpools of the pass, and we had some trouble to disengage ourselves. Nevertheless, on that occasion we ascertained that their aspect was very much more fearful than dangerous—at least, in manœuvring carefully.

In the morning some Natives came from Admiralty Bay as far as the reefs of the pass, and communicated with our people, but they would not venture on board. When we entered Current Basin we noticed near Lebrun Peninsula a small village, and when M. Guilbert was on the top of the hills which overlook the two bays he saw another village underneath him, on the side towards Admiralty Bay. None of the Natives of these villages showed themselves, although they could not have been ignorant of our presence. The tribes of these parts probably only knew of Europeans by tradition, and not one of them dared to make a closer acquaintance with us.

During the evening and the night the eternal west wind blew with violence in heavy squalls. At this time our position was more precarious than the preceding night, for if we had drifted the wind would have carried us directly on to the reefs of the pass, and there our end would not have been doubtful.

28th January.—At last I saw arrive a day which announced itself under happier auspices, and presaged to me a favourable wind. So as not to neglect any precautions in my power, at 4.30 a.m. I went to the S.E. point of the pass, and climbed to the top of the ridge overlooking it. It was not an easy thing to do, on account of the steepness and the thickets of impenetrable fern which covered the slopes for some distance; but I succeeded, and from a hillock my view plunged down on the pass, demonstrating that it was practicable with extreme precaution. Nevertheless, I did not dissimulate from myself that the enterprise might have a fatal ending. In looking towards the corvette I could not prevent myself fancying involuntarily that that machine, so well organized, so imposing, and destined for such a long career, would be for some instants, by the sole effect of my will, exposed to be lost on the rocks situated at my feet. Ten officers, an entire crew, inhabitants of that floating city now become their veritable country, might in a few hours find themselves reduced to seek their safety on a sterile and inhospitable shore, to lead a miserable existence, and perhaps perish without ever seeing again their relatives and friends. Such reflections for a moment shook my resolution; but it strengthened itself shortly, and I returned aboard decided to try my fortune.

At 7 a.m. the stream-anchor was got up and dropped near the ship, in 6 fathoms. A short time afterwards the breeze appeared established and moderate in the W.S.W., the tide was also slack, and I decided to get under way at once, so as to be master of my movements. We had taken the short cable to the stern, which presented the bows towards our route, and put us in position to catch the wind in the sails when unfurled. This was executed with great celerity. At the same instant the foresail, jib, the mizzen and lower topsail were set, and for some minutes we steered very well; but at the moment when we entered the pass the wind failed, and the current, coming against us with impetuosity, caused us to swerve to port. In vain I instantly put the helm up, and furled all after-sail, to try and approach the coast to the right—to touch it, as one might say, if it were necessary. The corvette would not obey at all, and, mastered by the current, she could not avoid being carried on to the rocks at the end of the reef, on which I knew there was but 10 ft. or 12 ft. of water [pl. xl]. Shortly after the "Astrolabe" touched twice. The first shock was slight; but the second time a lugubrious cracking, accompanied by a prolonged shaking, by a sensible pause in the movement of the corvette, and by a strong inclination to starboard, caused us a serious doubt that she rested on a rock, and would not come off. The crew at that moment involuntarily raised a cry of alarm. "It is nothing; we are over it!" I cried, with a loud voice, to reassure them. In fact, the current, continuing to drag the corvette, prevented her from remaining on the rock; beyond that the breeze freshened, and we got steering-way on her, and shortly, free of all fears, we sailed along under full sail in the peaceful waters of Admiralty Bay. We got off with the loss of several fragments of the false keel which the shock detached, and which floated in the wake of the ship.

Entirely occupied in the manœuvres of the moment, it was not possible for me to occupy myself with what passed around me. But those of my companions who could give more attention assured me that it was at that time an imposing spectacle to see the "Astrolabe," first heeling over as if ready to sink in the whirlpools that surrounded her, and then rising again gracefully and nobly, advancing through waters now become peaceful.

To preserve the recollection of the passage of the "Astrolabe," I named that dangerous strait the "Passe des Français" [French Pass]; but unless in case of urgency I would not recommend any one to try it, and then only with a strong breeze well established and nearly aft. For the rest, the charts that M. Guilbert has made from his surveys of all parts of the strait will considerably facilitate the navigation by those who follow us in the same place.

At 9 a.m. we laid to to make a "station," in 31 fathoms of water, and hauled up and secured all the boats. At that time we could contemplate at our ease the fine basin where we were. It merits certainly all the eulogiums of Captain Cook. I recommend, above all, a fine little harbour a few miles to the south of the place where that captain anchored. Protected by an advanced point (Point Bonne) against the swell and winds from the north, it offers an excellent shelter from all winds. [Probably Forsyth Bay, north-east entrance of Pelorus Sound.] I regretted sincerely that time did not permit me to spare some days to explore this bay, the more so that a Native village, situated just opposite us, promised fresh observations of interest. [The Natives that the expedition saw along this part of the coast were some of the Ngati-kuia Tribe of Pelorus, whose settlements extended in those days round Admiralty Bay, D'Urville Island, &c.—(TRANSLATOR).]

Our navigation of the French Pass had positively proved the land which ends in Cape Stephens, of Cook, to be an island. It is divided from the mainland of Tavai-Pounamou [Te Wai

Pounamu] by Current Basin. High and mountainous in all its extent, the coasts are sombre, escarped, and savage on the west, which looks out on Tasman Bay; but its aspect is much softer on the side of Admiralty Bay; there are even some very pleasant sites there. The island is twenty miles from north to south, and something under eight from east to west. The officers of the "Astrolabe," impressed with the desire to perpetuate the memory of their captain, wished his name to be attached to that part of the discoveries of the voyage, and he did not think it well to refuse that mark of esteem on the part of his brave companions. The name of D'Urville Island therefore will remain until the epoch when we shall learn the name it has already received from its inhabitants. [D'Urville Island is known to the Maoris as Rangi-toto; but even now, eighty years after the French captain's visit, it is better known by the name given it by his officers. The observation made by the celebrated French explorer in the last sentence quoted shows how fully he recognised the propriety of retaining the Native name of places, and is in keeping with the broad-minded views expressed all through his narrative.]

We may leave the "Astrolabe" here, to follow at a later period the interesting account of her stay at Tologa Bay and Auckland.

ART. XLI.—*Notes on Botanical Nomenclature; with Remarks on the Rules adopted by the International Botanical Congress of Vienna.*

By T. F. CHEESEMAN, F.L.S., F.Z.S., Curator of the Auckland Museum.

[*Read before the Auckland Institute, 28th August,* 1907.]

AT the present time all competent authorities recognise that natural science can make no satisfactory progress without a definite system of nomenclature, applicable to all countries, and available for the use of all workers. Names in the vernacular of any country, though convenient enough for local purposes, have the fatal defect of being, as a rule, intelligible in that country alone, and, in addition, are often ambiguous and uncertain in their application. It can be taken as an established fact, therefore, that in examining the species of any flora or fauna, for any purpose whatever, technical names must be employed if it is desired to fix the species under observation and to make their recognition by subsequent workers a matter of certainty.

The binomial, or binary, system of botanical nomenclature, which is the method now universally employed, was devised by the celebrated Linnæus, the bicentenary of whose birth has this year been fittingly commemorated. Under it all those species which agree in the possession of certain characters are collected into a group called a genus, to which a substantive name (*Clematis*, for instance) is applied. This name, which is common to the whole of the species of the group, is called the generic name. In addition to this, each one of the species is distinguished by a separate adjectival name, called the specific name; for instance, *Clematis indivisa*. Thus every species has two names—the first, or generic name, indicating the genus to which the species belongs; the second, or specific name, pointing out the particular species. It is this combination of the generic name with the specific epithet that constitutes the great merit of the system invented by Linnæus. Under it, a means is provided by which every known species of plant may have a technical name of its own, by which it can be known to all botanists, and which at the same time is readily distinguishable from the name of any other plant. Its simplicity and ease of application secured its immediate acceptance; and now, after the lapse of more than a hundred and fifty years from its inception, it can be said that no serious attempt has ever been made to depart from its leading principles.

But, although no one proposes to dispense with the binomial system, its practical working has, through a variety of causes, become exceedingly difficult and troublesome. Instead of stability of nomenclature, which is clearly the point to be aimed at, we have arrived at a chaotic state of uncertainty, which has a seriously deterrent effect on the study of systematic botany, even if it is not fast bringing it into contempt. The reasons for this regrettable state of affairs may be briefly particularised as follows:—

The botanical nomenclature of Linnæus is now usually considered to date from the publication of the first edition of his "Species Plantarum" in 1753. For many years after this date no difficulties of importance arose, although the absence of any code of rules, or even of any well-defined understanding as to modes of procedure, encouraged a laxity of practice sure to create trouble in the future.

Unfortunately, the idea of the inviolability of the specific name, when once conferred, now considered to be a point of the first importance, was of slow growth, so that eminent botanists, on the most flimsy pretexts, did not hesitate to alter or even reject names given by their own contemporaries. Then, as time went on it became apparent that many of the genera established by Linnæus or others of the early systematists required alterations in their characters. Some were much too extensive in their scope, and had to be divided into two or more; others were seen to be too closely allied, and had to be merged. All these changes involved alterations in nomenclature. And as the opinions of different authors working upon the same genera or groups of genera were naturally and probably unavoidably diverse, and as these opinions were often based upon totally different ideas as to the limitations of both genera and species, it followed, as a matter of course, that the resultant nomenclature was different. In the early days of botanical research, too, botanists were often imperfectly acquainted with each other's work. It often happened that two authors, working unknown to one another upon similar material, would independently propose new generic or specific names for the same plants. And although there was a vague understanding that the name first published was the valid one, it often occurred that the oldest name was not at first recognised, either from being described in some obscure publication with a small or purely local circulation, which consequently escaped the attention of botanists, or on account of the superior influence or position of one of the workers. It would be easy to enumerate other causes leading to disputed or uncertain nomenclature; but enough has been said to show that, with the progress of systematic botany, the nomenclature of the science yearly became more involved and difficult of application.

About 1865 the eminent botanist Alphonse de Candolle was induced to take up the question. After much careful study, and after an extensive correspondence with the leading botanists of the time, he prepared a code of rules or laws of nomenclature for the guidance of authors in the future. This code was submitted to an International Congress of Botanists held at Paris in 1867. It was then fully discussed, and, with a few unimportant alterations, accepted and issued to the world under the title of "Lois de la Nomenclature Botanique adoptees par le Congrès International tenu à Paris en Aout 1867." These laws embodied many essential principles, were well arranged and carefully drafted, and must be considered as constituting a decided step in advance. It was clearly laid down that in all cases of synonymy the earliest-published name, if accompanied by a sufficient description, should take precedence over names of later date; and this law was made retrospective, no doubt with the intention of providing that disputed questions of old date should be settled by the application of a fixed rule rather than by the preference of individual botanists or groups of botanists. But, notwithstanding the many excellencies of De Candolle's laws, and the fact that they received the nominal acceptance of botanists, it cannot be said that they were altogether successful. I have no intention of taking up space by inquiring into the reasons for this; but it may be profitable to discuss one or two points upon which the opinions of botanists differed, and which, in the absence of any definite rule, became the subject of much discussion, ultimately leading to still greater confusion of nomenclature.

As already mentioned, De Candolle provided that the first-published name should take precedence of all those issued at later dates. Now, this rule can be interpreted in two ways. By one school of botanists it is taken to mean that the specific name, when once applied, is absolutely unchangeable. The original author may have failed to place it under its proper genus, either through ignorance or neglect, or through a desire to avoid the multiplication of genera. But this matters nothing; under the rule the specific name first given to a plant belongs to it, and when changes of classification take place, and the plant is transferred from one genus to another, the name must be transferred with it; or, to put the matter in the forcible words of a well-known writer, the "specific epithet once given is indelible, and, whatever the taxonomic wanderings of the organism to which it was once assigned, it must always accompany it." But by another section of botanists it is held that the name entitled to priority is that under which a given plant was first placed in its *true* genus, even if the author had deliberately passed over pre-existing specific names under other but incorrect genera. At first sight this rule appears harsh, as it clearly refuses to recognise the work of the first describer of a plant, if he fails to place it in the proper genus; but, after all, it must be borne in mind that the object of botanical nomenclature is, as Mr. Bentham long ago pointed out, "the ready identification of species, genera, or other groups for study or reference, not the glorification of botanists." In the introduction to the "Flora of British India," Sir J. D. Hooker pertinently remarks "that a right comprehension of genera is of higher importance than the power of describing species. The number of species described by authors who cannot determine their affinities increases annually, and I regard the naturalist who puts a described plant into its proper position in regard to its allies as rendering a greater service to science than its describer, when he either puts it into a wrong place, or throws it into any of those chaotic heaps miscalled 'genera,' with which systematic works still abound." But the strongest argument in favour of adopting the earliest combination in the accepted genus as the rightful name of any plant is its simplicity and ease of application. It is comparatively easy to determine the first name applied to a plant in its correct genus; but it is often exceedingly difficult to ascertain the oldest name under any genus whatever. To settle such a point frequently demands a vast amount of bibliographic work, sometimes involving references to obscure publications often quite forgotten in their own country, and not always to be found in the largest public libraries. Such labour cannot be well described by any other terms than tedious, wearisome, and even repulsive.

Although published many years ago, it may not be without interest to quote the opinions of the renowned American botanist Asa Gray on this subject: "To keep up the name under which any plant is first placed in its true genus is simple, thoroughly practicable, and, in my opinion, most conformable to accepted rules, as well as most conducive to fixity of names. It is reasonable enough, under the stringent rule of priority, to resuscitate neglected older specific names pertaining to their proper genus; but surely it is unreasonable and inconsiderate to conclude any such right to specific names out of the genus to which they are subordinate" ("Journal of Botany," 1887, p. 355).

The following example will illustrate the working of the two interpretations of the Candollean law of priority. The genus *Haloragis* was founded by Forster in the year 1776, the type being a New Caledonian plant, to which he applied the name of *Haloragis prostrata.* In 1780 Murray proposed a genus called *Cercodia,* his type being *Cercodia erecta,* from New Zealand; but this genus has long ago been abandoned, all botanists considering it to be identical with *Haloragis.* In 1781 the Austrian botanist Jacquin described the species *Haloragis alata,* from New Zealand. It was soon ascertained that this was identical with Murray's *Cercodia erecta,* and the question at once arose as to which of the two names should be retained. Now, those botanists who believe that the earliest appellation under any genus is the only valid name will, of course, take the specific name of *erecta,* combining it with the generic term *Haloragis.* This course has recently been followed by Anton Schindler in his monograph of the family ("Das Pflanzenreich," Heft 23, p. 49). But those who hold the view that the earliest name in the correct genus is the one to be adopted will use the term *Haloragis alata;* and under this appellation the plant will be found described in Bentham's "Flora Australiensis," Hooker's "Handbook of the New Zealand Flora," and my own "Manual." Of course, the above is a simple case, and, were all questions of nomenclature capable of such easy determination, little more would be wanted than an agreement amongst botanists themselves as to the mode of procedure. But in cases where the species has been repeatedly shifted from genus to genus, and where botanists with very diverse views have worked more or less independently of each other, and perhaps without taking much trouble to ascertain what was already published, it is a matter of the very greatest difficulty to ascertain the earliest name. For instance, the late Mr. C. B. Clarke informed me that over eighty different names have been applied to the plant now usually known as *Scirpus cernuus.*

Another point which has led to much difference of opinion, and has produced many changes of names, is that several botanists working shortly after the times of Linnæus were not sufficiently careful in characterizing their new genera. In some instances it has been absolutely impossible to identify them; in others the identification is uncertain, and cannot be relied upon; while in not a few cases the genera were not recognised until other names had been proposed and passed into general use. In the latter case there has been much doubt as to the propriety of restoring such names, seeing that their adoption must cause great disturbance of nomenclature and great inconvenience to working botanists. The following example will make this clear:—

Most New Zealand botanists are acquainted with *Spergularia media,* a common plant in coastal districts throughout the Dominion, and equally abundant in many other parts of the world. The genus *Spergularia,* in which it is usually placed, was founded by J. and G. Presl in 1819. In 1820 the Swedish botanist Fries objected to its retention, on the ground that the genus had not been fully characterized; and, at his suggestion, Wahlenberg proposed the name of *Lepigonum* to take its place, our plant thus becoming *Lepigonum medium.* Shortly afterwards it was discovered that in Adanson's "Familles des Plantes" (vol. 2, p. 507), published in 1763, two genera respectively called *Buda* and *Tissa* were shortly characterized, which were evidently synonymous with *Spergularia.* As the descriptions of both genera occur on the same page, neither can claim priority over the other. According to the Candollean laws (article 55), in such cases an author can choose the name which he prefers. Dumortier, writing in 1827, selected *Buda,* which would make the name of our plant *Buda media.* But the change did not meet with the approval of the botanists of that time, and Presl's name of *Spergularia* passed into general use. Sixty years later, when the trend of opinion amongst systematists had become more favourable to the strict enforcement of the rule of priority, the American botanists Greene and Britton revived the name of *Tissa*, arguing that as its description, although on the same page, stands before that of *Buda*, it was entitled to priority. Under this view, which was adopted in Engler and Prantl's "Pflanzenfamilien," *Spergularia media* became *Tissa media*, and this name has been taken up by Dr. Cockayne in his "Report on the Island of Kapiti." It will be noticed that the species has been placed, in turns, in four genera at least; and, as the question of "sufficient description" has been raised with respect to most of them, it is not at all clear which name is really entitled to take precedence. No wonder that those botanists who consider that nomenclature is, after all, nothing more than a means to an end should object to the useless confusion thus occasioned. No wonder, too, that it should be argued that names which have passed into general use, and which for a long succession of years have been employed in important systematic publications by different authors, should not be disturbed in favour of long-forgotten names disinterred from obscure publications by a zealous innovator. It is satisfactory to know that the Vienna Congress has adopted this view, and that *Spergularia*, together with numerous other genera, are included in the "Nomina Conservanda," or list of names which must in any case be retained.

Many altogether useless changes of names are due to the fact that botanists have never been in satisfactory agreement respecting a starting-point for the binomial system of nomenclature. No doubt there has been a growing feeling in favour of taking the appearance of the first edition of the "Species Plantarum" of Linnæus in 1753 as the date of the first authoritative publication in systematic nomenclature. But there was no decided rule on the subject, and there are always people who scorn to follow the opinion of the majority, even where it is clearly conducive to the general convenience. Thus, some botanists have adopted the date of publication of the first edition of the "Genera Plantarum" in 1737; others that of the appearance of the "Systema Naturæ" in 1735; while there are still others who go back to pre-Linnean times, and accept names proposed by Tournefort, Ray, Dodoens, and others of the early botanists. Under such conflicting views confusion and disorder are unavoidable. Without dwelling upon this portion of the subject, it may be briefly stated that Linnæus did not perfect his system of botanical nomenclature until the publication of the "Species Plantarum," which contains his matured views. It is clearly unwise, as well as unfair, to base a system of nomenclature on his early works, all of which are more or less incomplete, or wanting in detail. As for taking up pre-Linnean names, it is hard to imagine what arguments can be advanced in favour of the proposal, while it is easy to see the many inconveniences which would result. And, if it be allowable to go back to the times of Ray and Gerard, there is no logical reason to prevent authors from making still more extensive excursions into the realms of antiquity, and quoting as authorities Virgil, Pliny, or Aristotle.

The foregoing remarks will give a general idea of the many difficulties which surround the question of botanical nomenclature. Before proceeding further, it is perhaps advisable to say a few words about the work of the late Otto Kuntze as a "reformer" in nomenclature, more especially as his publications, and the extraordinary number of changes proposed therein, constituted one of the chief reasons for summoning the Vienna Congress. His principal work is the "Revisio Genera Plantarum," the three volumes of which were published at intervals between the years 1891 and 1898. Although fully aware that botanical nomenclature, as devised by Linnæus, was not matured until the appearance of the "Species Plantarum" in 1753, he nevertheless takes as his starting-point the date of the publication of the first edition of the "Systema Naturæ" in 1735. This being settled, he next proceeds to give every publication that appeared after 1735 an equal value for the purposes of botanical nomenclature, and to rigidly enforce the application of the law of priority. Previous workers, as a rule, only concerned themselves with nomenclature when monographing a particular genus or family; with them, at any rate, it occupied a secondary position. But Dr. Kuntze boldly placed it in the forefront; and, at a vast expenditure of time and labour, instituted a systematic search through the whole of the botanical literature of the latter half of the eighteenth century, apparently for the express purpose of hunting out generic names of prior date to those commonly accepted. It is best to take his own statement as to the results of that portion of his work included in the first two volumes of the "Revisio." He says that he has monographed 109 genera; sunk 151 genera; renamed 122 genera, because they bore names identical with or similar to those of older genera; changed the names of 952 genera to older names, under the operation of the law of priority; and, finally, as the result of the above changes in generic names, has renamed more than 30,000 species. Sweeping changes of this character sap the very foundations of botanical nomenclature, and threaten to plunge it into a confusion tenfold greater than that from which it was rescued by Linnæus. Let us briefly examine some of the alterations in well-known and long-established names which we are asked to accept.

Taking the New Zealand genera first, as coming more directly under our notice, we find that the well-known name *Astelia*, published by R. Brown in 1810 from Banks's and Solander's MSS., gives place to the forgotten *Funckia*, published by Willdenow two years earlier; the equally familiar *Cordyline* (1789) is replaced by *Terminalis* (1744); *Luzula* (1805) is changed to *Juncodes* (1763); *Knightia* (1810) becomes *Rymandra* (1809); *Pimelea* (1788) gives place to *Banksia* (1776); *Calystegia* (1810) is changed to *Volvulus* (1791); *Wahlenbergia* (1814) is sunk in favour of *Cervicina* (1813); and so on. Altogether, between thirty and forty genera of New Zealand plants, if not more, receive new names, involving corresponding changes in the specific names of not far from 100 species.

Among plants cultivated in gardens we find such alterations as the following: *Pelargonium* becomes *Geraniospermum; Tropæolum* is changed to *Trophæum; Oxalis* is replaced by *Acetosella; Bambusa* gives place to the uncouth *Arundarbor; Protea* is dropped in favour of the sesquipedalian *Scolymocephalus;* the familiar *Zamia* becomes *Palmifolia;* and so on for scores of others.

Dr. Kuntze's appetite for change was by no means surfeited by many hundreds of alterations of a similar character to those just quoted. During his examination of certain obscure publications of old date he unearthed quite a number of generic terms which, though of prior date to others, had been ruled out of court by previous botanists because they violated the well-known law that botanical names should not be taken from barbarous tongues, or be unnecessarily long or difficult to pronounce. Thus, for instance, he takes the name of *Mokuf* from Adanson's "Familles," latinizes it by changing it to *Mokufua*, and then uses it to supersede the long-established *Ternstrœmia*. The still more hideous name of *Katoutsjeroe* he alters to *Catutsjeron*, and substitutes it for *Holigarna*. Finally, as a crowning instance of misdirected ingenuity, he brings forward the name *Jryaghedi*, which I fail to pronounce at all, and uses it for both the generic and specific name of a species of *Myristica*, which accordingly becomes *Jryaghedi Jryaghedi!*

One result of the wholesale shifting of names brought about by Dr. Kuntze is that well-known genera are sometimes left without a name at all. He then renames them, often dedicating them, in an original and amusing manner, to some of the lead ng botanists of his time. For instance, having decided, as previously mentioned, that the oldest name of the Australian and New Zealand genus *Pimelea* is *Banksia*, and finding that this change leaves the genus we have been accustomed to call

Banksia without a name, he resolves to provide it with one which will commemorate the late Baron Mueller's services to Australian botany. He cannot do this in the usual manner, as there is already a genus *Muellera;* but he gets over the difficulty by coining the new generic term *Sirmuellera!* In a similar way, Sir J. D. Hooker's connection with Indian botany is to be recognised by applying the name *Sirhookera* to a genus of orchids. Perhaps a more remarkable degree of ingenuity is shown by the invention of a whole series of names such as *Watsonamra, Kinginda, Ernstafra, Itoasia,* &c., all coined in honour of workers in botanical science. The addition "*amra*" implies that the prefixed author was mostly concerned with American botany; "*inda*" that his chief work was connected with India; "*afra*" with Africa; "*asia*" with the Continent of Asia; and so on.

It is difficult in a short sketch like the above to give a proper idea of the revolutionary changes proposed by Dr. Kuntze, and of the disturbing effect which their publication produced in the botanical world. It is true that, with the exception of a number of American botanists, some of whom have shown a disposition to go to greater lengths than Kuntze himself, hardly any workers in botanical science have accepted the conclusions arrived at in the "Revisio," and that very few of the generic or specific names proposed therein have passed into general use. At the same time, it is an undeniable fact that if the law of priority is to be rigidly enforced, then many of Kuntze's changes must be accepted, to the great detriment of botanical science. Under such circumstances, it is not surprising that a widespread feeling arose in favour of an agreement amongst botanists generally under which stability of nomenclature could be secured without revolutionary changes of such a sweeping character as to make the botanical literature of the past almost unintelligible to the workers of the future. The first practical step in this direction was taken in 1892, when a number of German botanists, under the leadership of Professor Engler, issued an important memorandum, recommending that the date of the publication of the "Species Plantarum" (1753) should be taken as the starting-point of botanical nomenclature, and suggesting a list of generic names to be retained which under the strict application of the law of priority, must otherwise be changed. Later in the same year, at a congress held at Genoa, a commission of thirty members was appointed to consider the question in all its bearings. The report of this commission, framed by Drs. Ascherson and Engler, did not appear until the commencement of 1895. It suggested the date of 1753 as a starting-point for both genera and species, provided that when transferring a species from its original genus to another the original specific name should be retained; and finally recommended that a name which had been lost sight of or neglected for fifty years should not be allowed to displace the corresponding one which had remained in common use. Following up this report, the Berlin botanists issued a series of rules embodying its principles, and suggesting a number of minor points for adoption. In the meantime recommendations or suggestions were freely made by individual botanists or groups of botanists in all parts of the world, and in 1900 a preliminary Congress met at Paris. At the outset, it was decided that its work, so far as botanical nomenclature was concerned, should be confined to providing the machinery under which the subject should be prepared for discussion at a fully representative Congress to be held at Vienna in 1905. A commission on nomenclature was therefore set up, of which Dr. Briquet, of Geneva, was appointed Rapporteur Général. It was understood that the duty of the commission was to provide recommendations for the amendment or modification of the laws of nomenclature drawn up in 1867 by Alphonse de Candolle. Mainly through the great activity and praiseworthy industry of Dr. Briquet the commission succeeded in preparing a "Texte Synoptique," in which were collated and compared the numerous suggestions made by botanists during recent years for the amendment of the Candollean laws. The suggestions were referred seriatim to the members of the commission, and were voted upon by the members, after which recommendations were tabulated according to the results of the voting.

The International Botanical Congress of Vienna, as it is officially styled, sat from the 11th to the 18th June, 1905, and was in every way a most successful and impressive gathering. Nearly five hundred botanists, representing most of the countries and nearly all the important botanical institutions in the world, attended the meeting. Among those present were several of those who may be styled the leaders of botanical science, and a majority of the names would be familiar to any one acquainted with recent botanical literature. The Congress can therefore be regarded as a thoroughly representative body, possessing a full claim to have its decisions respected by the great mass of working botanists. Passing over that portion of the work of the Congress not directly concerned with the subject of this paper, it is perhaps advisable to say that the plan adopted for the consideration of botanical nomenclature was as follows: Every afternoon the nomenclature conference, consisting of about a hundred and fifty representatives, with Professor

Flahault, of Montpellier, as president, Drs. Rendle and Mez as vice-presidents, and Dr. Briquet as rapporteur, met and worked steadily through the "Texte Synoptique," already alluded to. Much discussion arose on several debatable points, especially on the question as to the specific name to be adopted when a species is transferred from one genus to another, the result, as will be shown further on, being in favour of those who adopt the earliest epithet bestowed upon the species. But both in this and in other instances, although the points at issue were very fully and freely discussed, there was a total absence of all feeling, and an evident wish to arrive at a practical solution which would be acceptable to the majority of botanists. Quite four hours' work each afternoon for a whole week were found not at all too much for the proper consideration of the many intricate questions involved, and for the codification of the recommendations as finally agreed upon.

The main decisions of the Congress were promptly reported in botanical and other scientific journals, but the official report did not appear for considerably more than a year. It consists of a quarto publication of 100 pages, bearing the title (in French, English, and German) of "International Rules of Botanical Nomenclature, adopted by the International Botanical Congress of Vienna, 1905." The first sixteen pages are occupied by the preface, and a valuable "concordance" of the Candollean laws of 1867 with those now adopted. Pages 17 to 71 contain the text of the rules, or "articles" as they are called, given separately in French, English, and German. Pages 72 to 93 are taken up with a list of 408 "Nomina Conservanda" or generic names which are in any case to be retained, chiefly on account of long-established usage, although on the strict application of the law of priority they should be rejected. Finally, there is a useful "Index Analytique." But this report is only an extract from a larger publication entitled "Actes de Congres International de Botanique tènu a Vienne (Autriche) en 1905," which contains a full report of the debates and proceedings of the Congress, showing clearly the steps which led to the adoption of the rules.

It is not my intention to give the rules in full—every botanist should possess a copy of his own; and as they have been reprinted in pamphlet form by the proprietors of the "Journal of Botany," and can be obtained for the low price of 1s., no one need be without them. I propose, however, to make a few comments upon those which are of special interest to New Zealand botanists.

At the outset, it should be mentioned that the word "laws" originally adopted by Alphonse de Candolle in 1867 is changed in favour of "rules" and "recommendations." The difference between a rule and a recommendation is explained by Article 2, which states that the rules are "destined to put in order the nomenclature which the past has bequeathed to us, and to form the basis for the future." Recommendations "bear on secondary points, their object being to insure for the future a greater uniformity and clearness in nomenclature." Taken collectively the rules are divided into three chapters, containing 58 rules, or articles, as they are headed, and 37 recommendations. "The rules are retroactive; names or forms of nomenclature which are contrary to a rule cannot be maintained." "Names or forms of nomenclature contrary to a recommendation are not a model to copy, but cannot be rejected."

Article 9.—Under this rule it is provided that the nomenclature of cellular cryptogams and fossil plants shall be considered at the next International Congress, to be held at Brussels in 1910. To this Congress is also to be presented a proposed list of "Nomina Conservanda" for all divisions of plants other than phanerogams.

Articles 10–14.—These define the nature and subordination of the groups constituting the vegetable kingdom. It will be noticed that the word "order," which in the past has been commonly applied to groups such as *Ranunculaceæ*, is now used to designate those divisions of higher rank previously known as "cohorts," the word "family" taking its place. In future it will be necessary to speak of "the family *Ranunculaceæ*," "the family *Cruciferæ*," &c.

Article 15 provides that each group of plants, of whatsoever rank, can bear only one valid name, which must be the oldest, provided that it is in conformity with other rules.

Article 17.—"No one should change a name or a combination of names without serious motives, based on a more profound knowledge of facts, or on the necessity of giving up a nomenclature that is contrary to rules." It is to be hoped that the spirit of this rule will be acted upon in the future.

Article 19.—Under this rule it is definitely arranged that botanical nomenclature shall commence with the publication of the first edition of the "Species Plantarum" of Linnæus in 1753. The advantages of a fixed starting-point are undeniable, and the adoption of this rule alone marks a considerable advance in the direction of stability of nomenclature.

Article 20.—This important rule had better be quoted *in extenso:* "However, to avoid disadvantageous changes in the nomenclature of genera by the strict application of the rules of nomenclature, and especially of the principle of priority in starting from 1753, the rules provide a list of names which must be retained in all cases. These names are by preference those which have come into general use in the fifty years following their publication, or which have been used in monographs and important floristic (*floristiques*) works up to the year 1890. The list of these names forms an appendix to the rules of nomenclature."

I regard Rules 19 and 20 as the most important passed by the Congress, inasmuch as they will sweep out of existence many of the forgotten and useless names revived by Kuntze and similar writers. The list contains the names of 408 genera, containing many thousands of species. It is no light service to botanical nomenclature to preserve these names unaltered, and to obviate the worse than useless confusion which would have been caused by their change. I only regret that the list has not been made more extensive. For instance, *Nasturtium* might well have been included, seeing that some botanists propose to supplant it by the older but almost unknown name of *Radicula*. However, taking the list as it stands, New Zealand botanists will be glad to know that it preserves from alteration the names of thirty-one genera of New Zealand plants and of seventy-five species. We shall not be compelled to call *Astelia* by the name of *Funckia*, or to change *Cordyline* to *Terminalis*, or *Luzula* to *Juncodes*, &c. No doubt the setting-up of a list of plants not subject to the law of priority is an arbitrary measure; but then desperate diseases require vigorous remedies, and there is practically no other plan of preventing an entirely disproportionate or even overwhelming amount of change in botanical nomenclature.

Articles 24 *and* 25, dealing with the names of genera, are well worth attention. Clause (*d*) of Recommendation 4, subjoined to the rule, provides that generic names may be accompanied by a prefix or suffix, or may be modified by anagram or abbreviation, and in such cases count as different words. I mention this because the late Dr. Kuntze contended that all such names should be treated as synonyms, and only the oldest retained. Under the above recommendation both *Durvillea* and *Urvillea*, *Chloris* and *Chloræa*, *Glaux* and *Glaucium*, are valid, and will be allowed to stand.

Article 26.—Recommendation 10: This is to the effect that specific names begin with a small letter, except in the case of those taken from the names of persons, or from generic names, as *Phyteuma Halleri*, *Lythrum Hyssopifolia*. My reason for drawing attention to this is that all previous editors of the "Transactions of the New Zealand Institute" have insisted on treating botanical names in the same manner as zoological, where the practice is to use a small letter for *all* specific names. But the custom of botanists has always been different (see No. 34 of the Candollean laws). Now that the Congress of 1905 has reaffirmed the principle, it is to be hoped that botanists may be allowed to have their specific names printed in their own fashion.

The clauses of Recommendation 14, dealing with the formation of specific names, should have the attentive study of all botanists who have anything to do with the naming of plants.

Article 35, treating of the publication of new names, states, "Publication is effected by the sale or public distribution of printed matter or indelible autographs. Communication of new names at a public meeting, or the placing of names in collections or gardens open to the public, do not constitute publication." The words "public distribution of printed matter or indelible autographs" are a little vague. If it is meant that any person whatever may share, if he wishes, in the "public distribution," then no objection can be taken; but great objections exist to the publication of new species by the distribution of printed or autographic matter among a few friends. Nowadays there are so many regular publications in which descriptions of new species can appear that it would have been better to have limited publication to the sale of printed matter alone.

Article 36.—"On and after January 1st, 1908, the publication of names of new groups will be valid only when they are accompanied by a Latin diagnosis." This I regard as a great mistake. It is understood that the proposition originally submitted to the Congress was to the effect that the publication of names of new species, &c., must be accompanied by a description either in Latin, English, French, German, or Italian. This was strongly opposed by the Russian and Scandinavian members, and the limitation of the diagnosis to the Latin language was apparently taken as the only practicable solution of the difficulty. The voting on the question was very close—105 for the proposal, and 88 against. The most serious objection to the rule is that it tends to confine the publication of new species to a few professional botanists, and will thus narrow the interest taken in systematic botany as a whole.

Article 49.—Under this rule it is agreed that when a species is transferred from one genus to another the first specific epithet must be retained or re-established. This must be taken as one of the most important and far-reaching decisions of the Congress, asserting, as it does, the inviolable nature of the first specific name, no matter in what genus it may have been placed.

In another part of this paper I have mentioned the chief reasons which have induced almost all English botanists, up to the present time, to support the view that not the earliest specific epithet but the earliest name in the correct genus should receive the acceptance of botanists. While regretting the decision of the Congress, I am prepared to admit that, in the interests of botanical science, it is necessary that the rules should be generally accepted and implicitly followed. I therefore trust that finality has been reached on this question, and that all working botanists will adopt the new rule.

Article 50.—" No one is authorised to reject, change, or modify a name (or combination of names) because it is badly chosen, or disagreeable, or another is preferable or better known, or because of the existence of an earlier homonym which is universally regarded as non-valid, or for any other motive either contestable or of little import." This is a valuable rule, inasmuch as it prevents any alteration or tampering with valid names. A name once given must be preserved in its original shape. The only change which can be made is that provided for by Article 57, which permits the correction of a typographic or orthographic error. Even this, as stated in Recommendation 30, " must be used with reserve, especially if the change affects the first syllable, and, above all, the first letter of a name." The rule also disposes of the contention that a name once lapsed into synonymy is always a synonym, and cannot again be employed.

Articles 51–54.—These rules, which should be carefully studied, specify the circumstances under which it is necessary or allowable to reject, change, or modify names, whether ordinal, generic, or specific. They have been carefully framed, and appear to be fair and equitable. The chief reasons are specified in Article 51, which I quote herewith : " Every one should refuse to admit a name in the following cases : (1) When the name is applied in the plant kingdom to a group which has an earlier valid name ; (2) when it duplicates the name of a class, order, family, or genus, or a subdivision or species of the same genus, or a subdivision of the same species ; (3) when it is based on a monstrosity ; (4) when the group which it designates embraces elements altogether incoherent, or when it becomes a permanent source of confusion or error."

Article 55.—The important part of this rule is the second clause, providing that specific names must be rejected when they simply repeat the generic name. This rule will effectually put an end to such combinations as *Linaria Linaria*, *Abutilon Abutilon*, *Petroselinum Petroselinum*, &c., which have, through the craze for priority at any cost, come into partial use during the last ten years, particularly among a section of American botanists.

Recommendations 34 and 35, placed with some others in the appendix, suggest that the metric system only should be used in botany for reckoning weights and measures, &c. I am certainly of opinion that all measurements given in the Latin diagnosis, which is now imperative when a new species is described, should conform to this rule; and it might also be reasonably adopted in memoirs or communications prepared mainly for the use of professional botanists. But it is open to discussion whether the metric system should displace the system of measurement adopted in any country in the case of floras or other works written in the vernacular of that country, and intended for general use. After all, the convenience of the majority is the point to be considered.

In the above remarks on the results of the Vienna Congress I have, for the sake of brevity, passed over several rules which are of considerable interest and value to the working botanist. My principal object has been to draw attention to those rules which, if they are adopted and acted upon by botanists generally, may be expected to relieve the intolerable state of uncertainty into which botanical nomenclature has drifted during the last twenty-five years. The work of the Congress, as a whole, gives evidence of steady progress towards a stable nomenclature, and it is in every way desirable that the rules should have a fair trial. They have been fully and carefully discussed by a body specially summoned for the purpose, and are framed in moderate and reasonable terms. I think it can be said that they constitute a sincere and honest attempt to settle the many differences of opinion which of late years have wasted and divided the energies of systematic botanists, so far as matters of nomenclature are concerned. No doubt, to arrive at a permanent settlement will demand much forbearance, and necessitate the subordination of individual inclinations to the decision of the majority; but, on the other hand, the advantages to be gained from the establishment of a stable system of nomenclature are incalculable.

It may be asked what changes in the nomenclature of New Zealand plants will be caused by the new rules. To this I would reply that they are comparatively few. So far as the genera are concerned, the list of "Nomina Conservanda" appended to the rules shuts out most of the alterations proposed by Dr. Kuntze and his followers. With respect to the species, the majority of the changes will be due to the adoption of the rule that in all cases the earliest specific epithet must be maintained. Names like *Haloragis alata* and *Ipomœa biloba*, although the oldest in the correct genus, must give place to *Haloragis erecta* and *Ipomœa pes-capreæ*, as the oldest in any genus. In a similar manner, the affirmation of the principle that no one can reject a name because of the existence of an earlier homonym which is universally regarded as non-valid will cause a few alterations. For instance, Mr. Kirk's name of *Lepidium flexicaule*, given under the supposition that Hooker's *Lepidium incisum* was invalidated by the earlier *Lepidium incisum* of Roth, must be abandoned, and Hooker's name restored, Roth's name being now generally admitted to be non-valid. I propose to draw up a complete list of the alterations rendered necessary, but the work is not one to be hurriedly prepared or hastily published. Those who are so eager to promulgate new names that they do not take the trouble to consider them in all their bearings will probably find that later on they will have to supersede the very names they have themselves proposed. One source of trouble and delay is the necessity of referring to European libraries for the verification of the dates of publication of those species described in works not available in the Dominion. Experience has proved that it is not always safe to trust to the quotations of dates, &c., given in floras or even in general works on botany. With the view of showing the character of the changes that will have to be made, I give as an addendum to this paper a list of those necessary in the ferns —a family in which the proportion of new names will be larger than in most others. It will, of course, be understood that I am dealing only with the changes rendered necessary by the adoption of the international rules.

Addendum.

Changes in the Nomenclature of the New Zealand Ferns caused by the International Rules of Botanical Nomenclature adopted at the Botanical Congress of Vienna.

1. *Hymenophyllum subtilissimum*, Kuntze, Anal. Pteridog., 49 (1837). Oldest name, and the one to be adopted, *Hymenophyllum ferrugineum*, Colla, Mem. Acad. Torino, 39 (1836).

2. *Hymenophyllum unilaterale*, Willd., Sp. Plant., v, 521 (1810). Oldest name, *Trichomanes peltatum*, Poir., Encycl., viii, 76 (1808); name to be adopted, *Hymenophyllum peltatum*, Desv., Prodr., 333 (1827).

3. *Lindsaya trichomanioides*, Dryand. in Trans. Linn. Soc., iii, 43 (1797). Oldest name, *Adiantum cuneatum*, Forst., Prodr., n. 461 (1786); name to be adopted, *Lindsaya cuneata*, C. Chr., Index Fil., 392 (1906).

4. *Lomaria alpina*. Spreng., Syst. Veg., iv, 62 (1827). Oldest name, *Polypodium penna-marina*, Poir., Encycl., v, 535 (1804); name to be adopted, *Lomaria penna-marina*, Trev., Atti. Inst. Veneto, 14, 570 (1869).
5. *Asplenium falcatum*, Lam., Encycl., ii, 306 (1786). Oldest name, *Trichomanes adiantoides*, Linn., Sp. Plant., ii, 1098 (1753); name to be adopted, *Asplenium adiantoides*, C. Chr., Index Fil., 99 (1905).
6. *Aspidium capense*, Willd., Sp. Plant., v, 267 (1810). Oldest name, *Polypodium adiantiforme*, Forst., Prodr., n. 449 (1786); name to be adopted, *Aspidium adiantiforme*.
7. *Nephrodium unitum*, R. Br., Prodr., 148 (1810). Oldest name, *Aspidium gongylodes*, Schk., Krypt. Gew., 1809; name to be adopted, *Nephrodium gongylodes*, Schott, Gen. Fil. ad t. 10 (1834).
8. *Nephrodium molle*, R. Br., Prodr., 149 (1810). Oldest name, *Polypodium parasiticum*, Linn., Sp. Plant., ii, 1090 (1753); name to be adopted, *Nephrodium parasiticum*, Desv., Prodr., 260 (1827).
9. *Polypodium Cunninghamii*, Hook., Gard. Ferns ad t. 30 (1862); Sp. Fil., v, 58 (1864). Oldest name and name to be adopted, *Polypodium dictyopteris*, Mett., Ann. Sci. Nat., 15, 72 (1861).
10. *Gleichenia dichotoma*, Hook., Sp. Fil., i, 12 (1844). Oldest name, *Polypodium lineare*, Burm., Fl. Ind., 235 (1768); name to be adopted, *Gleichenia linearis*, C. B. Clarke in Trans. Linn. Soc., ii, Bot., i, 428 (1880).

In addition to the above, alterations affecting the names of *Polypodium australe* and *P. Billardieri* are held over for fuller inquiry.

Art. XLII.—*Metre.*

By Johannes C. Andersen.

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CHAPTER I.

1. Rhythm in music or poetry is an uninterrupted succession of equal divisions of time, each more or less filled with sound. Speech, as it becomes exalted or emotional, tends to become rhythmical. Rhythmic speech is intended to please rather than to instruct; to convince through the emotions rather than through the intellect. Therefore, the praises of their patrons were sung by the sagamen of old; prose would have insured ridicule rather than reward: so, too, a lover is allowed greater latitude when he sings his rhapsodies than when they fall from his lips in prose.

2. Apart from its audible nature, rhythm has a distinct form when written or printed as poetry. As distinguished from prose, its chief characteristic to the eye is that it is written in lines of definite lengths, each, as has been usually asserted by prosodists, containing a definite number of syllables. That the number of syllables is not everything, however, is implied when it is said above that the equal divisions of poetry are *more or less* filled with sound. This theory has of late years been amply set out by T. S. Omond, and need not now be further spoken of, as it must recur in the course of this essay. The external form of verse has not been so exhaustively treated as the internal, but forms almost as interesting a study, seeing that it is the external and visible expression of the internal and invisible spirit. Scansion studies the regularity of "feet," the component parts of verses, or, as they are more commonly called, lines; but little attention has been paid to the regularity of the lines themselves.

3. The length of the lines is supposed to have been given by their users, the poets, and to have been fixed by their usage. This study will be confined to the absolutely rhythmical lines that followed the alliterative and comparatively rhythmical staves of the old Scandinavian or early Saxon bards. Is it possible that the length of the lines could have been fixed arbitrarily? If one poet were great enough to fix them, another could arise great enough to alter them. In "Chambers's Encyclopædia," under the heading "Metre," it is stated that

the ten-syllabled line was adopted because the eight-syllabled was too short and the twelve-syllabled too long; but no reason is given. In the last "Encyclopædia Britannica" it is suggested that, whilst usage may have made the line what it is, there may be some deep underlying law which has unconsciously guided the poet. Without doubt there is an underlying law: nor is it of great intricacy, for it is clearly manifested every time a stanza of verse is read aloud. Yet of the many writers on English prosody, though all speak of the regularity of lengths, not one gives the reason nor suggests the law for this regularity.

4. It is this law that is to be traced; and, as any law is best seen in operation where simplicity offers no distraction, the simplest and commonest forms of verse will serve as the best illustrations. We will therefore turn to ballad-metres, taking as simplest and most convenient Ritson's collection of the Robin Hood ballads. The discovery of this law is as important as the discovery of a primary law determining the form assumed by any particular predominant type of animal—say, man.

CHAPTER II.

BALLAD-METRE.

1. The commonest form in which ballad-metre is now printed is in quatrains, or stanzas of four lines, the first and third *usually* eight-syllabled, the second and fourth six-syllabled.

The true and original form, however, is different, each pair as printed being really one line of fourteen syllables. In Ritson's prefatory note to the "Ballad of Robin Hood and the Beggar" he says, "It may be proper to mention that each line of the printed copy is here thrown into two, a step which, though absolutely necessary from the narrowness of the page, is sufficiently justified by the frequent recurrence of the double rime. The division of stanzas was conceived to be a still further improvement." This "narrowness of the page" has been given as one reason for the adoption of lines of certain uniform length, and it has also been stated that thus printed the eye more readily catches the substance of the words. Both statements can at once be dismissed when it is remembered that the length of line was fixed at a time when the ballads were transmitted orally, before books were printed at all. The lines are printed as fourteen-syllabled in Warner's "Albion's England."

2. From Ritson's remark that "the division of stanzas was conceived to be a still further improvement," it is evident (as from their oral transmission, too, it must be) that the long lines were run on without division into stanzas; but the fact that it was at all possible to divide them in this way is a significant one. It means that in most cases two fourteen-syllabled lines

formed a complete sentence. There are, naturally, many instances where stanzas are divided by colons only, but in the majority of instances each stanza is syntactically and synthetically complete.

Each line is, moreover, a complete clause, the comma after the eighth syllable being often no more than the mark of the printer's inordinate fondness for that symbol where verse is concerned.

3. Rimes, originally marking stanzas and aiding memory, came to be regarded as *end words;* and in printing, wherever rimes occurred, lines were cut off. This will be referred to more fully when rime is considered, and is only referred to now to indicate how rime has had an influence in splitting up and disguising the true metre. (See Chapter V.)

4. (*a.*) Other things helped to disguise the metre, such as variations from the true type. These variations consist of feet containing less or more than two syllables, dropped feet, and displacement or duplication of the accent. The following quotations will serve as illustration of these variations; the first-quoted, normal in metre, serving as type of the usual :—

(2.)

He met a beggar by the way, who sturdily could gang;
He had a pike-staff in his hand that was both stark and strang:
A clouted cloak about him was, that held him frae the cold,
The thinnest bit of it, I guess, was more than twenty fold.

The accent occurs regularly on the second syllable, and each line runs smoothly and with spirit.

(3.)

Rò|byn stòde | in Ber|nysdàle, | and lèaned | him tò | a trèe,|
And bỳ | him stòde | Lytèll | Johànn, | a gòod | yemàn | was hè.|
(Page 115, line 9.)

(4.)

Mùch | was rè|dy with | a bòlte, | rè|dly ànd | a nòne,|
He sèt | the mònke | to fòre | the brèst, | to the gròund | that hè | can gòne.|
(Page 154, line 73.)

(5.)

A rỳght | good à|rowe hè | shall hàve, | the shàft | of sỳl|ver whỳte,|
The hèad | and the fèd|ers of rỳche | rède gòlde, | in Èng|lond is | none lỳke.|
(Page 164, line 17.)

(6.)

For yè | have scàr|let and grène, | maystèr, | and mà|ny a rỳche | arày,|
There is | no màr|chaunt in mè|ry Englònde | so rỳche, | I dàre | well sàye.|
(Page 127, line 280.)

(7.)

Gòd | the sàve, | good Rò|byn Hòod, | and àl | this còm|panỳ.|
Wèl|come bè | thou gèn|tyll knỳght, | and rỳght | welcòme | to mè.|
(Page 160, line 237.)

(8.)

Have hère | foure hòn|dred pounde, thèn | sayd the knỳght, | the which | ye
lènt | to mè ;|
And hère | is àl|so twèn|ty màrke | fòr | your cùr|teysỳ.|
(Page 161, line 261.)

(9.)

When thèy | had shòte | abòut, these àr|chours fayre | and gòod,|
Ev|ermòre | was the bèst | fòr | soth, Rò|byn Hòod.|
(Page 165, line 53.)

(10.)

Rò|byn, sàyd | our kỳnge | nòw | prày | I thè,|
To sèll | me sòme | of thàt | clòth | to mè | and mỳ | meynè.|
(Page 188, line 5.)

(11.)

And ỳf | I tòke | it twỳse, | a shàme | it wère | to mè ;|
And trèw|ly, gèn|tyll knỳght, | welcòme | arte thòu | to mè.|
(Page 162, line 269.)

(12.)

Stỳll | stòde | the proùd | sherỳf, | a sò|ry màn | was hè :|
Wo wòrthe | the, Ray|nolde Grèn|elèfe ! | thou hast nòw | betrày|ed mè.|
(Page 147, line 181.)

(13.)

Theyr bòw|es bènt | and fòrth | they wènt | shò|tynge àll | in fère,|
Towàrd | the tòwne | of Nòt|ynghàm, | òut|lawes às | they wère.|
(Page 189, line 21.)

(14.)

Whèn | he càme | to grène | wòde, | ìn | a mèr|y mòrn|ynge,
Thère | he hèrde | the nòtes | smàll | of bỳrdes | mèr|y sỳng|ynge.
(Page 193, line 109. The only feminine rimes in the whole
geste of 8 fytte.)

(15.)

Alàs ! | then sàyd | good Rò|byn, alàs | and wèll | a wòo !|
Yf I | dwele lèn|ger with | the kỳnge, | sòr|owe wỳll | me slòo.|
(Page 191, line 81.)

Later Ballads.

(16.)

Althò' | good Rò|bin woùld | full fàin | of his wràth | avèn|ged bè,|
He smìl'd | to sèe | his mèr|ry young mèn | had gòt|ten a tàste | of the trèe.|
(Page 226, line 249.)

(17.)

Good mòr|rowe, good fèl|lowe, said Rò|byn so fàyre, | good mòr|rowe, good
fèl|lowe quo' hè ;|
Methìnks | by this bòwe | thou bèars | in thy hànd, | a gòod | archere thòu |
shouldst bè.| (Page 231, line 97.)

(18.)

And sòme|times, whèn | the hìgh|way fail'd, | then hè | his còu|rage ròu|ses,
Hè | and his mèn | have òft | assaìled | such rìch men ìn | their hòus|es.
(Page 246, line 209.)

The so-called varieties of metre (such as trochaic, dactylic, anapestic, amphibrachic) arising from these variations will be spoken of more particularly in the chapter on metre; all that is required in this place is to show that the normal fourteen syllables are maintained in all these lines, divergent as many may appear from the normal type. (See Chapter VI.)

(*b.*) As suggested in Chapter I, section 2, the equal divisions of poetry, called "feet," may be more or less filled with sound. The rhythm is the integral movement of which a foot is part: the foot is one of the equal divisions of the rhythm, and each foot normally consists of two beats—one light, one heavy. Words float on the beat of the rhythm, and the rhythm is constant, though a word may here and there be dropped or doubled. The place of the word in the former case is taken by a pause; in the latter a triplet is produced. Take the second line of the 8th quotation:—

And hère | is àl|so twèn|ty màrke | fòr | your cùr|teysỳ.|

Nine out of ten would read "marke" as one syllable, making the line the same as the second of quotation 13:—

Towàrd | the tòwne | of Nòt|ynghàm, | oùt | lawes às | they wère.|

The tenth might give the "e" of "marke" its full old-time value, when the line would have its fourteen syllables; so also to the gross ear would the line last quoted by the insertion of "bold" before "outlawes." In the same manner a pause takes the place of the first syllable in the first line of quotation 3: for "Robyn stode" read "Good Robyn stode." The second line of quotation 4 runs,—

He sèt | the mònke | to-fòre | the brèst, | to the gròund | that hè | can gòne.|

Here there are three syllables to the fifth foot, but it is evident they only occupy the time of two; they are, in fact, what triplets are in music—they alter the time *only of the foot* in which they occur. So again in quotation 6: here there are no less than four trisyllabic feet in the two lines; and, *the time remaining constant throughout*, an agreeable tripping effect is produced. In quotation 15, "Alàs! | then sàyd | good Ròbyn," the accented syllable is dropped: the line reads normally by inserting "Hood" after "Robyn." Taking quotation 11,—

And ỳf | I tòke | it twỳse, | a shàme | it wère | to mè; |
And trèw|ly, gèn|tyll knỳght, | welcòme | art thòu | to mè. |

In reading, a distinct pause is made after "twyse" and "knyght"—a pause equal to the two syllables dropped. In the second line of quotation 5,—

The hèad | and the fèd|ers of rỳche | rède gòld, | in Èng|lande is | none lỳke |

we have two trisyllabic feet followed by a foot in which both syllables are accented, forming a fine contrast.

(*c*.) These are the usual variations. Such a line as the first of quotation 8 is too rugged to be correct; it has too many syllables: the second of quotation 9 has too few: both may be instances of faulty transmission. It is possible to read them with their proper metre, but the effect is unpleasing, whereas the effect of the other variations quoted is the reverse.

All the variations arose, possibly, by accident; it is more than possible they were faulty slips of amateur ballad-singers seized upon by good craftsmen as means of embellishing and varying the sing-song of the measure.

5. (*a*.) Referring again to quotation 15,—

Alàs! | then saỳd | good Rò|byn, | alàs | and wèll | a wòo! |

As already suggested in (*b*) of the previous section, this line has the eighth syllable dropped, and reads normally by the insertion of "Hood" after "Robyn." It will be noted that the syllable dropped is one which when present *bears an accent;* and though lines such as this, containing thirteen syllables, do not often occur in English ballads, it is the normal line of the Danish and German ballad. The great German epic, the "Nibelungen Noth," is written entirely in this thirteen-syllabled line, varied in the same way that the English line is varied. In old pieces it is written as one line; in later compositions it is split in two just as the English line is, and a mid-rime further disguises it; as in Œhlenschlaeger's "Thor in Helheim":—

His mood and trust enduring,
He hasted through the night;
The darkness, less obscuring,
Was slowly lost in light.
One saw where torches glimmered
Within the chasm, as if
The moon had fall'n, and shimmered,
Caught in a cloven cliff.

In this metre the stanzas are, as a rule, made up of either four lines of thirteen syllables, or eight of seven and six alternately. The latter is the case when mid-rime occurs, as in example quoted; the former is the case where there is no mid-rime, as in the case of the German epic, and in the Danish poet Winther's series of tales entitled "Woodcuts." A stanza of similar construction is that employed by Allan Ramsay in "Christ's Kirk on the Green."

(*b*.) Quotation 11, again, has, as noted, a foot dropped in each line:—

And yf I toke it twyse, a shame it were to me;
And trewly, gentyll knyghte, welcome arte thou to me.

Such lines, again, are not very frequently met with except in solitary instances, but they also have their counterpart in the Alexandrine, forming the measure which, first used in France in the twelfth century, in a poem on Alexander the Great, became the heroic or epic line of French poetry. The line is not easily worked into long poems in English, Drayton's "Polyolbion" being the only one of any considerable length in which it is employed. It is, however, used with fine effect as a concluding line in heroic stanzas such as Spenser's "Faerie Queene": the stanzas seem to gather body like a wave, and break majestically in the long sweep of the Alexandrine. Part of "Polyolbion" may be quoted to show the effect in reading this line continuously:—

> From wealthy abbots' chests and churls' abundant store,
> What oftentimes he took, he shar'd amongst the poor;
> No lordly bishop came in lusty Robin's way,
> To him, before he went, but for his pass must pay.

It will be found that a pause, equal to a foot, is instinctively made after the sixth syllable, so that the metre is practically read as ballad-metre. The same is true of the German metre; so that it is evident all these metres have a common basis, each assuming the form most compatible to the nature of the people adopting it.

6. Whilst it has been noted that each ballad-line contains fourteen syllables, a pause at the end of each line must be accounted for; so that each line contains in reality eight feet, seven of which are filled with sound. Proof of this may be adduced from a source rather unexpected—that is, from Church hymns.

As may be seen from the Robin Hood ballads, the Church and its ministers were held in very scant respect by the ruder classes; indeed, Bishop Latimer complained to King Edward VI that, passing through a certain town, he let it be known that he would be there on a certain day, and coming to the church he found it locked, it being Robin Hood's Day, and the people to a man preferred celebrating his day to hearing the Bishop. It would therefore appear strange that the Church should ever countenance the perpetuation of a poetic measure which formed the medium in which were preserved the popular tales of the people—tales many of which would nowadays be considered *tapu*, and many of which were directed against the Church itself. But it was the Church in the first instance that practically gave this metre to the people, in the early metrical romances. This metre of eight-syllabled half-lines was taken from the French, and seemed to be the final outcome of a long evolutionary process in metre in the European tongues, gradually breaking up and changing, in England, the rugged lines marked only by alliterative divisions, such as are seen in "Piers Plowman." In this sixteen-syllabled metre were told the lives of the saints, and other religious subjects, which formed the literary staple of the people. It was no wonder, therefore, that when the people took to creating their own tales they took the metre which was most familiar to them; the more readily, too, that it was—though unknown to them—the *natural* metre. But its evolution was not complete, as was indicated by the fact that the second half of the sixteen-syllabled line showed a constant tendency to shorten itself when spoken; and, as the metre became more and more used by the people, it slowly but surely assumed the fourteen-syllabled form, which has remained unchanged to this day, and is the most attractive of all metres. Metre had, in fact, evolved to the natural type.

In the Index to the Church of England Hymns, A. and M., of the first hundred hymns, eighty-one are in ballad-measure. The strict measure, fourteen-syllabled, is in the index called "common measure"; sixteen-syllabled is "long measure"; and twelve-syllabled, "short measure." The confirmation of the measure comes in this: Minims are used as the basic note, and in every measure (common, short, or long) *each line is sung to sixteen syllables*; in long measure each line ends with a minim; in common and short the six-syllabled lines are eked out to eight syllables with a dotted semibreve. What is yet more suggestive is that in still shorter measures the sixteen syllables are obtained: for instance, in Hymn 306, whose lines contain six and five syllables alternately, the six-syllabled lines end with two semibreves, the five-syllabled with a breve, making the sixteen syllables in all. The last remark premises the statement that of the nineteen hymns in the hundred which are not ballad-metre to the eye—that is, they contain less than six-syllabled lines—the music makes them pure ballad; so that it is not too much to say that at least 90 per cent. of the Church hymns are in ballad-measure. The exceptions are mostly hymns of late composition, such as "Lead Kindly Light"; though even some of these later hymns, such as "Hark, hark, my Soul," though of eleven- and ten-syllabled lines alternately, are by the music made sixteen-syllabled. This is, metrically, an extraordinary fact, and shows how deeply the measure is imbedded in man's rhythmic nature. Here the conservative nature of the Church is of unexpected assistance in showing the primal and constant nature of the ballad-measure—the measure whose magic Sir Philip Sidney declared stirred his heart like a trumpet. In these later days, though the ear is attracted by the artificial forms of poetry that have been brought to perfection by men like Swinburne, the heart is at once touched and responds to a lilt in the old ballad-measure.

7. This long measure, the sixteen-syllabled line, has been especially used by two poets in English—John Gower and Sir Walter Scott. Gower's lines were meant for the eye rather than for the ear—that is, his tales were not to be sung; he was, too, in close touch with the metrical romances, whose teaching he continued. Scott's lines were certainly meant for the eye; and though in the first poem written by him in this measure, the "Lay of the Last Minstrel," they are supposed to be sung by an old minstrel, it never passes the supposition: the minstrel did not sing them; the printer gave them to the eye, not the minstrel to the ear. The point to be noted is this: the eye needs no pause in reading, such as the voice needs in reciting. Scott deliberately discarded the natural ballad-metre, as in his day it had become the medium of an enormous amount of jingling nonsense; he admittedly harked back to the metrical romance metre.

8. On these remarks a certain statement is to be based. Ballads were originally sung or recited; the common measures are in twelve, thirteen, or fourteen syllables; a complete phrase is almost invariably expressed in that number. The inference is that fourteen syllables proved to be the average that could be uttered in one breath; a breath was taken during the silent foot, and the second line then spoken or sung. The conclusion then is, the breath determined the length of the ballad-line; and it will be found that *almost invariably* a breath is taken at the end of each line of fourteen syllables. This is the law: so simple that it seems absurd; so natural that it is inevitable. In singing the metrical romances—or their latter-day equivalents, Church hymns—a gasp is taken after the sixteenth syllable: it was the awkwardness of this gasp that began the shortening of the second half of the line, and produced the line of fourteen syllables, the true ballad.

CHAPTER III.

1. An objection to the conclusion arrived at in the last chapter appears to arise at the very outset. Though ballad-metre was formerly employed as the common medium, that metre is no longer predominant, but has given place to one considerably shorter—that is, the ten-syllabled metre of blank verse. This metre was first introduced into English by Surrey, but was not in that form the popular measure that the rimed heroic of Chaucer proved itself: it was too indefinite; lines were fused, and the old definite pause was missed. It was therefore as the rimed heroic that the line took firmest root, and was

best used by Chaucer. With him it runs freely; the lines, though stopped by means of the rime, are yet not stopped abruptly; the mid-pause of the line, or cæsura, is varied, and it has some of the charm of blank verse with the primitive charm of rime added. With Pope the place of the cæsura became more definite, and the lines. too, were more definitely stopped; in fact, the rime broke his verses up into couplets; they became a string of epigrams: so that it has been said of Pope that under the curb of pause and rime his Pegasus became a rocking-horse. Such monotony must cause a revulsion. That revulsion took shape, not in discarding the metre, but in discarding the rime and in varying the place of the mid-pause. Dryden, among others, wrote against this innovation, maintaining that the rimed heroic was the suitable measure for tragedy, as it gave such opportunity for epigram—a state of things quite out of harmony in tragedy, where, of course, epigram has no place.

2. (*a.*) In Pope's couplets the two lines generally serve to convey a complete sentence, in the same way that the two lines of ballad-metre did. On reading Pope aloud, too, it will be found that a breath is taken invariably after the tenth or twentieth syllable—much more often after the tenth. Here, then, it would seem that the average length of a sentence is ten syllables: Pope by his artificiality has made the average the actual. Why should ten syllables be adopted here in the place of fourteen? Reading aloud gives one reply: it will be noticed that Pope's lines are read more slowly, more deliberately, than lines in ballad-metre. The reason will be at once seen on examining the nature of the subject conveyed by the words. The ballads are active, Pope is reflective: one relates an incident, intense and almost without detail; the other contemplates the incident, and elaborates the detail: one is active, one is sedentary. The very deliberate nature of his subject enabled Pope to measure his lines as if by scale.

(*b.*) In this light it will be interesting to compare two translations of Homer—one by Chapman, the other by Pope. Chapman employed the only metre really suitable—the equivalent, in English, of Homer's metre—when he employed the ballad-metre. One cannot but indorse Keats's sonnet in the main, but, whilst admiring the skill, the fault is also evident. Chapman made this mistake: he did not sufficiently stop the lines; he used the ballad-metre, the metre of action, but tried also to give it the flexibility belonging to blank verse in allowing his lines constantly to overflow; and it is these overflowing parts principally that cause his metre to halt. Rimes, when used, should generally coincide with pauses, not make them; with Chapman, they do not point his metre, but break it. Pope failed more signally in rendering Homer, since he adopted the reflective metre, heroic verse—too much stopped, and too evenly paused. Chapman enables us actually to see the action ; Pope compels us to imagine it. Scott had an instinctive feeling as to the reason for Pope's failure. He pointed out that Pope's opening lines of the Iliad could all drop one foot, reducing the ten syllables to eight : thus, instead of—

> The wrath of Peleus' son, the (direful) spring
> Of (all the) Grecian woes, O goddess, sing ;
> That wrath which hurled to Pluto's (gloomy) reign
> The souls of (mighty) chiefs untimely slain :
> Whose limbs, unburied on the (naked) shore,
> Devouring dogs and (hungry) vultures tore :

he read

> The wrath of Peleus' son, the spring
> Of Grecian woes, O goddess, sing ;
> That wrath which hurl'd to Pluto's reign
> The souls of chiefs untimely slain :
> Whose limbs, unburied on the shore,
> Devouring dogs and vultures tore.

Note that every pair of lines is in reality one long line. The dropping of this foot brings the metre into line with Scott's favourite, which is no other than the long ballad-metre referred to in section 7 of Chapter II—a metre in which many of Sir Walter Scott's ballads, collected and otherwise, as well as his own minstrelsy, run.

It would almost seem that the Iliad is best translated in ballad-metre, not heroics or blank verse ; in the verse of energy and action, not of rest and reflection. As suggested, the ballad recites an event ; Pope's heroics contemplate it ; blank verse acts it. This summarises the essential difference in nature : the two former are in a measure artificial ; the last is natural ; and in that fact will be found the reason for the overflowing lines.

3. Even when rime was discarded from the heroic line, the tendency to stop the lines was for a long time powerful. Whilst writers felt that the rime was a hindrance in emotional passages, they did not, as a class, see why. Soon, however, the lines overflowed, the sense incomplete in one being carried to the next.

CHAPTER IV.

Blank Verse.

At the outset the secret of blank verse becomes visible : its lines as printed are still those of the heroic, the *average* length of a sentence ; but the variations of actual speech can be fully displayed with no disruption in metre, no violation of emotion. As the emotions vary, so the breath varies in depth and duration ;

so, too, the length of the sentences uttered by that breath. Macduff (Macbeth, ii, 3) cries in horror,—

> Awake, awake !
> Ring the alarum-bell.
> Murder and treason !
> Banquo and Donalbain !
> Malcolm ! awake !
> Shake off this drowsy sleep, death's counterfeit, and look on death itself !
> Up, up, and see the great doom's image !
> Malcolm !
> Banquo !

Here all the feeling is in the short, abrupt exclamations : they are cries of horror at the deed : only when that horror is for a time forgotten in metaphor does the quickly drawn breath permit of longer sentences.

As a contrast, compare the length of the following sentences, where the emotion is so calm as to permit the breath to utter long imaginative phrases :—

> Proserpina, for the flowers now, that, frighted, thou lett'st fall from Dis's waggon !
> Daffodils, that come before the swallow dares, and take the winds of March with beauty,
> Violets, dim, but sweeter than the lids of Juno's eyes or Cytherea's breath.

How shall these two extracts be laid in the Procrustean bed of decasyllabic verse ?

Take another quotation, from the murder scene in "Othello," where the contrast in the varying emotion is more perceptible :—

> (10) It is the cause, it is the cause, my soul,—
> (14) Let me not name it to you, you chaste stars !—It is the cause.
> (6) Yet I'll not shed her blood ;
> (21) Nor scar that whiter skin of hers than snow, and smooth as monumental alabaster.
> (10) Yet she must die, else she'll betray more men.
> (10) Put out the light, and then—put out the light !
> (25) If I quench thee, thou flaming minister, I can again thy former light restore, should I repent me :
> (17) But once put out thy light, thou cunning'st pattern of excelling nature,
> (16) I know not where is that Promethean heat that can thy light relume.
> (16) When I have plucked thy rose, I cannot give it vital growth again,
> (5) It needs must wither.
> (6) I'll smell it on the tree.
> (16) O balmy breath, that dost almost persuade justice to break her sword !
> (4.) One more, one more.

(16) Be thus when thou art dead, and I will kill thee,
and love thee after:
(6) One more, and this the last:
(7) So sweet was ne'er so fatal.
(9) I must weep, but they are cruel tears:
(12) This sorrow's heavenly; it strikes where it doth
love.
(2) She wakes.

Here there are twenty sentences, with 218 syllables, an average of not quite eleven syllables to a sentence. Again it will be noted that the longest are those containing imagery. After the deed, all but the last sentences are pure emotion:—

Yes:—'tis Emilia:—by-and-by.—
She's dead!
'Tis like she comes to speak of Cassio's death;
The noise was high.—
Ha! no more moving?
Still as the grave.—
Shall she come in? Were't good?
I think she stirs again.—
No.—What's best to do?
If she comes in, she'll sure speak to my wife.
My wife! my wife! what wife?
I have no wife.
O, insupportable!
O, heavy hour!
Methinks it should be now a huge eclipse of sun and
moon;
And that the affrighted globe should yawn at alteration.

This passage from "Othello" has been taken at random as an emotional passage: many others may be found where the average is about ten syllables to a sentence, such as Lear ii. 4. beginning "The king would speak with Cornwall," and v. 3. "O, you are men of stones!" which both average slightly under nine; Hamlet, i. 4. beginning "Angels and ministers of grace, defend us!" which averages eleven; Hamlet, iii. 4. "Look here, upon this picture and on this," and iii. 4. "Ecstasy! . . ." both of which average slightly over eleven.

Though the natural way would be to write or print the sentences as above, such a disjointed manner, whilst perfectly correct for acting, would break the consecutiveness of rhythm in reading; and the ten-syllabled line, the general average of a sentence, has been adopted for readers. One advantage of printing them as breathing sentences would be that they would serve as a visible index to the fluctuating emotions.

CHAPTER V.

RIME.

1. As suggested in Chapter II, section 3, rime has been largely instrumental in disguising the metre, and at the same

time giving the variety of form to printed poetry. At first the two rimes, as in ballad-metre, marked the stanza, and the rimes came gradually to be looked upon as the end-words. When, therefore, mid-rimes were introduced into ballad-metre, the fourteen-syllabled line was cut into two—one of eight and one of six syllables—as in quotation 18 :—

And sometimes, when the highway fail'd,
  Then he his courage rouses,
He and his men have oft assailed
  Such rich men in their houses.

The leonine or internal rime in the eight-syllabled line, as in quotation 13, introduced a new change, such a line being sometimes printed

Their bòw|es bènt |
And fòrth | they wènt |
Shò|tynge àll | in fère. |

Sometimes the four syllables of each leonine will be expanded to eight (the "light-horse gallop of verse"), as—

When Ruth was left half desolate
Her father took another mate ;
  And Ruth, not seven years old,
A slighted child, at her own will
Went wandering over dale and hill,
  In thoughtless freedom bold.

And again, both halves of such a stanza may further be resolved into four-syllabled leonines, as—

With ravished ears
The monarch hears ;
Assumes the god,
Affects to nod,
And seems to shake the spheres.

Such variations become yet more complicated when the rimes are feminine or double. A first reading would entirely fail to make Shelley's "The Cloud" the same metre as "Jack and Jill"—both ballad. But that the metre is the same is evident in taking a more regular stanza :—

I sìft | the snòw |
On the mòun|tains belòw, |
And their grèat | pines gròan | aghàst ; |
And àll | the nìght |
'Tis my pìl|low whìte, |
While I slèep | in the àrms | of the Blàst. |

Jàck | and Jìll |
Went ùp | the hìll |
To fètch | a pàil | of wà|ter ;
Jàck | fell dòwn |
And bròke | his cròwn, |
And Jill | came tùmb|ling àfter.

In both each leonine has two accents, the odd line three—the common measure of ballad-metre. The simple metre of "The Cloud" is, of course, further disguised by its triple feet.

As has been said, double rimes occur only once in "A Lyttel Geste of Robyn-Hood," eight fytte of 461 stanzas, but they become more and more frequent as time goes on.

Once printing became common, this variation of the ballad stanza became more and more frequent and complicated, until now many stanzas that read well enough to the eye read roughly aloud; but still the most popular poems are those written in metre more nearly approximating to the old ballad.

CHAPTER VI.

Metre.

1. Coming now to the last chapter, a few words will be said concerning metre itself. All blank verse, all ballad verse—which two include by far the greatest bulk of English poetry—is essentially iambic—that is, each foot contains two syllables, the stress falling on the second. Is there any reason why two syllables should be the natural number to a foot? for the preponderance of two-syllabled feet, and of iambic, show the iambic to be the natural foot.

Speech in poetry being an expression of the emotions, it is natural that speech should be regulated by those emotions; and so it is, as was shown by the quotations in Chapter IV: as the emotion deepens or strengthens, the speech becomes more rapidly and forcibly uttered, the sentences being proportionately shorter. Directly, the voice is produced by the lungs; indirectly, it is affected by the heart: more rapid breathing, if involuntary, implies more rapid heart-action; and increased heart-action, besides being caused by increased physical exertion, is also caused by emotional excitement. Hamlet, accused by his mother of madness, says,—

> My pulse, as yours, doth temperately keep time,
> And makes as healthful music;

and between calm contemplation and emotional terror there is a whole gamut finding expression not only in the voice, but in the beating and throbbing of the heart.

Reading aloud, or reciting, say, the speech of Antony over the body of Cæsar, it will be found that an average of from 140 to 160 syllables are uttered in one minute. In ordinary speech, 120 words is the average number spoken in a minute —say, 190 syllables. But no man recites so fast as he speaks, more especially verse, for every beat must be regarded or the rhythm will be lost. The heart makes, normally, an average of slightly over seventy pulsations a minute, each pulsation being composed of two periods—that of rest, and the almost synchronous beat of the auricles and ventricles (one-tenth of a second only intervenes); it beats, in fact, almost in iambic measure.

This is, of course, no more than an approximation; but that such an approximation is at all possible is not without significance, and is of intense interest in determining the origin of the basic metre of poetry, the iambic. It may seem doubtful which is the effect, which the cause; but, the heart being the organ of the emotions, it is reasonable to suppose that it should affect the emotional expressions of the voice; and, similarly, the action of the lungs being affected directly by that of the heart, the duration of an utterance should naturally be affected by those organs.

That iambic is in reality the basic metre may also be demonstrated by tracing the growth of all the other metres from it.

2. There does not seem much doubt that the trochee is no more than the iamb with the first and unaccented syllable dropped. In Milton's "L'Allegro" and "Il Penseroso," what are called trochaic lines freely mingle with iambic lines without break in the rhythm, though with some difference in audible effect.

That the attack in music is made on the first note of a bar may be adduced as argument that the trochaic effect is a natural one; but it will be remembered that in a great many cases one or two accented notes occur isolated before the first bar; and more, the finale is always an attack. It is therefore more reasonable to suppose that the bar has been put before the note attacked rather as a visible guide to the performer than as the natural division-line of the rhythm.

It cannot be gainsaid that the "Lyttel Geste" is in iambic metre, yet what are called trochaic lines constantly occur (see quotations 3, 4, 7, 10, 12, 14). There is absolutely no warrant for calling them trochaic lines, for it is evident that a syllable has been dropped at the beginning of the line, and the line is iambic immediately after the first syllable and onwards. This erroneous nomenclature has arisen because syllables have been taken as the only constituents of a foot, instead of both syllables and pauses.

3. Take the second line of quotation 4:—

He sèt | the mònke | to-fòre | the brèst, | to the gròund | that hè | can gòne. |

Here the fifth foot contains three syllables, but the three are uttered in the time of two; they are, in fact, equivalent to a triplet in music: that is, the foot is iambic, with a triple effect. So in the second line of quotation 5:—

The hèad | and the fè|ders of rȳche | rède gòlde, | in Èng|londe ìs | none lȳke. |

Here the second and third feet have three syllables each; but the effect is only to make the line appear more rapid in movement: the normal tempo is unaltered. Again, the fourth foot, whilst still containing two syllables, has both accented. In quotation 6 the effect is still more marked:—

For yè | have scàr|let and grène, | maystèr, and màny a rȳche | aràу, |
There ìs | no màr|chaunt in mè|ry Englònde | so rȳche, | I dàre | well sàye. |

Here each line has two feet containing three syllables: and whilst the whole reads faster, the beat is still iambic.

As has been said, the later ballads become more and more trisyllabic. The following lines (date 1751) are alternately purely trisyllabic and purely iambic:—

As blìthe | as the lìn|net sings ìn | the green wòod, |
So blìthe | we'll wàke | the mòrn; |
And thrò' | the wide fò|rest of mèr|ry Sherwòod |
We'll wind | the bùg|le hòrn. |

but the trisyllabic line gives a decided trisyllabic effect even to the iambic. In quotation 16 the effect becomes still more pronounced:—

Althò' | good Rò|bin wòuld | full fàin | of his wràth | avèn|ged bè, |
He smìl'd | to sèe | his mèr|ry young mèn | had gòt|ten a tàste | of the trèe. |

and in quotation 17, trisyllabics are altogether predominant:—

Good mòr|rowe, good fèl|lowe, said Rò|byn so fàyre, | good mòr|rowe, good fèl|lowe, quo' hè; |
Methìnks | by this bòwe | thou bèars | in thy hànd, | a gòod | archere thòu | shouldst bè. |

Were the lines of the two last quotations given to a syllabic prosodist, he could not with certainty say if they were in duple or triple measure. Another example will illustrate his difficulty:—

Knòw ye the | lànd where the | cȳpress and | mȳr|tle
Are èmblems | of dèeds that | àre dòne in | their clìme? |
Whère the ràge | of the vùl|ture, the lòve | of the tùr|tle

These have been quoted by prosodists as an example where the trisyllabic metre is used in its three forms, the first line being composed of dactyls, the second of amphibrachs, and third of anapests. Poe was the first to point out that the measure is unchanged when the lines are run on without linear division; all three are in so-called dactyls if judged from the opening feet, anapests by the closing. What, then, is to be said of the lines just previously quoted? They begin like the second of the three above; the first line sustains the amphibrachic effect, but it breaks down in the second in three feet, or in one if the final "e" be sounded in "bowe" and "archere." This the prosodists say is the poetic license allowed in trisyllabic metre. The license is the other way: it is the iambic metre that has been overlaid with trisyllabic feet, and asserts itself time and again: there is an outcrop of the basic metre—or, as poetry is a living thing, a reversion to type. This reversion to type will be found in all the metres—trochee, anapest, dactyl, amphibrach; the reversion is always to the iambic—sufficient proof of the basic nature of that metre, of which the others are "sports," some cultivated to a perfect degree, but all nevertheless "reverting" under stress of circumstance. The reversion is sometimes so frequent that it is almost impossible for the prosodists to say which is the true metre and which are the exceptions—*e.g.*, Shelley's "The Cloud," and Cowper's "Poplars."

The reducing of all metres to one elementary metre, allowing the terms "trochee," "dactyl," &c., to be applied to *varieties of individual feet only*, is a reassertion of the simplicity of metre: there is but one metre, but its variations are legion. If we admit three-syllabled feet as native, what is to prevent an extension to four- or five-syllabled feet, as allowed by the Germans? The more loaded the foot is with syllables, the less is it able to mount to the heights, as could be shown with a four-syllabled foot much used by the Australian versifiers.

By this reduction, too, we abolish a host of perplexing licenses, exceptions, and a dictionary of technical phraseology. The whole of the former may be included in a sentence: a foot may (1) be an entire suspension of sound; or (2) may contain one syllable, either (*a*) accented, or (*b*) unaccented; or (3) two syllables, (*a*) one or (*b*) both accented; or (4) three syllables, always, it appears imperative, accented on the third syllable: *i.e.* :—

(1) Fourth foot, and normally at end of every line :—

And ўf | I tàke | it twўse | — — | a shàme | it wère | to mè | — — |

(2) (*a*) In the first foot :—

Gòd | the sàve | good Ròb|yn Hòod. |

In first and second feet :—

Stўll | stòde | the pròud | sherўf. |

In last foot :—

To sèll | me sòme | of thàt | clòth. |

(*b*) In the last foot :—

Alàs! | then saўd | good Ròb|yn — |

(3) (*a*) In all feet :—

(1.) A rỳght | good à | rowe hè | shall hàve |
(2.) Hè and | his mèn | have òft | assàiled. |

(*b*) In last foot :—

The hèad | and the fèd|ers of rỳch | rède gòlde. |

(4) Good mòr|rowe, good fèl|lowe, sayd Ròb|yn so fàyre. |

In the fourth license, it seems the accent must fall on the third syllable ; if it appear to fall on the second, it will be found that the phrase contains its basic iamb followed by an anapestic foot ; if on the first, the first syllable of the iamb has been dropped and again an anapestic foot follows. It will be seen that these licenses are the variations upon which all the varieties of metre have been built.

It may, then, be ruled that the natural metre of English verse is iambic, with its trisyllabic equivalent, anapestic ; and that the length of lines may vary from five to eight feet, depending upon the nature of the subject—those of five, blank verse, admitting of very frequent overflow, and those of eight, including generally the silent foot for breath, admitting of no overflow. It will be seen that this includes all the metres in which the world's best poetry has been written ; and a question here suggests itself : did not the hexameter arise in a similar manner to the ballad-metre ? for in English the ballad is its equivalent. I cannot speak with authority on classical metres, which are modelled on length of syllables rather than on stressed syllables —on quantity rather than accent ; but it would appear from analogy that both have sprung from and both were regulated by a common source and principle, the breath ; and whilst quantity may therefore have ruled the classic metres, their effect on the ear need not necessarily differ materially from our accented verse. Our own verse is sometimes quantitative, but rhythmical accent is always superior to the accent of individual words, and I believe the same to be true of classical metres.

To conclude, it is suggested that the normal measure, the iambic, has sprung from the heart-beat, as being the rhythmic source nearest to man, and most constant in its actions upon him. (It has been shown how the iambic measure varies in time in proportion as the heart-beat varies, influenced by changing emotions.) The suggestion may at first seem fantastic ; but I am convinced that, whilst proof may be difficult, proof will come. Next—and this is more than a suggestion—the length of line that the two primary metres, ballad and blank verse, have adopted has been fixed by the breath. (Here, again, it has been shown how the ballad, a bare recital of an event, is able to accomplish such recital in stanzas composed of lines of even length, this length being the average of a sentence spoken in a breath, whilst blank verse, the language of action itself, is in overflowing lines, an average length being still generally kept, and that length again the average of a breath; it has also been shown how the emotions affect such lengths of line, in that they affect the depth and duration of the breath; and that a breath is almost invariably taken at the ends of what are considered "artificial" lines.) This formulates a new law; not only so far as New Zealand is concerned, but new to the English-speaking world. The relation between the ballad and the hexameter is a suggestion more than probable; the origin of all metres from the iambic, and the predominance of that type, is comparatively certain, as is the fact that a pause may form an integral portion of a foot. Should these laws and suggestions become established, we have come absolutely to the bed-rock of verse forms; and, personally, I have no doubt whatever but that, including the most important, the heart-beat and breath, they *will* be established.

ART. XLIII.—*The Disappearance of the New Zealand Birds.*

By DR. FULTON.

[*Read before the Otago Institute, 11th May, 1907.*]

THE birds of our islands, largely through the efforts of Sir Walter Buller, Captain Hutton, Mr. Potts, and Mr. Colenso, are well known to the scientific world as interesting, if not in many ways unique; but, owing to change in environment, alterations in food-supply, disturbance of the balance of nature by ridiculous importations of birds and animals, our beautiful feathered friends are fast going to the wall; and it is to review the position fairly and squarely that I am here to-night.

It is not my intention to speak here of our sea-birds. The advance of civilisation, the spread of cultivation, the increase of population, does not touch them; their destruction by millions on the outlying islands, cruel and wasteful as it may be, hardly affects them at all. Their migratory habits, their extremely prolific powers, their almost inaccessible nesting-places, seem to protect them, and there is little fear of their disappearance.

My purpose is to show what has become, and what is becoming, of our perching-birds, our climbers, our waders, our rails, our fresh-water swimmers.

Now, with regard to the scarcity of our birds at the present day, we must remember that, although where we are the birds are undoubtedly scarce, there are millions of acres of virgin bush where still our birds exist in great numbers. It is now hardly possible for us city men to make original observations on the birds. We must therefore avail ourselves of information at second-hand, endeavouring to find out what is correct and reliable. Such careful observers as Dr. Cockayne, Mr. Elsdon Best, Mr. W. W. Smith, and Mr. Guthrie Smith, have given me much assistance, and I have had the advantage, through the courtesy of the Government Biologist, Mr. Kirk, of examining all the circulars from the Department of Agriculture on the subject of our feathered immigrants and their effect on the native birds. I have also been fortunate in obtaining from Mr. J. Drummond, F.L.S., copies of his Bulletin, which have been most valuable. To all of these gentlemen my thanks are due, and are hereby gratefully rendered. Dr. Cockayne says that, generally speaking, "all the country along the railway-lines (the west coast of the South Island excepted) is quite denuded of forest, except small patches here and there. Proceeding from the north coast of the North Island to the latitude of Auckland is still much forest, the greater part partly cut out, but still fairly dense, while along the flanks of the higher mountains and near Hokianga Estuary, and both north and south, and Whangape is virgin kauri forest. Along the shores of the northern Wairoa and its affluents is much white-pine forest. Forest extends from the Little Barrier Island, by way of the Big Barrier, to the Thames mountains, and thence to Rotorua, almost meeting the great forest which covers with a dense mantle the whole East Cape region, and follows the main chain of the North Island to Cook Strait; though, so far as the Tararua and Ruahine Mountains are concerned, the forest is only to be found now upon their flanks. North of Lake Taupo is a fine forest, and this extends in a more or less broken manner westwards, where to the west of the volcanic plateau comes the great Waimarino Forest. North and east Taranaki and Egmont is still forest-clad, and so is much of northern Wellington along the head-waters of the Rangitikei, &c. As for the South Island, the western spurs of the dividing-range and the coastal plain, where such exists, is virtually primeval forest. Patches of forest occur on the mountains of north-east Nelson; and there are patches here and there still in the Marlborough Sounds, as well as more extensive areas in D'Urville

Island. The eastern Southern Alps contain many smaller and larger forest areas, the Seaward Kaikouras are bush-clad, and the coast ranges to the south have usually the gullies full of forest. Then comes the great break of the treeless Canterbury Plains, the upper river-valleys, and eastern and central Otago. Finally, southern Otago still contains some large forest areas, as, *e.g.*, west and south of Catlin's and the Longwood Forest. Stewart Island is all forest, and perhaps one-fifth of Chatham Island, while most of the lower country of the Auckland Islands is forest-covered."

Our birds of prey, consisting of three hawks and two owls, are now rarely seen. The sparrow-hawk, relentlessly gunned; the bush hawk, deprived of much of his shelter, his main bird-food (quai's) gone; lizards all but absent through cultivation, ploughing, and draining; ground-larks well out in the open fields, where he dare not follow—a price upon his head; in all directions, save in the densest West Coast bush or hidden mountain-bound swamps, he is not; he is reported at Brightwater, near Nelson, Hororata, Ihuraua, and Little Barrier.

The harrier, a leisurely, wary bird, still hangs on, though slowly and surely he is going. He can be occasionally seen on the Taieri, and he is reported as increasing at Temuka, Ashburton, Waihemo, Waitaki, Waverley, Rongomai, and the Bay of Islands; he is extinct at Tauranga and other places; but he is mentioned from many localities as just holding his own.

The owl, timid at all times, practically blind in the daytime, is turned out of its forest haunts by the onward march of saw-mills—the hollow tree brought down or fired; his flight, heavy and noiseless, is not quick enough to save him from the worrying sparrow and blackbird; at all times stupid in the daylight, he is driven back to the depths of the West Coast. His some-time rocky homes are trodden round and destroyed by sheep and cattle, and his animal food is getting less and less as agriculture advances. He is shot on sight by every gun-bearing fool, and the New Zealand morepork's cry will soon be heard no more. His principal food, the native rat, is removed, ousted by the introduced, more wary, rodent from Europe; everything is gone; nothing remains but oblivion. Moreporks and owls are reported as "existing" to-day at Brightwater; as "present" at Mataura, North Wairoa, Rodney County, Omata, Ngatimaru, Ormond, Paradise, Patutahi, and Manganui; as "not decreasing" at Pohonui, Raglan, and Ramarama; as "disappearing" from Waimea, Rongomai, Waverley (Patea), Hokianga, Waiheke Island, Wangaehu, and Helensville. Owls are mentioned at Waikaka, Wainuiomata, Temuka Road, Ihuraua, Kaukapakapa, near Dunedin, and Wyndham.

Of our perching-birds, none was better known to our early settlers than the kingfisher. The spread of the brown-trout: the reign of the angler: the nest in hollow rotten trees or clay-bank, easily traced and robbed by stoats and weasels; food reduced by every imported songster; shot at by all and sundry: he has not a chance. Sir Walter Buller, as late as 1882, thought the bird was holding his own; but it is evident that in the last twenty years he has practically disappeared from our midst. He is "holding his own" at Kaipara, Kaitaia, Bay of Islands, Carnarvon, and Havelock; "present" at a number of places in both islands; "extinct" at Castlepoint since stoats were introduced there. I saw one at Otakou kainga on Good Friday of this year.

The stitch-bird, according to the Maoris once common throughout the islands, was rare on the arrival of the pakeha, no doubt owing to its striking appearance and pretty feathers; it was taken both for food and ornament. Rare in the North Island, it has never been seen by a white man in the South Island. This bird is now confined absolutely to the islands of Kapiti and Little Barrier, where, although he is protected by the Government, one fears he will soon die out. There is no doubt in my mind that collectors, in the last thirty years, have done much towards exterminating the stitch-bird.

I now come to the tui, our king of birds, who is fast disappearing from our midst—his nesting-place appropriated by the alien; his nest built higher and higher in the creeping vines; harried by weasel and ferret (he has been seen fighting and struggling with the red-eyed monster, falling from the dizzy height and giving his life for his young). Snared in thousands by the Maoris, he held his own, for his forest fortresses were intact; but at last the advance of the vulgar alien has scared him, and back he goes into forest primeval. Honey is taken from the flax and fuchsia by many imported birds—notably the starling—and thus his chief food is lessened, if not absent. It may be interesting to record here a point I have not seen mentioned about our tui. He has a habit of flying at a great height from one place to another: rising, say, from a deep wooded glen at a gradual angle, flying leisurely, he arrives at a point directly over his destination, and then he absolutely drops, with a terrific rush, to the bush below. When two or three of them do this, as frequently happens—and I believe they do it as a sort of play—the noise as they rush through the air can be heard a quarter of a mile away. I believe this is the explanation of the curious fact mentioned by Dr. Hocken in "The Early History of New Zealand." Mr. Tuckett's diary says, "All the people frequenting this coast believe in the existence of an extraordinary bird or phantom which they can never see but only hear rushing past them through the air with the rapidity of a falling rock, and making a terrible rushing sound. The Maoris declare that it is a bird possessing many joints in its wings. The whalers call them break-sea devils, after the name of an island where this phenomenon is of most frequent occurrence." I should be glad of further information of this curious habit, which is generally seen and heard at about dusk or sunset, the tuis returning home for the day ending their journey with this wild rush. The tui is reported as "more plentiful" at Rissington than formerly; "holding his own" at Raglan, Rongotea, Waiheke, Wainui; "said to be increasing" at Waitotara, Waitohi; "rare and uncommon" at most other places.

With the tui is the mocker, or bell-bird, another honey-eater whose food in flax-bush and *Pittosporum* is lessened by the honey-bee, thrush, and starling. Lovely in its song, as it is modest in its plumage; nesting in the creepers, where it is hunted by weasels and ferrets and by that curse of bird life, the rat; fruit which it soon became fond of actually removed from its very beak by the blackbird and sparrow; the undergrowth of native bush cleared away; every tree-crown or festooned totara dotted with a dozen alien nests, and the korimako, in its turn, displaced. A weasel has been seen to attack a bell-bird on its nest, and, the two falling to the ground together, the weasel was despatched by the observer; but the bird was fatally injured. In some seasons the bell-bird makes a fresh spurt. In 1905 I heard the notes every day through the winter months, and I took particular notice of it; then the birds seemed to disappear, and I have not heard the notes of one for the last eighteen months. It was snared in millions by the Natives—their title to land was often proved as an act of ownership by the "snaring of the korimako"—and yet this did not suffice to greatly diminish their numbers. It was left to the pakeha and his pestilential friends to exterminate them. It is pleasant to note that the bell-bird is still "plentiful" at Pipiriki, Raetihi, Pavanui Pa, Stewart Island, all up the West Coast bush, at Banks Peninsula, on Kapiti Island, and on the Barriers; but where the imported birds are he is almost gone. He is reported as "still existing, though scarce," in many localities throughout both islands.

Coming to our little white-eye, or tahou, "the stranger," who came from Australia in 1856, and has been with us ever since, once so common in our manuka and on our plum and apple trees, where he took his full share of good things, he is now as rare as he was common. The bird is still fairly common in some parts of the North Island. He is said to "swarm" at the

Wairarapa, to be "increasing in numbers" at Ellston, Waerenga, the Bay of Islands, and the south-east coast of the North Island; but, save very rarely, he is not now seen with us. Easily supplied with necessary food, prolific, laying four or five eggs twice in the season, its nest well protected from rats and weasels, it is astonishing that it is not more numerous; but it is probable that it will survive the storm, and, though not strictly an indigenous bird, be one of the last of our feathered inhabitants.

Among our creepers, the three wrens—bush, rock, and rifleman—timid, but active and quiet; attending strictly to their own business; running up tree-boles; catching small insects in the bark of the pine or birch; placing their eggs in the deepest recesses of the broadleaf or pine tree; careful to choose the tiniest hole that they can safely emerge from; always certain that they are protected from animal or bird—there is little or no fear that our wrens will become extinct. The advance of civilisation has little effect on them, save by destroying their forest homes. Where sound bush remains, there the wrens will perpetuate their species. They seldom or never build in rotten trees, like the kingfisher or parakeet; their nests are generally very high up, and the trees sound and growing. Feeling instinctively their tiny size and helplessness, they choose the most impenetrable fortresses they can find. All up the West Coast the rock wren flourishes, deep in tiny recesses of the rocks; and the rifleman and bush wrens abound wherever are our native trees. It is pleasant to learn from Mr. Drummond's Bulletin that the wren is reported as existing in all parts of the country; it is said even to swarm in the Maruia Forest and on Kapiti Island; and in December of this year I saw over a dozen riflemen in the ribbonwood-trees near Waimate.

The native canary, once common at the Taieri and round Dunedin, has now absolutely disappeared from these parts. It is quite scarce at Catlin's, where the bush is almost untouched; and at Milford Sound it can occasionally be seen, but not in great flocks, as of yore. It is still common at Stewart Island; and in the Urewera Country its near relative, the white-head, can be often seen. Its nesting habits and its bright-yellow colour and attractive appearance have had, I am afraid, much to do with its extinction. It lays its beautiful red eggs in hollow broadleaf branches or stumps, in places easy of access to weasel, rat, or mouse. Its home is becoming scarcer and scarcer, as the broadleaf-tree is one of the first to disappear. In addition to this, it has the misfortune to be one, if not the chief, host of the long-tailed cuckoo in this island, as is the white-head in the North. This means that every cuckoo that lays, say, five eggs in one season may be the means of destroying from three to five broods of four each of the unfortunate canary. Where thick native bush remains untouched our canaries—the yellow-head and the white-head—will be with us. They are still found in considerable numbers in the great pine and birch forests of Hawke's Bay, Waikato, Kapiti, and the Barriers; and in the Maruia Forest, at Hokitika, and throughout the Nelson District. They are not so common at Catlin's or Milford as they were ten years ago, but they are found sparingly at Wyndham.

Our utick, or fern-bird, heard everywhere in swampy ground, and fairly common twenty years ago, now that draining and ploughing has so much enhanced the value of our low-lying swampy grounds has become very rare. Near Fortification Creek he can still be heard, and wherever fairly large swamps remain there he is; but the firing of swamps has almost done for the fern-bird. The utick can last only so long as the great swamps of Canterbury, Lower Taieri, Manawatu, and Piako remain undrained and uncultivated. He is still very common at Stewart Island and Kapiti, where, so far, no weasels have been introduced; and he is reported from many other places, including Hangaroa, Kaitaia, and Mangonui.

Our grey warbler will hold his own through all time. His merry cry can be heard in garden or bush to-day. His curious nest is always well concealed. Though the victim of the shining cuckoo, and losing numbers of chicks every year, the two, or possibly three, clutches of eggs, each five or six in number, give it an enormous "lift" over the other birds. The nest—pensile, and absolutely weasel- and rat-proof—still further protects it. It is restless, active, and vigorous on the wing, and was known from time immemorial to Maori and pakeha. Let us hope that centuries hence the "cry of the riroriro" will be heard in the land.

The little brown creeper, quiet and shy, never a very common bird, and one difficult to see, always keeping in dense bush and thicket, is hardly ever heard, save when calling to or feeding its young ones. Nesting in high trees, its little cup-shaped domicile is always hard to get at; but where the bird once flourished it cannot now be easily found. No doubt they still exist far back on Maungatua, but in the bush near Dunedin I had not observed one for quite ten years until I saw six all together in some manuka in the Newington Bush on the 4th June, 1907. They are seen at Wyndham in little flocks, and are often called the "grey creeper" and "the other canary"; but that the bird is hardly known to many is evidenced by the name not being even mentioned by one of Mr. Drummond's correspondents.

The tomtit and the robin, two well-known birds, the latter almost the tamest in our islands, have no doubt almost "gone under" for this very reason. An additional factor is the method of nesting, which is generally in a broadleaf stump, under an overhanging rock, or beneath a fern-bush—all situations easily got at by weasel, mouse, or rat. It is eminently satisfactory to find from Mr. Drummond's Bulletin that the North Island robin is reported as present in nearly a dozen places on the main land to-day, to say nothing of being common on Kapiti and the Barriers; in the South he is very common in the Maruia Forest, where, however, weasels have obtained a fair footing: he is reported at Hokitika, Wyndham, Tautuku, Tuapeka, Waihemo, Riccarton, Ashburton, and as being fairly common on Banks Peninsula. Tomtits are reported as uncommon, but present, in numerous places in both islands. Robins are also reported at Wainuiomata, Waipa, Greytown, Raglan, Ramarama, Wairoa, Wanganui, Waitotara, Tararuas, Te Peke, and other places in the North Island to-day, although Sir Walter Buller's last volumes assert that the bird is extinct.

The ground-lark, once swarming on all downs and tussock-clad hills, is still fairly common, especially on the Canterbury Plains. He is blamed by the farmer for the destruction of his tender shoots of grain, and consequently shares the penalty of the feathered members of the community known as the "bird nuisance." In spite of cultivation, he holds his own. His nest is carefully concealed, and is very hard to find. His insect-food abundant, supplemented by grain and grass; his natural enemy, the hawk, largely diminished; his two or three broods of four or five chicks reared well out in the field or tussock land, far from danger, and allowing of a wide sweep of vision and time for concealment before the enemy can come near—our ground-lark holds his own with the best of them, and can be seen on the Town Belt or golf-links almost any day of the week. Reports say that he is holding his own in many localities; he is increasing notably in the Wairarapa, at Dannevirke, Wimbledon, Waikaka Valley, and elsewhere.

The thrush, one of our finest whistlers and singers—a handsome bird—is now very rare throughout the Islands. Formerly common at the Taieri, by the seventies he had gone from that locality entirely, and no one I can find remembers him near Dunedin. He still exists at Milford Sound and among the fastnesses of the West Coast. In 1895 I saw over a dozen at Milford Sound, and in the bush around we heard the whistling of many more. Later on Mr. George Fenwick reported that thrushes were common, though he did not see them himself.

The black and pied fantails (tiwakawaka and piwakawaka) famed in Maori lore, once very common near every house, have almost entirely gone from our midst. I saw a solitary pied fantail in Jubilee Park last spring, and a black fantail in Leith Valley Road in November of last year. At the Taieri an occasional specimen still lingers, but their extreme gentleness, their fearlessness, and curiosity, allow of their easy destruction. I am pleased to report that they are considered common at Raglan, Piako County, Rangi-iwi, Port Albert, Tauranga, Stratford, Manganui, Castlepoint, and numbers of other places throughout the islands. One came into my garden at Pitt Street on the 21st April, 1907.

Our crows, once common in many localities, but always restricted in their range, far from common near Dunedin in the fifties, and never seen by white man between Mount Cargill and Catlin's River, have long disappeared from our locality, though they are still sparingly distributed through the pine forests of Owaka, at Milford Sound, and in the Urewera country. The North Island crow is reported as being extinct in a large number of places, but is still mentioned as existing in four or five; and, as the birds in the Tararua Range are said to be as common as ever, it is probably found there in numbers; he is also found at Komako, Maungatawhiri, Ngatimaru, Raglan, and Mount Egmont. The South Island crow is reported as being pretty common at Stewart Island: this bird, which is quiet and shy in its habits, largely a ground feeder, its nest an easy object for weasels and rats to rob (being built not many feet from the ground), is now found only on rare occasions. The collecting fiend has had a great deal to do with the destruction of these birds; and the small clutch of eggs—not more than two or three—has also been a factor of no mean importance.

The saddleback was never to my knowledge known at the Taieri or near Dunedin. At all times curiously local in its habits, rarely found on the east coast of our Island, fairly common in the Waikato district, the Barriers, and the depths of the West Coast, it was to be met with sparingly at Milford ten years ago, but latterly I hear it is almost gone. It is still found at Wairoa Gorge, near Nelson. For some reason which is not quite clear, the saddleback had the habit of accompanying the flocks of yellow-heads on their expeditions; possibly some food found by the chattering crew was made more easily attainable by the saddleback than when he hunted alone. Much of the scarcity of the saddleback is due to the insatiable greed of collectors, who invariably bagged every one that appeared. Sir Walter Buller himself makes that clear in his supplementary volumes. The saddleback is practically extinct in inhabited parts of New Zealand.

The huia, a bird we have all read about, but few have ever seen alive, is now very nearly extinct. Almost confined to the mountain fastnesses of the Ruahine and dark glens of the Tararua and Rimutaka Mountains, the huia was never common, but it is reported as still existing in several places in the North Island—Mangahao, Ngatimaru survey, Raglan, Komako, Kimbolton, Ihuraua, Castlepoint, and Rongomai. Several observers are emphatic in the statement that the birds were decimated by the high price offered for them by collectors.

Of our climbing-birds, the most notable is the kakapo—that weird night-bird, half-owl half-parrot. Before the coming of the pakeha he had been trapped by the Maori, and so decimated were his ranks that he was to be found only in limited localities, and those almost untrodden by the foot of man. He could be found fairly frequently near the West Coast sounds about ten years ago; but the tourist traffic, with its accompanying dogs, cats, rats, and, later, ferrets and weasels, has brought this unique flightless bird to the verge of extinction. His great white eggs placed in hollow logs, and his stupidity and sleepiness in the daytime, make him and his progeny an easy prey to the four-legged enemy. In the great wooded forests of Tuhoe Land the bird is absolutely extinct. The experiment of breeding them at Resolution Island will not, I fear, prove a permanent success, as I hear on good authority that a weasel has been seen there.

The "passing" of the parrakeet has always seemed to me a strange business. The different species are all active, vigorous, powerful of flight, pugnacious, and are able to subsist on grain, fruit, seeds, insects, and native berries such as fuchsia, &c.; they nest in hollow trees, and lay a large number of eggs—eight to ten in one nest; and it seems curious that the bird should have practically gone. He came in flocks in the seventies; he was a scourge in the eighties; he was shot in thousands for his destruction of grain and fruit; then gradually he seemed to disappear; and now he is rarely heard near civilised parts. Possibly the destruction of timber, the felling of the broadleaf-tree, his favourite home; the attacks of weasels and rats, which can get into his nesting-holes; the increase of bees in hollow trees; shooting by farmers; trapping by fruit-growers, are all reasons why this pretty little parrot has gone. The non-success of the large clutches of eggs in preserving the species, in strange contradistinction to those of the kaka with three or four eggs, points perhaps to the presence of some unknown natural enemy against which this bird has had to struggle. It can be seen and heard rarely in the dense bush at Catlin's, Milford Sound, Hawke's Bay, and Waikato; but reports from all parts of the

Islands say that the bird is becoming very scarce everywhere. He is very common on the outlying islands, where there are no cats, weasels, or bees; but on the mainland he is rare.

The kaka is a splendid bird, with a harsh cry but a melodious whistle. His sociable habits, his fine plump berry-fed body, and his comparative fearlessness, have made him an easy prey to sportsman and settler alike. The kaka hatches out two or three chicks, but, according to Mr. Richard Henry, is credited with deliberately sacrificing whichever of her offsprings she judges to be the weaker. This practice has not been confirmed by independent observation, and I cannot yet accept such an instance of parental wickedness. The kaka was snared by the thousands before the white man came, and the early settlers in the sixties failed to make much impression on them, when they lined stable-roof and grain-stacks, eating the grain, and doing immense damage. They were shot in hundreds, often a dozen at one shot, but even that did not exterminate this determined creature. At Catlin's he is now becoming scarce; and can you wonder at it, when Dunedin "sports" come back from their expeditions with three, four, or six sacks full of kakas and pigeons? The kaka still swarms in the dense bush in Nelson, Marlborough, and Stewart Island, but must eventually go. In Marnia he is found in thousands. Last year three men shot four hundred in three days in that district, and the statement was made to me that they were required for food! The bird is also plentiful on the coast range of the Bay of Plenty.

The kea will remain stationary unless a determined crusade of flockowners is made against him. Powerful of flight, savage and strong with bill and claw, he can effectively deal with ferret and rat—probably turn the tables upon them, and make them food for his young. Nesting deep in the rocks, where seldom the eggs or young can be found; inhabiting wild and mountainous country, seldom visited save by the shepherd; wary and alert; tame in the early days—he has no doubt become more fearful on the approach of man. He has acquired a taste for mutton, which may prove his undoing; still, the kea has a chance of surviving most of our feathered friends of New Zealand.

Of our two cuckoos—the bronze and the long-tail—we need have no apprehension. Both migrants, and both parasitic, they are finding homes for their young in the nests of the imported birds. When our warbler, our robin, our tomtit, and our canary go, there will still be the nests of the sparrow, linnet, blackbird, and thrush for his workhouse brats. The canary and robin and others may all go under, but the koekoea will never fail to find homes for his young and nests to rob from among the imported birds. Both birds are predatory, and have been repeatedly seen eating eggs of other species.

Our wood-pigeon, the most beautiful and harmless bird we have, one of nature's noblemen, is, like the kaka, deliberately being gunned to death. At Catlin's, where it breeds, it is actually shot in the breeding season. It lays but two eggs, in a flimsy and unprotected mass of sticks, which does duty for a nest, and numbers of young perish on this account alone. If, as now happens, we permit of indiscriminate shooting at this time, the eggs and callow young will rot, and this noble bird will soon be wiped out of existence altogether. The pigeon is still plentiful throughout New Zealand, but with this sort of thing going on he must go. A weasel has been seen to run up a tree to a pigeon on the nest, and, with its active twisting and turning, running round and round, so fascinate the bird that it has fluttered helplessly to the ground, where it was soon "polished off." You will thus see that unless some strong steps are taken to protect this bird from man and beast, neither bush resident nor nature-lover elsewhere will have any opportunity of seeing it outside of our museums. The birds are found in immense numbers in the Urewera country, the Upper Wanganui and Rangitikei districts, Whangape, northern Auckland, and on the Bay of Plenty coast ranges.

On the Taieri Plain in the fifties our native quail abounded through tussock and flax-bush. Now, search New Zealand through length and breadth and you will find them not. They are absolutely extinct. Tussock-burning destroyed nests and eggs innumerable. These birds were the natural quarry of the sparrow-hawk and harrier. Their eggs—from ten to twelve—were carefully hidden in tussock, and their numerous progeny were ready to hide almost the moment they were hatched; but what chance had they when the settler came among them? The quail was an active little bird, with keen sight, but poor of flight, beautifully coloured (for protection), a born mimic, and clever hider, and the sparrow-hawk and harrier and Maori would never have exterminated it, but the white man, with his gun, dog, and, worst of all, his agricultural implements—his plough, his harrow, his poisoned grain, his scythe, and, later, his reaping-machines—has gradually done the deed, and the quail has gone.

Our kiwis, with our kakapos, are being wiped out of existence. Conspicuous, easily captured by dog or weasel, hatching but one egg at a time, and the egg or young comparatively easily got at, no wonder the kiwi finds the tourist traffic too much for it, and that the day of the wingless bird is over. Semi-nocturnal as it is, man is not its hunter, but man's satellites, the dog and the weasel. Save only on our sanctuary islands are the birds common, on Stewart Island, Resolution Island, Kapiti, and the Barriers; but they are practically extinct on the south-east coast of the North Island and the great forests of Tuhoe-land.

Of our waders, the plovers, dotterels, oyster-catchers, and stilts, moving from district to district, breeding in shingle-beds, eggs protectively coloured, inhabiting marshes and sea-coast, are brought less into contact with civilisation, and in many localities—especially the great river-beds of Canterbury—are still fairly numerous. On the great inland lakes of Wanaka and Te Anau, and even as near as Waikari and Cargill's Links, the dotterels and plovers are to be found to-day. They are reported as increasing at Sheffield and Waihemo.

Our herons are very rare. The kotuku, that magnificent bird, so scarce even on the advent of the pakeha that for the Maori to have seen one was evidence of a lifetime, too often mercilessly shot by every observer, his limits are narrowed down to a few spots in Westland. A pair were known at Stewart Island last year; now only one remains there. Perhaps one or two specimens are still to be seen at Te Anau; the rest are in museums or private houses. Two years ago one appeared in Pelichet Bay for a few days, and then disappeared. Herons (species not mentioned) are reported from Raglan and Waianiwa.

The blue heron is almost as rare, and the little bittern is extinct. The bittern is seen now and again where swamps remain, but as these are drained he is bound to disappear. It is pleasing to note that he is still seen at Mongonui, Raglan, Kaikoura, Ramarama, Waiau, Ashburton, Patea, Tautuku, on the Islands of Kapiti, Stewart, and the Barriers, and in the Urewera swamps. He is also recorded at the Bay of Islands.

Our godwits, migratory, and breeding elsewhere, will always remain with us, but our snipe has gone, save on our outlying islands.

Our weka, breeding in hollow logs and under fern-trees, or in clumps of *Astelia*, suffers to a great extent with our kiwi and kakapo. He seems to be weathering the storm in many places, for he is on the increase at Romakoriki, Havelock, Hawke's Bay, Rongotea, Waverley, Albert Land, Carnarvon, Streamlands, and the Maruia Forest. He is reported from many other places to be present, if not on the increase. He is probably too powerful for weasel and stoat, and is getting the best of them. He has found some suitable food, and some better nesting-places. Government protection is undoubtedly assisting him, and so this flightless bird has a better chance than his *confrères;* but, as far as can be seen, near us and on the hills and valleys of Otago he is very scarce. He is disappearing from Ashburton, West Oxford, and Tauranga, and is considered extinct at Wairio and other places.

Our striped rail, water-crake, and swamp-crake, with the bittern and the pukeko, remain only in such portions of our islands as are undrained so far as swamp exists. Mr. Hamilton reported them common at Petane in 1885, and I quote from the Trans. New Zealand Inst.: "A cat belonging to a neighbour has brought me in during the years 1881–1883 seventeen specimens of this crake and twelve specimens of the next species (*Tabuensis*). Both of these birds abound in the raupo swamps of the district, but are extremely difficult to obtain unless a friendly mouser takes the matter in hand." If one cat could do this damage twenty-three years ago there is little wonder that these birds are now seldom seen.

Whether our takahe still remains deep in the fastnesses of the West Coast time alone will show. Probably in some of the yet untrodden millions of acres of south-west Otago we shall light upon him. He is much too big and powerful for the weasel, so that if he is in the forests at this day he will remain till such time as man and dog rout him out.

The pukeko, a conspicuous bird, with slow laborious flight, is fast going—his swamps extensively drained, his nests easily found. To a great extent gregarious and easily potted in numbers, slow and stupid in getting out of range, exchanging his original diet of lizards, worms, and small birds' eggs for the product of the farmyard and paddock, he falls a prey to poisoned grain and gunshot. He is still found fairly common in the great swamps of the north, but near habitations he is very rare. I see he is plentiful near Wanaka, and is blamed for a lot of egg-stealing; and at Parua Bay he is credited with destroying crops of maize. He is on the increase at Waimate, Streamlands, and Waikaka Valley, and is held as common at Ramarama, but elsewhere throughout the Islands he is very scarce. Grain-poisoning caused his downfall; where such has been abandoned he shows signs of increase.

There remain our ducks—those beautiful birds which we allow to be slaughtered year after year. Our blue-duck still exists in North Canterbury in great numbers, and on some of the inaccessible inland lakes and in the Marnia Forest may be found nesting in trees 20 ft. or 30 ft. from the nearest creek. It seems a pity that numbers of our inland lakes are not made sanctuaries, and stiff fines imposed on law-breakers. I think the "sport," who represents a very small proportion of our people, should have his daily bag curtailed—say, three to six pairs of grey-duck, teal, or paradise; or, if popular feeling could be aroused, put a stop to native-bird shooting altogether, and preserve for all time our splendid creatures.

The paradise duck can be seen in many places in immense numbers; and in the Maruia Forest he abounds, but as this is settled he will go. This is one of the loveliest birds we have, and might well have protection. A friend described to me how he surprised a pair, with ten small ones, on a branch of the Buller River. The old birds instantly took to the water of the swollen rushing torrent, and, beak to tail, sailed diagonally across, with all the tiny ones resting safely above and against them as they bravely breasted the turbulent stream. A more beautiful device or a more marvellous display of instinct could hardly be imagined.

Our grebe and dabchick, expert divers, remain in fair numbers on some of the lakes in Nelson and Otago. Alert enough to escape gunshot, diving at the flash, breeding in hidden places, living more in lagoons and lakes than swamps, escaping in this way the fate of the swamp birds, useless as food, too clever for the sportsman, and protected by the Government, they survive, and let us hope will long survive, their less fortunate brethren.

Our sea-birds I have touched on. Our shags, though shot at and destroyed in great numbers, remain with us: breeding in rookeries in almost inaccessible positions, feeding on fresh- and salt-water fish, they have a better chance. Our penguins, though slaughtered in millions for oil on the outlying islands, remain and will remain when our present generation has been forgotten.

Dr. Cockayne urges the setting-apart of Stewart Island as a sanctuary for our flora and fauna. Let us of the New Zealand Institute give the utmost assistance in urging this matter on our local Members of Parliament. What a magnificent scheme; what pleasure it will give the tourist of the future and our children's children to be able to go in two days to an island teeming with the kiwi, kakapo, weka, tui, mocker, pigeon, kaka, robin, fantail, tomtit, and canary—all these and more abounding, and making the forest welkin ring!

In addition to this, I should urge the preservation of such areas as Maruia: 1,000 acres of virgin bush (totara and pine), teeming with bird-life, is plotted, and being felled for settlement. Here the kiwi and weka are common; weasels are plentiful; kakapos are very rare; tuis, mockers, wrens, and robins are very common; tomtits not so common; fantails plentiful; canaries very common, in flocks; pigeons very common; kakas shot in hundreds; and paradise and other ducks very common indeed. Surely as good, if not better, agricultural land can be obtained elsewhere, at less cost. Why hack down, burn, and destroy splendid timber land in one part of the country and feebly attempt to sow and replant with trees other parts? Why make an attempt to preserve our native birds by providing sanctuaries in parts where birds are scarce, when in other parts, where the birds exist in myriads, we wantonly and by law exterminate and destroy them?

Thus have we taken a hurried survey of our avifauna, birds many of them unique in the scientific world. The least valuable for game, the poorest songsters, the least interesting still survive in considerable numbers; the battered ranks of the rest tell the sad tale. It is indeed pitiful reading, this passing of the New Zealand ornis.

Art. XLIV.—*The Little Barrier Bird-sanctuary.*

By James Drummond, F.L.S., F.Z.S.

[*Read before the Philosophical Institute of Canterbury, 2nd October,* 1907.]

By the courtesy of Mr. T. E. Donne, General Manager of the Department of Tourist and Health Resorts, and of Mr. R. H. Shakespear, Conservator of the Little Barrier Bird-sanctuary, I was able, at the beginning of 1907, to spend a fortnight on the island sanctuary, and to observe some of the birds there.

The numbers of our birds have been greatly decreased in recent years. Species have been driven out of districts with the advance of civilisation, and many birds which were once plentiful in nearly all parts are now found only in secluded spots. But I do not think that the position is as bad as it has been freely reported to be. Extensive inquiries have convinced me that we are justified in striking a much brighter note than has been struck by writers on ornithology in this country for a long time. It is quite probable that no native bird has been completely exterminated since Europeans came to New Zealand; there is, at any rate, no absolute evidence to show that any New Zealand bird has been exterminated during the past sixty years. The great destruction which has been wrought, however, has placed our birds in a distressing position, and a visit to one of their sanctuaries has a deep interest for all New-Zealanders.

The Little Barrier Island is four miles and a half long and three miles and three-quarters wide. It lies forty-three miles north-east of Auckland, in the mouth of the Hauraki Gulf. Cape Rodney, the nearest mainland, is fifteen miles to the west, and the Great Barrier is twelve miles to the south-east. Although the island is only 10,000 acres in area, no human being has crossed it. This is accounted for by its extremely rough and rugged character, which adds to its suitableness for a bird-sanctuary.

I took an early opportunity of seeing the birds. There was no difficulty in this respect whatever. Large numbers of them came close to Mr. Shakespear's house, flying in his garden, and making themselves quite at home. I had only to go outside my tent to see scores of bell-birds, whiteheads, tuis, tomtits, fantails, and other small species. They are not interfered with in any way, and, as they have confidence in the members of Mr. Shakespear's family, who are the only residents on the island, they show no signs of fear. Guided by my observations, I should say that the bell-bird (*Anthornis melanura*, the korimako and makomako of the Maoris) is the most plentiful. It is found in all parts of the island, and seems to be present in countless numbers. The best feature of its presence is the fact that it is increasing at a fairly rapid rate. Its nest is often found in thick manuka and bush within fifty yards of Mr. Shakespear's house. Mr. Shakespear told me that in the previous season a pair safely hatched out their brood in a clump of manuka overshadowing the meat-safe, ten yards from the back door. Twenty years ago Sir Walter Buller said that "it is only a question of a few years and the sweet notes of this native songster will cease to be heard in the grove, and naturalists, when compelled to admit the fact, will be left to speculate and argue as to the causes of its extinction." A visit to the Little Barrier sanctuary shows that there are no grounds for adopting such a pessimistic tone. If the bell-bird was chased entirely off the mainland—which is a remote probability according to reports received lately—there is every likelihood that it will live on the Little Barrier as long as the forest there is preserved and the sacred character of the island is maintained.

I saw the North Island robin (*Miro australis*) several times. I was delighted with the little whitehead (*Certhiparus albicapillus*), another bird which the North Island claims as its exclusive property. On the Little Barrier the whiteheads exist in very large numbers. Scores of them came hopping and flitting down to watch me make my way through the thick manuka, and followed me as long as I remained in the manuka-clad parts of the island. The whiteheads and the fantails seem to be very friendly, and a flock of whiteheads may often be seen accompanied by two or more fantails.

The time at my disposal on the island was drawing to a close before I saw a stitch-bird (*Pogonornis cincta*, Maori hihi). Two days previous to my departure I was given the privilege of an interview. I was one of a party of five or six. We were on our way to the Heri-Kohu Peak, and at noon, when we were walking along a bushy track, a stitch-bird, which had come down from the heights, flitted about in an excited manner on the boughs above our heads. When its cry was imitated it came closer, and flew among some saplings, uttering a cry which might be written "steech, steech," repeated quickly several times. The bird was a female. She ran along the boughs, carrying her tail erect, at almost a right angle with her body, and her wings drooping. She turned round several times, and was the very embodiment of motion. Her cry hardly ceased, and there were very few moments when she took her black eyes off us. We saw seven stitch-birds on that occasion. They were all females. This is rather strange, as the female is described by several naturalists as being specially shy and retiring. The stitch-birds I saw on the Little Barrier were very tame. They had no fear, and even when a stone was thrown into the trees on which they alighted, they only flitted off to another bough. The locality which they favour with their presence most is in the north of the island. The haunt can be visited only with great difficulty and inconvenience. There these birds are numerous, and as many as fifteen have been counted at one time.

I saw a good deal of the white-breasted tits, which came near my tent every morning and gave me many opportunities for watching them as they flitted about in the low scrub. They have a peculiar method of alighting on a tree. The tits seem to be utterly devoid of fear, and they make close friends with all visitors to the island.

I saw many other native birds. Tuis are present in large numbers. The two migratory cuckoos—the long-tailed cuckoo (*Urodynamis taitiensis*) and the shining cuckoo (*Chalcococcyx lucidus*)—come regularly in their seasons, and depart again for their other homes across the sea. In the summer the long-tailed cuckoo's note may be heard at almost any time of the day, and also at night. I have heard the loud, shrill, and piercing "whirrt, whirrt," continued for nearly a quarter of an hour, ringing out over the gorges at intervals of from six to twenty seconds.

I did not hear the "song of dawn" on the Little Barrier in its perfection. It can be heard at its best only in the spring, and the time of my visit was too late in the season. In the spring months, as soon as the dawn appears, all the birds burst into a joyous chorus. The bell-birds and the tuis lead, and are followed by the robins, the whiteheads, and others, until an almost incredible volume of sound is created. There is a surprising variety of notes, and, as they are all poured forth at the same time, they make a din of bewildering music.

Pied shags (*Phalacrocorax varius*) are plentiful, and are increasing rapidly. There are several shaggeries near the cliffs; the largest is about three-quarters of a mile from Mr. Shakespear's house. The black shag (*P. carbo*) is occasionally seen on the island. I became personally acquainted with the black petrel (*Majaqueus parkinsoni*) and Cook's petrel (*Œstrelata cooki*), both of which nest in the burrows upon the heights. The cry of the black petrel, which is often heard at night, is unlike that of any other bird. It sounds like the combination of a soft whistle and a deep "whirr," coming from a husky throat. I examined the nest of one of these birds, in the soft soil at the top of Mount Heri-Kohu. The nest was at the end of a burrow, about 2 ft. long. A female bird was sitting on a single egg, and a chick had just thrust its head through the shell. The bird and the egg, after being examined, were placed back in the nest, and, in accordance with the rules of the island, neither was interfered with.

There are no huias (*Heteralocha acutirostris*), saddlebacks (*Creadion carunculatus*), North Island crows (*Glaucopis wilsoni*), wekas (*Ocydromus*), pukekos (*Porphyrio melanonotus*), bitterns, or North Island thrushes (*Turnagra tanagra*) on the island. The godwit (*Limosa novæ-zealandiæ*), the turnstone (*Arenaria interpres*), and the knot (*Tringa canutus*), the famous migrants that breed in the Northern Hemisphere and spend the summer in New Zealand, do not visit the island in their regular flights, and shore birds are seldom found on the sanctuary, as there are no mud flats or beaches and no food-supplies for them. Ducks are entirely absent.

In 1868 Captain F. W. Hutton reported that saddlebacks were present, but were not common, and Mr. Reischek recorded their presence in 1886; but Mr. Shakespear has seen none during the ten years he has resided on the island. Mr. Reischek states that he saw the North Island kiwi (*Apteryx mantelli*), but it must always have been very rare on the island. In 1862 Captain Wood, of the "Porpoise," spent several days on the island with the express object of obtaining kiwis, but found none; and Sir George Grey, who spent two days on the south-west portion of the island, met with the same disappointment. Mr. Shakespear has not seen any kiwis on the island. Four years ago Captain Bollons, of the "Hinemoa," liberated a southern kiwi (*Apteryx australis*) and two North Island kiwis

(*A. mantelli*) from New Plymouth, and also kakapos (*Stringops habroptilus*), but nothing has been seen of them, although they may be getting on very well.

Large numbers of kiwis could be liberated on the island with advantage. Some of these birds might be sent from the south in the "Hinemoa," which could make a special trip for the purpose; and wekas and other native birds might also be placed on the sanctuary.

Several introduced English birds are on the island. Amongst these are the house-sparrow, the thrush, the blackbird, and the starling. They do no harm to the native birds, and the English birds and the native birds do not associate.

Of other animal life, insects are exceedingly plentiful; among them are four species of wetas, notably the large black one. A tuatara lizard (*Sphenodon punctatus*), nearly 2 ft. long, was caught near the landing-place, but was liberated again. It is supposed that other tuataras exist on the island, but this is the only one that has been seen by the present residents. There is at least one large colony of bats. It is thought that they belong to the short-tailed species (*Mystacops tuberculatus*), which was supposed to be on the verge of extinction. I was taken to the tree in Kauri Gully where the bat-colony exists, but no bats were seen. The Maori rat (*Mus exulans*) is very plentiful. There is a rare black lizard, which lives amongst the boulders near the shore. A gigantic earthworm (*Diporochæta gigantea*) is found on the hills in the bush. One specimen measured 4 ft. 6 in. long. It is one of the largest earthworms in the world. The waters teem with fish of different species.

The birds, on the whole, thrive exceedingly well on the sanctuary. Many of them are increasing fairly rapidly in numbers, and there is no evidence to show that any of the species represented will become extinct. The Norway rat, the pig, and the English bee are entirely absent, and cats are very rare. A theory has been put forth that the English honey-bee takes possession of the forests and drives honey-eating birds, like the bell-bird and the tui, away from the flowers and starves them out. Bees will take their share of the honey from the forest flowers, but it is hardly likely that they do so to such an extent as to affect the numbers of the birds. As far as any evidence brought forward goes, I think the bees should be acquitted, and all the blame for the birds' banishment from large tracts of country should be placed upon cats and rats, and bush fires, and on the advance of civilisation generally.

The climate of the island is very mild; there has been only one frost in the past ten years. In all respects it is an ideal place for a bird-sanctuary. It is well wooded; there is no regular communication with the outside world; absolutely no natural enemies of the birds are present, except a few cats; and unauthorised people cannot land without experiencing inconvenience, hardship, and danger. The members of Mr. Shakespear's family, the only residents, are devoted to the birds, which are given all the protection that can be accorded to them, and it is gratifying to know that on this sanctuary they are secure from enemies.

Only two visits from unauthorised persons have been discovered since Mr. Shakespear has resided on the island. Owing to the island's rugged character, it is impossible to traverse it from coast to coast, but Mr. Shakespear frequently goes round in his yacht.

I append a list of birds on the sanctuary, supplied by Mr. Shakespear:—

Grey warbler; riro-riro (*Pseudogerygone igata*). Very plentiful.

White-breasted tit; miromiro (*Petrœca toi-toi*). Plentiful.

North Island wood-robin; toutouwai (*Miro australis*). Increasing.

Pied fantail; tiwakawaka (*Rhipidura flabellifera*). Plentiful.

Whitehead; popokatea (*Certhiparus albicapillus*). Very plentiful, increasing rapidly.

Ground-lark; pihoihoi (*Anthus novæ-zealandiæ*). Rare.

White-eye; tauhou (*Zosterops cœrulescens*). Very plentiful.

Tui (*Prosthemadera novæ-zealandiæ*). Plentiful.

Stitch-bird; hihi (*Pogonornis cincta*). Keeps to the rugged parts, but is increasing.

Bell-bird (*Anthornis melanura*). Present in very large numbers.

Bush-wren, or rifleman; ti-titi-pounamu (*Acanthidositta chloris*). Rare.

Kingfisher; kotare (*Halcyon vagans*). Not so plentiful as on the mainland, but fairly plentiful.

Shining cuckoo; pipiwharauroa (*Chalcococcyx lucidus*). Plentiful in the summer; its egg has been found in the grey warbler's nest on the Great Barrier, but the egg has not been found on the Little Barrier.

Long-tailed cuckoo; koekoea (*Urodynamis taitiensis*). Plentiful.

Kaka (*Nestor meridionalis*). Plentiful.

Red-fronted parrakeet; kakariki (*Cyanoramphus novæ-zealandiæ*). Plentiful at certain times of the year.

Yellow-fronted parrakeet; kakariki (*Cyanoramphus auriceps*). Rather rare.

Kakapo (*Stringops habroptilus*). Three liberated four years ago, but not seen since.

Bush-hawk; karewarewa (*Nesierax australis*). Plentiful.

Harrier; kahu (*Circus gouldi*). Plentiful.

Morepork; ruru (*Ninox novæ-zealandiæ*). Plentiful.
Wood-pigeon; kuku (*Hemiphaga novæ-zealandiæ*). Plentiful.
Marsh-rail; koitareke (*Porzana affinis*). Very rare.
White-fronted tern (*Sterna frontalis*).
Caspian tern (*Hydroprogne caspia*). Has been seen.
Black-backed gull; karoro (*Larus dominicanus*). Nests on the north-west corner of the island.
Red-billed or mackerel gull (*Larus scopulinus*). Does not nest on the island.
Nelly, or giant petrel (*Ossifraga gigantea*).
Diving petrel (*Pelecanoides urinatrix*).
Rain-bird (*Œstrelata inexpectata*).
Mutton-bird (*Puffinus griseus*).
Shearwater (*Puffinus gavia*).
Allied shearwater (*Puffinus assimilis*).
Cook's petrel (*Œstrelata cooki*). Nests on the top of the hills.
Black petrel (*Majaqueus parkinsoni*). Nests on top of the hills.
Grey-faced petrel (*Œstrelata macroptera*).
Dove petrel, or whalebird (*Prion vittatus*). Nests on the Hen and Chickens.
Blue penguin (*Eudyptula minor*). Nests on the island.
Gannet; takapu (*Sula serrator*). Nests on the Great Barrier.
Black shag; kawau (*Phalacrocorax carbo*). Seen sometimes.
Pied shag; kawau (*P. varius*). Present in large numbers; nests on the south-western side of the island; and, as it is never interfered with, it is increasing in numbers rapidly.
Kiwi (*Apteryx australis* and *A. mantelli*).

Art. XLV.—*The Grasses of Tutira.*

By H. Guthrie-Smith.

[*Read before the Hawke's Bay Philosophical Society, 3rd September,* 1907.]

Tutira lies in the northern part of Hawke's Bay, about midway between Napier and Mohaka, and contains limestone of the varieties known to geologists as "Hawke's Bay limestone" and "Maungahararu limestone," the former bounding the eastern edge of the run, and containing many distinct and unbroken shells; the latter the western, and exposing only crushed fragments. Between these ranges are conglomerate and sandstone formations; papa crops out in a few places. Slips are very numerous on the steep country, and the whole surface has been heavily sprinkled with wind-borne pumice-grit.

For the purposes of this paper, I should say that the Tutira Run includes part of the Maungahararu Education Reserve, part of the Heru-o-turea Block, part of Waitara, &c. About 300 ft. above sea-level on its eastern edge, it rises to over 3,200 ft. on the west.

There are soils of every quality, from small alluvial flats and papa outcrops to wretched low valleys stretching north and south between barren ridges of sandstone, and areas of black humus superposed on pumice-grit. Grasses, therefore, have the choice of many varieties of soil in this block of land.

The run came into my possession in 1882, but before that date a certain amount of work had been done—fires had been run through large tracts of fern, some fencing had been erected, and a very small proportion of the country grassed. The remainder was almost wholly in fern, tutu, or koromiko. Where there was bush it was unfelled, and where there was swamp it was undrained. I may say, therefore, that I have seen the run being grassed, or grassing itself, for the last twenty-five years, and have noted practically its whole development from the old indigenous herbage. For over a quarter of a century opportunities have been afforded of watching the arrival of each grass, its subsequent spread, or in some cases its decline. The long struggle between the native and alien species still continues, but is inclining slowly though surely to the former. Sufficient time has now elapsed to prove which are the best of these native grasses, and which, also, are the aliens most likely to survive—survive, that is, in fair competition, and where the soil cannot be turned over by the plough.

For such reasons my paper may be of interest to those who have perhaps in other districts watched similar processes. It must, however, be borne in mind that the notes and observations here recorded are purely local, and probably would not apply, or, at any rate, would not apply with equal force, to the better soils and drier climate of southern Hawke's Bay.

Looking back over this quarter of a century, the feature that stands out first and foremost, and most prominently, is the enormously lessened fertility of to-day's surface soil as compared with that of the early eighties. The proofs of this are the visibly thinner proportion of rye-grass and the almost complete disappearance of white-clover, the decrease in carrying-capacity, the lessened germinating-power of grass-seed (surface-sown), the later "spring" in the grass, the later lambings, and possibly too the pretty general change throughout Hawke's Bay from Lincoln to Romney Marsh, Corriedales, and other hardier breeds.

Watching a paddock year by year and month by month is like watching the face of a constant companion—the daily difference is imperceptible, yet revert to any day ten or twenty years back and the alteration is at once marked and striking. So it is with all processes of nature; and the condition of one particular paddock at Tutira is marked to me specially by two events—the one in 1882, the other in 1884. On the former date Vermont merino rams were bought from an Otago stud flock. A paddock was "spelled," or shut up for them, and into it they were turned on arrival. They throve very badly, although we had confidently reckoned on their improvement owing to the fine sward of rye-grass. The year 1884 was one of those dry seasons during which less than 20 in. of rain fell during the year in parts of Hawke's Bay, and when even the Tutira hillsides began to dry up. We were trying everywhere to take advantage of this dry weather, yet no attempt even was made to burn this part of the run, owing to the mat of white-clover. To-day in this same paddock rye-grass is almost altogether absent and white-clover is almost gone; they make a very miserable show when compared with the exuberant growth of over twenty years ago. Now the turf consists of *Danthonia pilosa, D. semiannularis, Microlæna stipoides*, ratstail, *Poa pratensis, Bromus arvensis, Festuca myuros, Aira caryophylla*, a proportion of fog and cocksfoot, a patch or two of fiorin, stunted trefoil and *Trifolium arvense*, sorrel and the smaller plants that now form a considerable proportion of to-day's sward, members of the geranium family, *Cotula asiatica*, oxalis, &c.

These are particular instances of one paddock; other evidence will cover the whole run—the evidence of the bees. In the eighties and early nineties every hollow tree and every crannied rock on Tutira contained a colony of bees, and in the eighties more especially there were scores of swarms hanging in low manuka and tutu bushes. The country was then actually grey with the heads of white-clover, and the bees prospered accordingly. At this present date all the rocks are empty of bees, and though clover is not rye-grass, yet its disappearance (comparatively speaking) will show the great alteration in the constituents of the surface soil, and make it easy to understand how rye-grass too should have so largely disappeared.

Evidence even more convincing is the smaller amount of stock carried. Referring to the old station diaries, I find that when only about 1,500 acres of ground had been sown seven thousand sheep passed through the shed. Of these, between two and three thousand survived, rather than lived, on the conglomerate or sandstone ranges. There they just managed to exist on tutu, fern-root exposed in wild-pig rootings, and patches of native grass—grass that has since been smothered in fern and manuka, but which twenty-five years ago was probably the last vestige of the herbage that succeeded the ancient totara forest which at one time covered this region. The 1,500 acres of artificially sown grass would seem, therefore, to have carried the balance of four thousand five hundred or more. That it did so I am convinced, for not only were the sheep a smaller breed, but, as there was almost no fencing, only the most fertile, most sweet, and most warm portions of the run were worked by stock. These few spots of really good land were the old Native clearings and gardens, the long narrow strips immediately beneath the limestone outcrop (the ancient ocean-floor), sheep-camps, papa slips, and the northern and western faces of the best hills.

During the succeeding years up to the present date two synchronous processes have been going on, the one the " breaking in " and surface-sowing of new blocks, the other the deterioration of the blocks already sown. For many seasons the run has passed successively through the phases of rapid increase, slight increase, balance, slight decrease, and, lastly, rapid decrease.

The lessened germinating-power of surface-sown English grasses has been mentioned; and experience leads me to believe that the second sowing of inferior lands that have got rough with fern and been again burnt is a partial failure, while a third sowing is almost pure waste of seed. Even those that germinate make a miserable appearance, and are mostly destroyed by winter frosts and rain. The ground is, in fact, " sick " of these alien species, just as during the later years it has become " sick " of thistles, the seeds of which do not germinate, though they must be thick on the ground, for immediately the soil is stirred they appear in thousands. (This past season—1907—I notice crops of thistles again appearing to some extent, but only on sheep-camps, and not, as used to be the case, over entire hillsides and over hundreds of acres.)

Lastly, the later " spring " in the grass and the later lambings may, I think, in large measure be attributed to this deterioration of the turf. In the eighties and early nineties a change about mid-August could be quite easily detected in the colour of the warm hillsides, and about that date there was a slight but quite perceptible new growth. Nowadays it is the first week in October before much " spring " can be observed in the turf. For many years, too, our lambings have been getting later, owing to the elimination, I believe, of the more nutritious grasses and the consequently later date of the ewes coming in season. Sheep-farmers will understand that in the case of later " springs " and later lambings I have not forgotten to take into account the results of heavier and lighter stocking. With average stocking, however, I believe I am making no mistake in attributing our later springs and later lambings to the dying-out of rye-grass and clover, and the lessened vigour of cocksfoot, *Poa pratensis*, and fog.

My conclusion is, then, that land is worth less than it was a quarter of a century ago. Larger prices are now paid for it because there is a greater demand, and partly because we now know better how it should be treated.

The alien grasses at present on the run, or which have been on the run, are—*Paspalum dilatatum*, *Panicum crus-galli*, *Setaria viridis*, *Phalaris canariensis*, *Anthoxanthum odoratum*, *Phleum pratense*, *Alopecurus pratensis*, *Polypogon monspeliensis*, *Agrostis alba*, *Holcus lanatus*, *Aira caryophylla*, *Cynodon dactylon*, *Briza minor*, *Dactylis glomerata*, *Cynosurus cristatus*, *Poa annua*, *Poa pratensis*, *Festuca elatior*, *Festuca ovina*, *Festuca rubra*, *Festuca myuros*, *Festuca bromoides*, *Bromus mollis*, *Bromus racemosus*, *Bromus unioloides*, *Lolium perenne*, *Lolium italicum*, *Agropyrum repens*, *Hordeum murinum*, *Sporobolus indicus*, "Johnson's grass."

Of these thirty-one species, only nine have been purposely sown, or eleven if *Cynosurus cristatus* and *Agrostis alba* are counted. These two, however, were only sown long after the species had found their own way on to the land. Twenty-two, therefore, out of the thirty-one enumerated have reached Tutira unseen and unnoticed.

The vast proportion of the run does not carry anything that can be dignified by the name of turf. On the pumiceous lands, although to some extent the hill-tops have become grassed, the valleys still support only fern and manuka.

Over this country at intervals of five or six years fires can be run. After such a fire, until the first rain falls, a delicate grey veil of brittle ash, still retaining the mould of the fern-fronds, lies light on the surface, and a pleasant scent of sea-salt pervades the air—an odour similar to that of new-cut bracken. Here and there a totara log, relic of the old forest, sends up a blue smoke, and over the desolate scene sail harriers looking for roast lizards and small birds.

The first shower lays the light ash flat on the ground, changing the surface to jet-black, and almost at once new growths appear. Most prominent at first are the bright circles of verdure from the red-clover roots; green needles shoot up from the old roots of *Danthonia semiannularis*; multitudes of small convex *Microlaena stipoides* leaves appear singly; some of the old cocksfoot-stools show life—indeed, as the ground around hardens, this grass survives to a greater degree. Then thistle-seeds germinate—few in comparison to the sward of prickly stars of the eighties; and hardly later appear the cotyledon leaves of clover, trefoil, pelargonium, geranium, silene, capeweed, &c. *Poa pratensis* perhaps shows up last, though not least satisfactorily, as this grass is better suited than any other alien grass to stand alternate smothering and fire. Seedling fog, cocksfoot, *Danthonia*, *Dichelachne crinita*, break through the soil, and finally appear millions of circinate fern-fronds.

During the years succeeding such a fire, and on such quality of soil, the fern gradually succeeds in covering the worst, or at any rate the softest, part of the land, and everywhere the seedling manuka has come up thick—it is impossible to eat the fern out thoroughly, as then there would be only manuka left, completely putting a stop to future burning. Then, as time passes, and the surface becomes less open, stock "work" it less.

Lastly, after four or five years, the red-clover has been well-nigh eaten out; the white-clover and trefoil has been smothered; the grasses have disappeared from the valleys; only the long soft plumes of *Dichelachne crinita* pierce the sea of fern-fronds; and the sheep-camps are deep in tall seeding cocksfoot and fog. Last stage of all in this eventful history, the country again becomes "rough" enough to "carry a fire."

On this type of soft spongy pumiceous soil at each successive fire the net result is a slight increase of native grass on the hill-tops, an increase of manuka, and a lessened growth of fern throughout the whole block. Twenty-five years ago there was scarcely any manuka on Tutira, or the small patches that did exist were confined to the most sterile flats. The limestone or conglomerate lands, however, take grass well, and real turf exists on the steeper Tutira hills, and on the Maungahararu tops.

By examination of the turf on—*A*, hill-tops (other than sheep-camps) and upper slopes (Tutira); *B*, the lower more fertile foot-hills or flats (Tutira); *C*, hill-tops (Maungahararu), sown in the sixties, we shall get a fair idea of the proportion and varieties of grass carried, and the admixture of clover, trefoil, *Carex*, rush, and weed.

On acre *A* we shall discover traces of rye and white-clover, and cocksfoot and fog, this last thickest on the damper slopes; *Poa pratensis*, well established; goose-grass, often much stunted and depauperated; *Festuca myuros*; *Aira caryophylla*; perhaps a little crested dogstail and a little fiorin; *Danthonia semi-annularis*, an important constituent, and *Microlæna stipoides*, another important constituent; *Danthonia pilosa*, on the hardest, driest spots; *Trifolium minus*, a valuable plant; *T. arvense*, worthless. There will be several members of the *Carex* family, notably *C. Colensoi*, which is spreading fast, and which stock will not touch, leaving the spreading tufts of this wiry and worthless plant to crowd out better herbs and grasses. There will be a little yarrow; cranesbill; four sorts of *Geranium* —*G. sessiliflorum*, *microphyllum*, *molle*, and *dissectum*—all of them eaten by sheep; sorrel; and, finally, a dozen or so of weeds.

On acre *B* we shall find a much larger proportion of rye, white-clover, cocksfoot, and fog; rather more *Poa pratensis*; better-grown goose-grass; a sprinkling of crested dogstail and ratstail; and decidedly less of such natives as *Danthonia pilosa*, *D. semiannularis*, and *Microlæna stipoides*. The weeds will be thistles, sow-thistles, *Plantago lanceolata*, and *P. major*. Generally speaking, in fact, we shall find that the better soils hold the better grasses for the longer period.

On acre *C* almost no rye, no cocksfoot, no fog, no white-clover, and but little trefoil is noticeable. The alien grasses are sheep's fescue, fiorin, crested dogstail, *Poa pratensis*; but the bulk of the pasture is *Danthonia semiannularis*, with a considerable proportion of *Poa anceps*, and *Poa Colensoi*, while the weeds in this half are almost all subalpine varieties.

This ground was sown in the late sixties, and here too, I am told by former managers, white-clover was at one time abundant. To recapitulate: Acre *C*, probably the oldest turf of the run, has deteriorated to its normal sheep-carrying capacity; acre B has still got to reach its minimum value as pasture, for in it the native grasses and the less-good aliens are still ousting the better varieties; acre A is undergoing a similar process, its already less-valuable sward being yearly depauperised and adulterated more and more largely with varieties of worthless *Trifolium* or *Carex*.

Before proceeding to consider the native grasses of the run it will be interesting to note the manner of arrival and spread of the alien species. *Lolium perenne*, *Dactylis glomerata*, and *Poa pratensis* were the grasses almost exclusively sown on Tutira in the eighties, and among such seed, no doubt, appeared *Holcus lanatus*, *Bromus mollis*, *B. racemosus*, *Poa annua*, *Festuca myuros*, *F. bromoides*, *Aira caryophylla*, and *Briza minor*. On the Maungahararu Range, then a separate run, probably *Agrostis alba*, *Cynosurus cristatus*, *Festuca rubra*, and *F. ovina* were purposely sown. At Tutira the last two have never been sown, and only in 1906 were the two first named sprinkled as an experiment in one part of the run.

Of all these grasses, *Lolium perenne* is the most valuable, and the deterioration of the pasture is owing to its gradual disappearance; cocksfoot is another almost equally useful grass; and *Poa pratensis* ranks third, I believe, on Tutira, for it is not only a good turf grass, but also the least injured by fire. Fog is also a species we could ill spare: it seeds profusely, and appears everywhere after a fern or bush fire, and, if not allowed to get too rank, sheep will thrive admirably on it. Hundreds of bags of this seed have been scattered over Tutira, and, though temporarily dying out in many places, it always reappears.

Bromus mollis, *B. racemosus*, and *Poa annua* all throw a certain amount of feed, but latterly have become much less evident in the turf, and only flourish nowadays in gardens and worked soils.

Festuca myuros, *F. bromoides*, *Aira caryophylla*, and *Briza minor* are almost useless. The last, however, is a handsome little stranger; it has always kept to the warmer part of the run, and, although not now so common as formerly, still appears after fern or manuka fires.

Agrostis alba and *Cynosurus cristatus* are grasses that have appeared during the last few seasons in many parts of the run. I do not doubt that shortly they will be very important factors in the pasture.

Festuca ovina and *F. rubra* are species of which stock are fond, judging from their cropped conditions; if they spread at all, it is very slowly.

The other alien grasses on the run have appeared in the following order: *Cynodon dactylon*, *Anthoxanthum odoratum*, *Sporobolus indicus*, *Festuca elatior*, *Lolium italicum*, *Phleum pratense*, *Alopecurus pratensis*, *Bromus unioloides*, "Johnson's grass," *Setaria viridis*, *Panicum crus-galli*, *Phalaris canariensis*, *Hordeum murinum*, *Polypogon monspeliensis*, *Paspalum dilatatum*, *Agropyrum repens*.

Cynodon dactylon appeared in 1884 on the edge of the old pack-track, where it strikes the southern end of the lake. In the twenty-three years that have passed it has never become accustomed to the hills, but still is to be found on the road-sides. It makes some attempt to take possession of gardens and dry soils, and has also established itself on the sandy edges of the lake.

Anthoxanthum odoratum appeared in 1885 on a low clay hillock in the home paddock, near the lake. Since then this grass has slowly been spreading up-hill; but after all these years, and although now fully 50 acres are overrun, there is comparatively little in other parts of the run. It seems to have stuck to one spur of fairish clay, taking no hold of the pumiceous ground in the north and west, and but little of the better limestone soil to the south and east.

A handful of the seed of *Sporobolus indicus* was gathered by my overseer whilst on a holiday in Auckland, and dropped about the place on his return. This is one of these inferior aliens that is destined to take possession of large tracts of the run. It is, however, better than most of the native grasses, and will be welcome on certain soils. It originally reached New Zealand in hay used for feeding a cargo of horses from Valparaiso.

Festuca elatior probably arrived in grass-seed. As far as I know, there is but a single plant on the run.

Lolium italicum, *Bromus unioloides*, and *Phleum pratense* have been purposely sown on Tutira. The first and second have done fairly well on good worked soils; the third has been twice sown and twice been given a good chance, and altogether failed on each occasion—at rare intervals I see an occasional plant.

Alopecurus pratensis has found its own way to the run, where it is a very rare plant.

For several years I had a plant of "Johnson's grass" in my garden, and although the plant thoroughly established itself, and even to some extent spread, the seed never matured. Cattle and horses, I remember, used to eat the great succulent leaves with eagerness.

Setaria viridis has been a garden-weed for several years.

Panicum crus-galli appeared in a lawn-mixture, and *Phalaris canariensis* in bird-seed.

Hordeum murinum has quite lately arrived on the roadsides, almost certainly carried in mud adhering to wheels.

Polypogon monspeliensis appeared also on the roadside. At first a single plant, it has spread into several damp spots, and was also probably carried up in mud during wet weather, for it is a common species in flooded land near estuaries.

Paspalum dilatatum I surface-sowed during 1903 on the pumiceous lands. It has completely failed, though seeds that were roughly scratched in with a knife appeared in a few cases. The species, however, must have great vitality, for in the dense sward of the homestead paddock a chance-dropped seed has forced its way through the other grasses and reached the state of seeding. The seeds sown in a well-manured garden of pumiceous soil, after a good start, were overrun by fog that germinated weeks later. It was also badly burnt by winter frosts.

Lastly, *Agropyrum repens* arrived in the roots of plants bought from a Hawke's Bay nurseryman.

Of the native grasses enumerated by Mr. Cheeseman in his "Manual of the New Zealand Flora," one-fifth have been noticed on Tutira, or twenty-one out of 113. This proportion is not small, I think, considering that there was almost no open land, and that the whole countryside was forest, fern, flax, and raupo. Probably, however, several of the varieties that have now spread, or become noticeable, may have precariously survived on cliffs, shingle-beds, sandspits, and rocks —any spot, in fact, where they had not been smothered by the enormous growth of fern.

The most efficient plan in observing these natives is to mark a particular plant in, say, a cutting well above reach of sheep, or in some barren gully in a lightly stocked portion of the run—anywhere, in fact, where the grass is likely to be undisturbed for several seasons. There, in its self-chosen spot, the natural habits of the plant can be correctly determined, and this is the method I have followed for many years.

Last year, however, I thought a native-grass garden would give even more accurate results. What with weeds, however, and abnormal growth, the outcome was a total failure, and I found that in fertile land and a soil constantly stirred to keep down weeds the plant's true characteristics were lost. With the utmost care, and dealing even with minute fragments of sod, it was impossible to eliminate the seeds of other grasses—even their roots in some cases—and there was a constant insurrection of these unwanted grasses, besides the growth from seed of sorrel, sow-thistle, thistle, and other weeds, all of which must have been lying dormant among the roots of the particular species selected for observation. Then, the growth was very misleading for practical purposes, *Agropyrum scabrum* reaching 7 ft. 6 in. when held up straight, and *Dichelachne crinita* standing erect 5 ft. 6 in., and with seed-stems like fine-grown straw.

The twenty-one native grasses on Tutira are: *Isachne australis*, *Microlæna stipoides*, *Microlæna avenacea*, *Hierochloe redolens*, *Echinopogon ovatus*, *Deyeuxia Forsteri*, *Deyeuxia quadriseta*, *Dichelachne crinita* and var. *intermedia*, *Deschampsia cæspitosa*, *Trisetum antarcticum* and slender form, *Danthonia semiannularis*, *Danthonia pilosa*, *Arundo conspicua*, *Arundo fulvida*, *Poa anceps*, *Poa cæspitosa*, *Poa Colensoi*, *Poa imbecilla*, *Agropyrum multiflorum*, *Agropyrum scabrum*, *Asperella gracilis*.

Isachne australis grows only on the marshy edges of the lake, is of no particular value, and does not seem to spread.

Microlæna stipoides, in 1882, was the most widely spread of my native grasses, and since then it has fully held its ground. Its value is dependent on its treatment, and when newly burnt it is a nutritive grass, and is kept closely cropped. As it becomes rank, however, it becomes less and less palatable, until at length sheep will sooner starve than touch it. When growing amongst manuka the stems add season by season to their growth, until the grass has almost developed a climbing habit. I have measured such stems, and found them fully 5 ft. long, and often, I dare say, longer specimens could be obtained. These high stems never seed, and when burnt their crackling is noticeable and peculiar. The normal plant, growing in the open, seeds very freely, not only in spring, but after early summer or early autumn rains a second heavy crop is quickly produced. This *Microlæna* goes by the local name of "coast grass," but it grows freely sixteen miles inland at least, and at an elevation of over 3,000 ft. The Bishop of Waiapu informs me that *Microlæna stipoides* was the grass in full possession of the alluvial Poverty Bay flats, and that in a very short time it was completely dominated and subjugated—indeed, killed out—by English rye-grass.

Microlæna avenacea prefers hill or ridge tops in fairly open bush, and though to some extent browsed upon by wild cattle it does not seem a very favourite grass. On newly fallen forest country, especially during the first season, when thistles are too thick and high for stock, this grass thrives enormously, showing that it can and does do well in the open. I have measured seed-stalks over 4 ft. long, and the whole plant presents then a very handsome and stately appearance.

Hierochloe redolens is worthy of a place among garden-plants on account of its handsome appearance and long drooping silver-grey seed-heads, and has, moreover, when touched, the pleasant scent of sweet-vernal grass. It grows but sparingly in the Tutira Block, but immediately beyond my western boundary, and on country over 3,000 ft. high, this species and *Poa anceps* form over large areas by far the bulk of the herbage. It seems to enjoy a certain amount of damp.

A dry situation and some shade are necessary to *Echinopogon ovatus*. It will thrive beneath open clumps of kowhai on dry ridges, on edges of barren cliffs and slips among the logs and boughs of newly cleared bush land, but never in a sward. My local experience would lead me to put a very low value on this grass, both from its infrequency and straggling arid habit.

Deyeuxia Forsteri occurs very rarely in Tutira, and from its appearance I should think was a poor, useless species. Mr. Buchanan, however, in his "Manual of Indigenous Grasses," declares it is greedily eaten by horses and cattle. It grows locally in the soaking edges of waterfalls flowing over papa, or, rarely, on the edges of the lake.

Deyeuxia quadriseta will grow where no other grass can live, and appears on the most arid and sterile pumiceous land—lands where even the manuka hardly survives and the fern is depauperated. Its young leaves in such situations become quite brown and very remarkably scabrous. On better lands the leaves become much less rough; but in a sward the plant is insignificant, and must be only a very worthless species from the pastoralist's point of view, for lands that will only grow *Deyeuxia quadriseta* are better out of cultivation altogether. When transplanted into good soil this plant showed little improvement, and is apparently unable to assimilate the more nutritious elements.

Dichelachne crinita is one of the better-known native grasses, and at once claims attention by its handsome erect plume of feathery looking seed. This species is especially noticeable in rough pasturage, and is well able to survive owing to the height of the flowering stems, that pierce through the fern, and seed above it. On steep banks *Dichelachne crinita* is always plentiful, and grows equally well on hard clay or soft pumiceous soils. On second-class lands it is certainly a useful grass. It will survive, besides, on well-manured sheep-camps, and was one of the three native species growing among Mr. J. N. Williams's sample strips of turf at Frimley, on the alluvial Hastings plains. To thus survive amidst English grasses on rich soils proves an abundant vitality, and corroborates what I have already mentioned as to the great growth made by this species when transplanted into a good soil. There is a more slender form (*D. intermedia*) also on the run; this variety, although much less common, seems also to be a good grass.

Deschampsia cæspitosa is locally a very rare grass, and my specimens were gathered from a single plant. It covers considerable areas at the mouths of several of the rivers that feed Lake Waikaremoana.

Trisetum antarcticum is one of the natives very much in evidence on edges of cuttings and such spots as sheep cannot reach. On the higher country and the foothills of the Maungaharuru Range it is pretty common. It is an early grass, and, as the seed-stems are rare in the turf and rough open lands, presumably the plant is palatable to sheep, and therefore closely cropped. The slender form of this species has also been got on Tutira.

Danthonia semiannularis is a species of first-rate importance that was firmly established in 1882. Even in those early days it was widely spread, and has increased every year. On the whole, it is the best native grass we have, as it never gets very rank. It prefers good country and hard surfaces to pumiceous and sandy soils, although it leaves the hardest and driest clays to its cousin *Danthonia pilosa*. Even on fair hill country it is worth sowing purposely, and there must be now in my own district hundreds of acres very largely, and in some areas almost exclusively, grassed with *Danthonia semiannularis*. In good soils, and where the sward is well worked by cattle, this grass would carry one and a quarter sheep per acre.

Danthonia pilosa is a species about which I have some hesitation in writing, as I am not sure of the type. The commoner form at Tutira is locally a bad grass, both on account of the dislike to it—except when fresh from a burn—of stock, and furthermore that in the wet Tutira climate fires can only be run over this grass every second, or third, or even fourth season. On the other hand, this form might be a valuable plant on hard clay soils in a dry district. This, the less-good form, has narrow involute leaves on erect culms. In the better variety the leaves are broader, flatter, very pilose, and of a noticeably deeper green colour, and the culms have at first a decumbent habit, the seed-stalks rising only from the first joint and some continuing to lie flat. This habit of the culms may arise, however, from the centre of the plant having been eaten out by sheep, for I have noticed in heavily stocked country *Microlæna stipoides* and some other grasses to a lesser degree adopt the same device, as if for self-preservation, and with an apparently instinctive knowledge that culms lying flat on the ground would be more likely to reach maturity and perpetuate the species. These two forms of *D. pilosa* were unknown at Tutira in 1882, and the first clump ever seen by me in the district was on the old Tongaio–Tutira pack-track, at a spot several miles from my southern boundary. In 1885, however, I discovered it covering scores and even hundreds of acres twenty miles to the north-east; but it was not until the early nineties that it began to make its appearance on Tutira. Then, within a couple of seasons, it seemed to establish itself all over the run on spots specially adapted to its requirements, and since then each succeeding year sees the hard dry clay soils more and more overrun. On pumiceous soils it seems less happy, and so far it has not encroached on the turf of the high ranges to the west.

Arundo conspicua adorns many parts of the run with its long nodding plumes.

Arundo fulvida grows thickly on several of the almost precipitous papa slopes that face towards the south.

In the eighties there was a patch of land on Tutira known as the "Burnt Bush"; this had been forest through which in an extra dry season a fire had run, probably about twenty years previously, and long before the run had been "taken up" or stocked. Fern had in the eighties not quite taken possession of every foot of this land, where still the great gaunt boles stood in thousands, and here the commonest of the surviving grasses was *Poa anceps*. There are several very slightly differing varieties on the run, and it is one of the native species that will probably compose eventually the turf of the poorer or higher lands.

Poa cæspitosa grows naturally though sparsely on my higher country towards the west, though it is not found on the main ridges of Maungahararu. On the Tutira hills it has been sown by chance, probably with rye or cocksfoot seed harvested in Canterbury, where the species is common. I remember in the early eighties but one single tussock, and after twenty-five years there are but two or three patches, the largest, perhaps, 60 ft. by 20 ft. Though so exceedingly slow to spread, it takes possession very surely, allowing no other grass to survive. The increase seems to be by root.

Poa Colensoi is a rare grass, on the highest country I possess, and I have not noticed it under 3,000 ft.

Poa imbecilla seems to be another high-country grass, and grows locally at about 3,000 ft., and in the edges of bush lands.

Agropyrum multiflorum and *Agropyrum scabrum* are common grasses on the dry edges of road-cuttings and steep banks. They also manage to find plant-food on the most barren pumiceous lands—flats so dry and poor that even in our rainy climate they dry up after a few days' drought. But it is not only on such barren spots that these species survive; in all good free soils, wherever the herbage gets rough for stock, and the plants consequently are allowed a chance, these species appear and seed freely, and in my native-grass garden, on good well-worked soil, long healthy bronze-green shoots appeared immediately from the transplanted sods, and I have mentioned the height of the seed-stalks. These species, therefore, like many other natives, would do well on good soils if not choked by rye, cocksfoot, &c.; as, however, it is practically impossible to prevent this on such soils, these natives are only worth cultivation on lands where the strong alien species will not thrive.

Asperella gracilis is the last of my native grasses, and I have only one plant of it on the run. It makes up the twenty-first species, and with it my list ends.

Any interest attaching to these notes seems to me to lie in the fact that with the deterioration of the surface soils the hardier natives tend to resume possession, and that the balance of nature is again tending to right itself.

The exuberance of growth during the eighties was abnormal, and the alien grasses are no more going to permanently destroy and oust the native grasses than the British weeds are going to destroy the indigenous wild flowers, but one of which has vanished from Tutira during the past quarter-century.

The alien weeds, however, will form a future paper, and with these concluding remarks my notes on the grasses of Tutira must end.

Art. XLVI.—*The Struggle for Foreign Trade.*

By H. W. Segar, M.A.

[*Read before the Auckland Institute, 21st October, 1907.*]

Part I.

[This part is considerably condensed.]

Though in the same community the operation of supply and demand brings it about that at any given time price is for most goods more or less proportional to real cost of production, it is necessary to distinguish carefully between the two, and neither should be taken as necessarily the measure of the other. The price of an article is its exchange value expressed in terms of money; the real cost of production is measured by the amount of labour and capital required in its production. In different communities prices are less intimately related to the real costs of production. As one person may produce certain goods only with much greater labour or effort than is required by another, so one nation's productions may cost it far more in labour and capital than is required for similar productions by some other nation. Yet any particular product may sell at about the same price all the world over. The distinction here indicated is of the greatest importance in considering the essential character of foreign trade.

The utility of foreign trade, like that of domestic trade, is generally acknowledged. No one claims that trade should cease at the national frontier. The advantage consists in the increase of utility arising from exchange. In the case of every nation there are goods which could only be produced within its borders at a real cost of production greatly in excess of what is required to produce the goods which are exchanged for them. Rather than insist on being self-sufficing, it is better for a nation to produce an excess of those goods in the production of which she has an advantage, and to exchange a portion for those in the production of which she is at a disadvantage.

It must not be thought, however, that when goods are imported they are necessarily produced with less expenditure of labour and capital in the country of their origin than that with which they could be produced in the importing country. A nation may obtain goods by exchange at a smaller cost even than that at which she could herself produce them, although to the exporting nation they may have cost more. Though it may appear paradoxical, it is nevertheless true that it may be to a country's interest to import goods which she could herself actually produce with less cost than the exporting country, for she obtains them at still smaller cost by exchanging for them goods for the production of which she has a still greater advantage. The cost to her is not the amount of labour and capital actually spent in the foreign country on producing the goods, nor even what would be required for herself to produce the same goods, but the still smaller amount spent on producing the goods which are exchanged for them. The reason that one country gains by trading with others is not that other nations produce at less cost than itself, but lies in the differences in the characters of the capabilities of the various nations.

A nation may be very wealthy and still exchange little comparatively by way of foreign trade. The United States, *e.g.*, is amongst the wealthiest nations in the world, whether its wealth be measured absolutely or relatively to population; but relatively to population its foreign trade is amongst the smallest, being only about £7 per head, while that of New Zealand is about £33. From what we have briefly considered above, it would appear that foreign trade will tend to be large if a nation has some great special advantages, or even special disadvantages, in the production of some goods, or in the supply of some services. A special advantage will lead the nation to export the goods produced with this special advantage and purchase others for the production of which she is not so well fitted; a special disadvantage will lead her to purchase the goods she can only herself produce at such disadvantage and pay for them by exporting those for the production of which she is better fitted. We may say that causes producing a great differentiation in national productive powers tend largely to promote foreign trade. Now, the most general and at the same time most considerable causes affecting the relative powers of production in various branches of industry are the relation of population to land and the magnitude of the community or of the national estate.

The first of these is the relation of labour to land. If the population is small compared with the area of good land, even though there may be abundance of coal and water-power, the nation will have a great relative advantage, not in manufacture, but in the production of food and raw materials. Australasia, Canada, and Argentine export foodstuffs, minerals, and other raw materials, and import manufactured goods. Even the

United States, with its much greater relative population and stringent tariffs, though exceptional resources in the way of coal and iron has given it a great advantage in the production and manufacture of iron and steel, remains to this day predominantly a producer of food and raw materials. If the population of a country, on the other hand, is large compared with the area of good land, the nation is at a great disadvantage in the producing of food and many raw materials in sufficient quantity for the needs of its large population. Unless it is equally handicapped in other directions, it will take up other pursuits, and import food and raw materials in return for manufactured goods, or for services rendered such as England renders by and in connection with her great carrying trade. The great and numerous advantages for manufacture and commerce possessed by Britain brought it about that as population increased it was much easier for her than for her rivals to turn for the support of her growing population from the pursuit of more and more intensive culture of the land to manufactures and commercial pursuits. Consequently she started earlier on her great manufacturing and commercial career than other nations; but some of these are now at last, by reason of the continued growth of their populations, being forced in the same direction. If, however, there be in any country little source of power, or such can be obtained only at great cost, the nation may be forced by increasing population rather to a more intensive cultivation of the soil than to manufactures; and a very intensive system of cultivation may have to be reached, calling strongly into action the law of diminishing returns, and leading to a greatly diminished prosperity of the people, before the point is reached at which its labour and capital can be more economically utilised in the development of manufactures.

Smallness of population or of territory is the second of the two general causes we are considering which promotes great specialisation of national industry by a great differentiation in the national productive powers. The smaller the resources the more restricted generally will be the variety of occupations in which the population can engage with advantage, partly through diminished variety in the resources themselves, and partly by the smaller field for the division of labour. The variety of resources of the United States we cannot expect and do not get in the much smaller area of, say, Holland. But a nation may not be exceptionally small in respect to its territory or resources, and yet may be unable, by reason of the smallness of its population, to engage with advantage largely in a variety of industries. A small community is not suited to a high development of the division of labour. Our own Dominion comes within this class. We have resources in great variety, but the absolute smallness of its population aids the influence of its smallness relatively to the extent of the land of the Dominion, in constraining a one-sided development of industry in the direction of mining, agriculture, and pastoral pursuits.

According to this argument it is in the case of nations that have either sparse or very dense populations that we should find generally the greatest foreign trades relatively to population; and of these generally the most conspicuous should be the smallest populations in the former class and the smallest countries in the latter. Table I refers to countries of sparse populations producing an excess of food and raw materials. The statistics are mostly quoted for the year 1904, and the countries are arranged in the order of magnitude of the foreign trade per head of population.

TABLE I.

Country.	Population.	Trade per Head. £	s.	d.
Western Australia	236,516	71	12	10
South Australia	369,697	43	1	11
New South Wales	1,446,440	41	16	2
Victoria	1,207,537	36	17	0
New Zealand	845,022	33	3	8
Queensland	519,178	33	2	9
Tasmania	178,826	31	0	0
Australia	4,013,722	29	12	0
Argentine	5,410,205	19	4	0
Canada	5,604,328	17	7	0
United States	82,859,211	7	0	0
Russia	143,000,000	1	1	0

It will be noticed here that the trade per head is less for Australia as a whole than for any of the separate States. This is because much of the trade of each State is with the other States; this counts as foreign trade for each separate State, but is omitted as internal trade from the foreign trade of the whole. This further illustrates why the trade per head is largely influenced by the size of the community. The larger the community the greater tends to be the proportion of its total trade which is merely internal trade.

Table II refers similarly to a number of countries of dense population in which the import of food and raw materials exceeds the exports.

TABLE II.

Country.	Population.	Trade per Head.		
		£	s.	d.
Netherlands	5,430,981	65	0	0
Belgium	7,074,910	31	19	0
Switzerland	3,463,609	28	5	0
United Kingdom	44,000,000	20	15	0
Germany	60,605,183	9	19	0
France	38,961,945	9	11	0
Italy	33,346,514	4	4	0

In the trade per head is included only the special commerce. The position of the three smallest countries at the head of the list is noteworthy.

PART II.

Present Tendencies in Foreign Trade.

We may now proceed to consider some of the tendencies characterizing the course of the industry and commerce of the world at the present time. We may notice that the growing complexity of manufacturing processes, combined with improvements in the means and methods of transport, have a conservative tendency, and assist the manufacturing nations to retain and increase their manufactures; while, on the other hand, the operation of the law of diminishing return, acting on their supply of raw materials, especially on that of coal, is likely in the future to tend to place such nations at a disadvantage. The existence, too, of local supplies of raw material, and especially of coal, combined with growth of population, is tending to start manufactures in many new districts. The use of water-power through electricity is giving to some nations an impulse towards manufacturing that was formerly lacking through want of supplies of coal, formerly the only extensive supply of mechanical power. The improvement and opening of waterways are important agencies influencing commerce. The improvement of the navigation of the Rhine has proved of great assistance in the development of the iron industry of Germany. But it can hardly be said that there has been any epoch-making development of this character since the opening of the Suez Canal. Of schemes for new waterways, no other appeals to the popular imagination as strongly as does that of the Panama Canal. The coming canal is already called "the Gate of the Pacific." On this perhaps we may dwell a little with advantage, because of the exaggerated notions that seem to prevail.

That the opening of the Panama Canal will result in the diversion of the routes of a considerable portion of the world's trade, and will bring some portions of the earth into much closer commercial relations, goes without saying. But it will not have the same proportional effect on the world's trade as a whole as did the opening of the Suez Canal, which greatly shortened all the voyages between the East, including Australia, and the West, including the east coast of North America. The Panama Canal will not shorten the distance between Europe and Australia or the East generally. It will not even make the voyage from New York to China shorter than is that from England by the Suez Canal, and it will make it only slightly shorter than the voyage from New York itself *via* Suez. The Suez Canal must continue almost to monopolize the trade of Europe with Asia. Australasia will not be benefited to any extent beyond the shortening of the distance to the eastern ports of the United States. This, no doubt, will tend to encourage trade with the United States; but as regards trade with Europe, Australia will not be appreciably better off than she is now with the Suez Canal. The Panama route will only shorten the distance from Auckland in New Zealand to Plymouth or London by something less than thirteen hundred miles as compared with the route round Cape Horn—*i.e.*, by about 10 per cent. This is only about three or four days' sail for the modern ship. As against this advantage, there will be the slow and expensive progress through the canal and its locks, and the disadvantage of there being no great ports of call on the new route. The present route round Cape Horn enables boats to call at the great and rapidly growing ports of the eastern coast of South America, including Buenos Ayres, with its population of over a million.

On the other hand, the United States will get a much shorter way of water-communication between its east and west coasts. There will also be shorter communication between Europe and the west coasts of the Americas. But the commercial importance of the west coast will never be comparable with that of the east coast: its mountainous formation, and the arid character of so much of the country beyond, is very different from the rich plains and great river systems of the east coast. As regards, then, the commerce of Europe in general, or of England in particular, it is a mistake to think that the opening of the Panama Canal will be in any way of the nature of a revolutionary event.

Looking now at phenomena rather than at causes or influences, we may remark that in the struggle for foreign trade no feature has attracted more attention than the rapidly increasing foreign trade of Germany. It has been made a persistent argument for a revolution in British fiscal policy.

We shall now be able to appreciate the real force mainly responsible for producing this rapid expansion, and to see how helpless is Germany's own fiscal policy, or those of other nations, to arrest, though they may impede, its progress. The soil of Germany is cultivated to the utmost degree. and is devoted mostly to the growing of food, and only to a comparatively small extent to the growing of raw material for manufacture. With an area only some 70 per cent. greater than the United Kingdom, she has four times the number of persons engaged in agriculture. In spite of this, she now fails even to feed by any means the whole of her population. For a large portion of her food-supply and for a much greater portion of her raw materials she is dependent on other and younger nations. The change which has been taking place is illustrated by the great diminution in the flocks of sheep. In the twenty-one years from 1873 to 1904 the sheep of the Kingdom of Prussia declined from 19,670,000 to 5,650,000, and those of the whole of Germany from 25,000,000 to 9,690,000. Pasture has been giving place to intensive culture of the land; but, notwithstanding this, Germany fails now to supply the whole of the food of her people. In 1905 the value of her import of wheat was no less than £16,470,000. The magnitude of her imports of raw materials is sufficiently indicated by the values of her imports of wool and cotton in the same year. Raw wool she imported to the value of £16,360,000; woollen yarn, to the extent of another £4,670,000; and cotton cost her £19,910,000. The census of the same year showed an increase in population during the quinquennial period of 4,087,277. This represents an annual increase of population almost equal to the total population of New Zealand, and the area of Germany is only double that of New Zealand. This increase in population is considerably more than double that of the United Kingdom. If the same rate of increase were continued, the population of Germany would double in some forty-five years.

Now, this growing population has to be supplied with food and raw materials, and it can only be done by the export of manufactures or the rendering of other services. For progress in manufacture she has many advantages. List perceived it long ago. In the year 1844 he was able to write, "If any nation whatever is qualified for the establishment of a national manufacturing power it is Germany; by the high rank which she maintains in science and art, in literature and education, in public administration, and in institutions of public utility; by her morality and religious character, her industry and domestic economy; by her perseverance and steadfastness in business occupations, as also by her spirit of invention; by the number and vigour of her population; by the extent and nature of her territory, and especially by her highly advanced agriculture and her physical, social, and mental resources." Germany has large supplies of both coal and iron, and certainly the quality of her people is second to none. She is surrounded by some of the wealthiest nations of Europe, and can exchange products with them by rail without breaking of bulk and frequent handling. The progress in European railway-communication and the tunnelling of the mountains have given Germany an advantage in markets in which she was formerly handicapped. It was, then, inevitable that Germany should have utilised these advantages to obtain food for her people, and become a predominantly manufacturing nation earlier than she would have done had her advantages for such a career been less pronounced. Her foreign trade has to struggle against her own restrictive policy. She taxes imported food, and imports cannot be restricted without restricting exports. But the influence of the German tariff pales before that of the growth of population. German foreign trade flourishes in spite of the policy of German statesmen, and the author of the victory is the German mother. The declining birth-rate has affected Germany less than most countries, while she feels with most others the operation of the diminished death-rate, due to improved sanitation, the progress of medical science, and the improvement in the general knowledge of the laws of health.

As the great increase in population has produced in the past such a rapid increase in German foreign trade, so it is sure to produce the same effect in the future. Even an exceptional fall in the German birth-rate would not materially affect the progress of German commerce for many years to come. The high birth-rate of the last fifteen years is only now about to increase the effective labour force of the country. Even if there were to be no increase in the annual number of births, though this would involve a rapidly falling birth-rate, the population would continue to increase rapidly, for the present annual number of births is sufficient to raise the population to some 110,000,000. The increase in the labour force of Germany during the next twenty years will be enormous. It will be largely directed to manufacture, and it will want food and raw material —very much food and still more raw material; for it should be noted that in the case of an increasing population that already requires more of these commodities than its land produces, not only is food and raw material required for the consumption of the accessions to its population, but still more raw material on which to bestow the labour of manufacturing, which is to purchase the former. An excess of raw materials must be imported over and above what is required for consumption, to be re-exported in a manufactured form, and with an increased value making it sufficient to pay for the whole. Unless Germany is to obtain much of her supply of food and raw materials in return for services of shipping, or as interest on increasing capital invested abroad, as in the case of England, the amount of manufacturing in Germany will increase far more rapidly than her population, and the export of manufactures more rapidly than the total amount of manufactures. It cannot be many years before the volume of German trade will pass that of England. Germany is rapidly assuming a position of equal dependence with England on imported food and raw material. Probably the addition of twenty millions to her population would produce an equal proportional dependence, and at the present rate of increase she will acquire this additional population in a little over twenty years. When Germany has reached that stage of like economic condition, if not before, her total trade will greatly exceed that of England, by reason of her much greater population, which will be sufficient to outweigh any advantages which may tend to produce a greater British trade. And with German trade will grow naturally and inevitably the German navy.

When we reflect now that, although the most conspicuous instance, still Germany is only an example of what is taking place over a great part of Europe, one is inclined to question from this point of view the wisdom on our part of a policy that would tend to throw away these rapidly growing markets in favour of one. In the period 1901–3 we have the following excess of births over deaths per hundred of population in various countries of Europe: Germany, 1·49; Austria, 1·25; Hungary, 1·16; Belgium, 1·13; Holland, 1·55; Italy, 1·04; Norway, 1·50; Sweden, 1·08. The smallest of these rates of increase would lead, apart from emigration, to a doubling of the population in sixty-seven years; and these countries as a whole are already dependent on an excess of imports of food and raw materials.

People generally in this country do not realise the importance of the growing general European market, because the figures in the Official Year-book are so illusive. We read there, for instance, that in 1905 we imported from Germany goods to the amount of £277,467, and exported to Germany to the amount only of £38,958. This, no doubt, is true; but the great volume of goods that pass from here to Germany through the English market is ignored. It will be a revelation to many to realise how great this volume is. The estimate of Mr. W. de Haas, Commercial Attaché to the Imperial German Consulate-General in Sydney, is that Germany really takes from New Zealand goods to the value of £750,000 yearly, the wool alone amounting to £500,000. So great is this trade between Germany and these colonies becoming that it is unlikely to continue much longer to pass so largely through the English market; the goods will be carried more and more direct to Germany, and much of it in German vessels. Again, the import of butter into Germany in 1904 reached 34,340 metric tons, and was of the value of £3,000,000. It had considerably more than doubled in two years. Russia and the Netherlands each sent butter to the value of about £1,000,000. It is a good thing to have a choice of markets, and it is worthy of consideration whether New Zealand would not be doing better to cultivate the rapidly growing continental European markets instead of pursuing a policy tending in the direction of confining her trade to the Home market.

As Germany is the leading example of a striking tendency in Europe, so in the East we find Japan the leader of an important movement in Asia. The country has attracted the attention of the world by reason of its rapid development in many ways. She does not yet cut a great figure commercially in the world, for in 1905, even after some years of rapid increase, her trade was less than £83,000,000. But even this represents a striking change and a great advance upon small beginnings. It is the rapidity of this advance and the great possibilities of future progress that arrest one's attention. In Japan, China, and India there has long been present one important condition favourable to an extensive commerce in the density of the populations of those countries. But it is only recently that Japan's pursuit of western knowledge, adoption of western methods, and willingness to trade with other nations has given play to this influence, and the world to-day stands expectant of a further remarkable industrial development in Japan. In China we have a great population, of great density, with resources of the richest, including one of the largest coalfields of the world. The Press has informed us at intervals recently of the many ways in which she is freeing herself of the shackles of her traditions. Amongst social reforms in progress are the suppression of opium-smoking, the removing of racial distinctions between the Chinese and Manchus, the permission to daughters of upper-class Chinese to marry into the Imperial family, and the abolition of the binding of the feet of females. We have, further, such political and economic forms as the forming of a Government Council, intended to be the nucleus of a regular Parliament, the adoption of uniform weights and measures throughout the country, and the adoption of the gold standard. Chinese students are going abroad in large number to acquire the most modern education. The awakening of China has been long foretold. China has been going to awaken for fifty years past, but it would appear that at last we are now in the presence of the realisation. If, as appears now almost inevitable, the Chinese evolve in the same way as the Japanese have done, the industrial development of China is likely to be of the stupendous order. Labour and capital will find a greater reward in utilising the mineral and other resources for manufacture than in intensifying the culture of the land. It has been so in Japan, where with the growth of manufacture has also come a great improvement in the condition of the workers. The rise in wages that has characterized recent years has of course been no local phenomenon, but a general feature associated with widespread prosperity and a universal rise in average prices. In Japan, however, the rise in wages is remarkable, though they still remain small compared with those paid in many other countries. As in Europe the average welfare of the people is being maintained, and even advanced, in spite of growing numbers, by the increasing adoption of manufactures, so in the East, as the stagnation of Eastern civilisation is gradually lifted, will the industry of the teeming millions of Asia seek the same welfare by the same means.

The Future.

The full effect of these tendencies in the future it is given to no man to foresee. We have seen how many nations are already dependent on others for supplies of food and raw material, and how rapidly this dependence is growing. To the greater part of Europe must be added Japan, and in the near future probably China and possibly India. Later on the United States will reach the same economic stage. The United States is rapidly fulfilling the destiny clearly foreseen for her by List when he wrote, in 1844, "For the same causes which have raised Great Britain to her present exalted position will (probably in the course of the next century) raise the United States of America to a degree of industry, wealth, and power which will surpass the position in which England stands as far as at present England excels little Holland. In the natural course of things the United States will increase their population within that period to hundreds of millions of souls. . . . The naval power of the western world will surpass that of Great Britain as greatly as its coasts and rivers exceed those of Britain in extent and magnitude." Development has not been quite as rapid as List expected, but the vision of List must be realised in the near future. What then will be the position of the younger nations that have started later in the race for wealth and population? They will be supplying food and raw material for manufacture to these others. The welfare of the people need not necessarily suffer on that account, as it certainly does not at the present time. Only if it be thought essential for the nation to grow out of an agricultural state and achieve eminence in manufactures, thus increasing in population and aggregate wealth to an extent that would not be otherwise possible, need the prospects of this time be contemplated with any anxiety. It is true we have previously spoken of the growth that has been achieved in some cases, and is likely soon to be achieved in others, as the result of developing manufactures for export, as of a phenomenon by no means remarkable, but the natural result of present conditions. But in the days to which we refer, when so vast a proportion of the world's population will be living on land totally inadequate to providing them with the necessary food and raw material, and will be exporting manufactures for the food and raw materials of the remainder, the world will move more slowly. England, the first nation to attain to great manufacturing pre-eminence, was able to feed her people from the new world and pay with her manufactures. Germany, coming next, found the world wanting more manufactures than England could supply, and found it easy to follow in her footsteps. But no such easy path can lie before Canada, Australia, Argentina, or New Zealand. Even when these countries reach the stage when their further development will require the exporting of manufactures for food and raw material, there will no doubt be then, as probably always, parts of the earth whose want of power, climate, and other circumstances will prevent their ever assuming the manufacturing state. Such parts must export food and raw materials; but these exports will be required by the nations that will then have become the great manufacturing nations. New Zealand and the other countries at about the same stage of development will have to compete with these in the effort to change themselves from agricultural to manufacturing nations. If it be still possible for any of these younger nations to urge forward and attain the manufacturing state, Canada, Australia, and Argentina, with their greater populations and greater resources, will grasp what opportunities there are. States of the magnitude of New Zealand will have small chance. International competition will be very different from what it is to-day. The more backward nations will only be able to come to the front at the expense of the more highly developed. Every nation cannot export manufactures in return for food and raw materials to maintain a population greatly in excess of what could live on her own produce.

Any fresh accession to the manufacturing ranks would involve the defeat of the existing predominantly manufacturing nations, and possibly the reduction of their populations. Certainly, too, the process will not be facilitated by tariffs if they continue to that time, for in economic war, as in any other war, victory is apt to lie with the biggest battalions. If New Zealand has to depend for her economic transformation on struggles with the great industrial States of the future the issue can scarcely be in doubt.

The question we have been considering is an important one, for on the answer depends some other points of interest. If New Zealand can never escape from the position of a predominantly pastoral and agricultural nation, the rosy estimates we sometimes hear of her great future population are foredoomed to non-fulfilment, and her rapid development will cease at a much earlier period than is commonly anticipated. It is quite certain that New Zealand cannot maintain in anything like the present standard of comfort five million people exporting the same proportional amount of food and raw materials as at present. It seems quite certain that her transformation, if it ever eventuates, will be slow and painful. The rapid development from the agricultural to the manufacturing state that we have witnessed in Germany cannot be emulated by this country. What small chance there may be would consist in leading in the race for a rapid increase of population. This is not encouraged by the present policy. The industry best suited to the present time and conditions in this country is the development of the land. Growth of population would be more encouraged by the removal of the artificial expenses inflicted on the farmer. This would make farming more profitable, and this would tend both to widen the area of cultivation and to promote a more intensive culture, and so lead more rapidly to the state in which the country would be economically ripe for manufactures. Again, from another point of view, the answer to our question must influence our judgment of the wisdom of a restrictive policy designed to encourage manufactures. Not only is the population of the country too small, both absolutely and relatively to its land, to be ripe for such as a general policy, but if New Zealand is never to attain the position of a manufacturing nation, one great incentive to protective measures does not exist. Many admit, that are not generally adverse to such a policy, that while an industry lives only on protection, however profitable it may be to the capitalists who engage in it, the result is a present loss to the country as a whole. By such persons the policy is recommended by arguments such as commend a policy of education in the case of an individual. A present loss or sacrifice is submitted to for the sake of a future gain. The gain is to come when the industries can and do stand alone. It was by such arguments that a protective policy was successfully advocated in Germany and the United States. Now, if in the case of New Zealand this time of national profit resulting from protection is never to come, or can come only in a dim and distant future, this form of argument ceases to be effective in support of the adoption of a general policy of protection in this country.

This is as far as we have time to indulge in these speculations as to the future. Summarising, in conclusion, the drift of some of the remarks that have been made as to this country, we may say that it cannot anticipate a rapid and uninterrupted development to the manufacturing state. Once the output of food and raw materials has nearly reached a maximum, development will receive a check. The population may still advance, but any considerable advance in population will be accompanied by a lowering of the standard of living, and the rate of increase of the total wealth of the community will be on a greatly inferior scale to that of the present time. So long as New Zealand can continue to increase her output of food and raw materials without pressing too hardly on the law of diminishing returns, the prosperity of her people is assured; but once that point is passed, anything like what we now consider a normal rate of increase of population must lead to a rapid approximation in the condition of her workers to that of those of the old countries.

ART. XLVII.—*Further Notes on* Lepidoptera.

By GEORGE HOWES, F.E.S.

[*Read before the Otago Institute, 13th November, 1906.*]

Melanchra molis, n. sp.

Five specimens, varying from 30 mm. to 36 mm. Antennæ ochreous, filiform. Legs and palpi light-ochreous. Thorax strongly crested, crest outlined in light-brown. Abdomen ochreous; in one specimen reddish-ochreous. Forewings light-ochreous; all markings delicately shaded in reddish-brown. Reniform hardly shown, but shaded, especially to-

wards base, with reddish-brown. Seven short distinct marks from base to ¾ along costa. A jagged transverse line near termen, inclining towards centre of wing as it nears dorsum. Edge of termen deeply scalloped. Cilia light-brown. Hindwings ochreous, with strong darker terminal suffusion. Cilia ochreous.

Apparently close to *M. rubescens*, which it resembles in the markings, but it is easily distinguished. Has occurred in Dunedin in December, and on blossom here in October. Mr. Philpott has three specimens taken at Wallacetown.

In the 1905 volume of the Transactions I described a new *Leucania* as "*Leucania obsoleta*." As this name proves to be preoccupied, I alter the name to "*L. innotata*."

Leucania innotata, n. sp.

About 37 mm. Antennæ ochreous, filiform. Legs and palpi greyish-ochreous. Legs fuscous beneath. Face and thorax dark-ochre. Thorax moderately crested. Abdomen dull-grey; anal segment paler. Forewings uniform light-ochre. Veins plainly outlined in grey. Orbicular and reniform obsolete. Very slight dark shading from base to half-way along wing-centre. Termen very slightly sinuate near apex. Hindwings uniform fuscous, with cilia light-ochreous as in forewings.

This moth appears to be close to *L. arotis*, but differs in coloration, in the absence of dots on the forewings, and in its pale-ochre cilia.

The first specimen was taken in Dunedin in December, but since then, when collecting with Messrs. Lee and Oliver, we have taken several more in October at Anderson's Bay, Dunedin.

Art. XLVIII.—*Additional Notes on the Kea.*

By George R. Marriner, F.R.M.S., Curator, Public Museum, Wanganui.

[*Read before the Philosophical Institute of Canterbury, 11th December,* 1907.]

Plates XXXII–XXXIV.

In order to verify some of the accounts that I had heard of the damage done to the sheep-farmers through the depredations of the kea, and, if possible, to obtain some photographs of the murdered sheep, in July, 1907, I made a week's excursion to Mount Algidus Station. This run is situated near the confluence of the Rakaia, Mathias, and Wilberforce Rivers, a few miles above the Rakaia Forks, where the birds have been very troublesome for some time. Though midwinter is the worst time of the year to visit this kind of country, owing to frequent heavy storms of snow and rain, yet in order to catch the kea at work one must travel at this time of the year.

I was not fortunate enough to actually catch the bird in the act of killing sheep, yet I was able to follow closely in his tracks and obtain several photographs of dead sheep which had evidently been killed by him. Also, through the kindness of Mr. R. Urquhart, manager of the station, who did all in his power to aid me in my investigations, I was able to get some photographs of keas' nests. As I believe that these are the first photographs that have been taken of these interesting phases in the natural history of the kea, I thought that some of the pictures, accompanied by a detailed description, would be of sufficient interest to place on record.

SHEEP KILLED BY KEAS.

The first dead sheep was found at the foot of the Rolleston Range, about ten miles above the Rakaia Forks, on a broad expanse of river-flat, known at the homestead as the "Top Flat." The animal was a merino ram, in splendid condition, and, from the place in which it was found, it had apparently been chased by the bird or birds until it was cornered where two wire fences met, and there injured. The sheep was quite dead, and lying on its wounded side. On turning the beast over we found an ugly black-looking wound on the right loin at 11 in. from the tail. The hole was 5 in. long by 4 in. wide. The wool was all torn off, and the flesh was removed so that the transverse processes of lumbar vertebræ were visible. Though a deep hole had been made in the flesh, the birds had not reached the body-cavity, nor had they injured the kidneys, and from the appearance of the animal it seemed as if it had died from blood-poisoning. Further up the back there were several other places where the wool had been picked. We propped the sheep up in order to photograph it, and on returning next day we found that the keas had evidently been at it, as was shown by the wool which was scattered around the carcase.

On the same flat we noticed another merino ram which had apparently been picked, and on rounding up the mob and capturing the animal we found a V-shaped scar 6 in. by 4 in. on the right loin. The sheep was still running with the mob, but, as the wound was dirty and very much festered, there was all probability of the animal succumbing to its injuries.

On my return to the Lake Coleridge Station I found that during my short absence the keas had been at work, and a wounded sheep was found dead near the homestead. Through the kindness of Mr. J. Murchison, who kept it for me, I was able to photograph it, and take notes. The animal was a four-toothed merino ewe, and apparently in good condition. Over the left loin was a round wound 4 in. by 3 in. in size, and, like those seen at the Mount Algidus Station, the flesh was black-looking and much lacerated. The birds had just made a small hole into the body-cavity, but on opening the sheep we found the kidneys and kidney-fat intact. On skinning the back we found the flesh for some distance blackish in appearance, as though blood-poisoning had been the cause of death. Though the wounds in the sheep seen in this excursion were horrible enough, often the whole side of the sheep is eaten out, and various internal organs pulled out.

However, from what I saw, it appears that the death of kea-picked sheep is not always due to the injuries to the internal organs, but that foreign matter getting into a small flesh-wound made by a kea causes blood-poisoning and death. It may be that the kea's beak itself is not quite clean, or perhaps that the cruel laceration of the flesh due to the kea's attacks is sufficient to poison the blood.

Keas' Nests.

The position of the kea's nest depends a good deal on the surrounding country. If the mountains have numerous long narrow tunnels running for some yards into solid rock the kea will make use of them; but otherwise a rabbit-burrow or a cairn of stones will suffice. When the birds build, as they usually do, in the face of almost inaccessible cliffs, their nests are invulnerable, for even if a mountaineer can manage, at the risk of his life, to reach the exit of the "run" he will have to use a crowbar to force an opening, and in many cases nothing but a charge of blasting-powder would make a hole large enough to effect an entrance. The nest that we visited was situated in a narrow tunnel at the top of a 900 ft. cliff, caused by the Chimera Creek cutting a deep narrow gorge through Jack's Hill. We had to leave our horses in the gorge, and climb along the top of the cliff for some distance, which, owing to the slippery nature of the ground, made our progress very slow. The nest was fairly easy of access, owing to it being situated near the bottom of a small ravine, about 10 ft. deep, which poured its waters over the top of the cliff.

In the spring of 1906 Mr. Urquhart, having discovered the nest, determined to plunder it, and so one night he, with several of his men, climbed along the top of the cliff, but owing to the darkness they were unable exactly to locate the nest. The difficulty was overcome, however, by one of the men imitating the call of a kea, to which the young birds responded. A large stone was forced away from the opening with the aid of a crow-bar, thus enabling a man to crawl in and reach the nest. The female bird was killed, but the male escaped, and the four young birds were carried back to the station. Mr. Urquhart brought two of the young birds to Christchurch for me, thus enabling me to photograph them.

The nest of a kea is almost a misnomer, for the bird chooses some natural hole in the rocks which has a narrow opening just wide enough to allow the adult birds to pass in and out, and then, placing a few pieces of tussock-grass at the far end, she lays her eggs.

The first nest that I saw was situated at the end of a long narrow tunnel running some 6 ft. into solid rock. The opening, after the removal of a large stone, was in the shape of a triangle; the distance from the apex to the base was 14 in., and the length of the base 19 in. The tunnel, or "run," narrowed as it approached the end, and here, in the narrowest part, was the nest placed, which, when it was robbed some months before, contained four keas.

On the opposite side of the ravine the remains of another nest were found, which could not have been reached without blasting the rock. The opening was 30 in. deep and some 13 in. wide, and the tunnel ran back some 10 ft. into solid rock, and a more secure place for a nest could hardly be imagined.

With such inaccessible nesting-places there seems very little chance at present of these interesting but cruel birds being exterminated.

EXPLANATION OF PLATES XXXII–XXXIV.

PLATE XXXII.

Fig. 1. A sheep killed by keas on Top Flat, Mount Algidus Station.
Fig. 2. Close view of the wound seen in fig. 1, Plate XXXII.

PLATE XXXIII.

Fig. 1. A sheep killed by keas on Lake Coleridge Station.
Fig. 2. Close view of wound in fig. 1, Plate XXXIII.

PLATE XXXIV.

Fig. 1. Opening into the "run" leading to the nest where four young keas were captured. A large stone has been removed from the entrance.
Fig. 2. Opening into the "run" of another nest.

Art. XLIX.—*A Preliminary Note of a Metaphysical Hypothesis.*

By Maurice W. Richmond, B.Sc. (Lond.), LL.B. (N.Z.), Professor of English and New Zealand Law, Victoria College, Wellington.

[*Read before the Wellington Philosophical Society, 2nd October,* 1907.]

The hypothesis of which this is a preliminary note is a particular form of monism.

It rejects the dualistic view that there are two kinds of being, the spiritual and the material, and adopts the monistic view that there is only one kind of being—namely, the spiritual. It accepts the latest view of physical science in regard to the constitution of the universe, according to which (using for the moment the language of physical science) the whole of the (so-called) material world (including both ponderable matter and the imponderable ether), and the whole of the phenomena of the (so-called) material world, is resolved into the elements of the ether and the transmission of states through the elements (or from element to element) of the ether; and it gives to this view a particular monistic, and therefore spiritualistic, interpretation.

It supposes every single one of the elements of the ether to be in itself a conscious being or spirit. It supposes each of these elements to have a sense of the existence of its neighbour elements, to have feelings and to be affected towards them, and to produce by an effort of will the effects which it produces upon them. It supposes every single element of the ether, therefore, to be conscious in all the three ways of knowing, feeling, and willing.

It supposes the principal seat of consciousness in man to be in certain of the elements of the ether permeating or surrounded by the brain of the man, and occupying a certain position relatively to the brain as a whole, varying probably, more or less, with the particular state of consciousness. And similarly in regard to the principal seats of consciousness in the case of animals and in other cases.

The hypothesis is, in fact, one not only that every single one of the elements of the ether is a conscious being, a seat of consciousness, but, further, that they are the seats of all consciousness, or, at the least, of all finite consciousness, in the universe, whether human, or animal, or other- that they are the only beings, or at least the only finite beings, in the universe.

It is a necessary part of the hypothesis that what are ordinarily spoken of as the successive states of consciousness of a man are not experienced by a single permanent being, or spirit, or soul, but by a succession of beings, or spirits, or souls—namely, the elements of the ether which from time to time occupy the central position in the brain of the man. The sense of continued personal identity is, according to the hypothesis, created and maintained, notwithstanding this, by the continued corporate identity of the brain and nervous system and body, notwithstanding continual changes of the elements which constitute them, and by the functions of the brain as the organ of memory and anticipation.

Though every single element of the ether has, in the hypothesis, at least an elementary consciousness, the simplicity or complexity of the consciousness of any element must, of course, be supposed to vary immensely, from a very great simplicity when little in the way of change is going on around it and in it (as, for instance, in inter-stellar or ultra-stellar space), to a very great complexity when it is, for instance, surrounded by the brain of a man and subject to the influences of the immensely complex processes going on in the brain of a man.

In the view of physical science the elements of the ether are spatially related, in the sense that each one of them has a certain number of others immediately next or contiguous to it, and acts directly or immediately upon, and is acted upon directly or immediately by, those only which are immediately next or contiguous to it. Action between elements which are not immediately next or contiguous to one another is indirect or mediate only—namely, through the medium of the intervening elements. In the hypothesis here suggested this view takes the following form: The multitude of the elements of the ether is a multitude of conscious beings or spirits. They are spatially related to one another in the sense that each of them is directly and immediately related to a certain number of others, which it directly and immediately knows, and by which it is directly and immediately known, or between which and it there is direct and immediate communication; but communication between it and all others than that certain number is indirect or mediate only—namely, through the medium of those with which it is in direct communication, and of others again with which those are in direct communication, and so on.

The transmission of states through the elements (or from element to element) of the ether, into which, in the view of physical science, the whole of the phenomena of the (so-called) material world is resolved, is interpreted, in the hypothesis, as the communication of states of consciousness from being to being, or spirit to spirit.

It is impossible within the limits of a short note to attempt to work out the application of the hypothesis in further detail, but enough has perhaps been stated to indicate the kind of interpretation which it would give in each case to the detailed results of physical science.

The hypothesis is, it is believed, equally consistent with all the results of mental science or psychology. The manner in which it deals with the subject of personal identity has been already very briefly indicated, and cannot be further gone into in this note. The hypothesis, as a monistic one, in which all the constituent elements of the brain are themselves seats of consciousness and are in themselves beings of precisely the same nature as that which is for the moment the principal seat of consciousness, has, of course, an immense advantage over any form of dualism, in which the substance of the brain is supposed to be of a wholly different order of being from, and wholly incommensurable with, the substance or being of the soul. In the monistic hypothesis here suggested the different elements of consciousness may be supposed to be separately experienced by elements of the ether within the different regions of the cortex, and to be communicated through the intervening elements to the seat for the time being of the principal consciousness, where they are together experienced as a whole. The unity and co-ordination of the different elements of consciousness, and the possibility of their being experienced in the principal seat of consciousness as a coherent whole, would be secured by the communications taking place between the different regions of the cortex through the nervous arcs of the higher levels.

Speaking generally, the hypothesis is a monadology in which the elements of the ether are the monads. They are not, however, cut off from one another as in the monadology of Leibniz. On the contrary, every one of them is in immediate or mediate communication with every other. The hypothesis may also be said to be, in some sort, a unification of idealism and realism: it is idealistic in that it supposes the existence of only one kind of being—namely, conscious being or spirit; it is realistic in that it supposes every single element of the (so-called) material world to be self-subsisting, to the same extent and in the same sense, at all events, as the soul of man is self-subsisting—the soul of man being, indeed, itself an element or elements of the (so-called) material world. To what extent and in what sense any finite being can be said to be self-subsisting is a question which the hypothesis leaves untouched.

NEW ZEALAND INSTITUTE

NEW ZEALAND INSTITUTE.

THIRTY-NINTH ANNUAL REPORT.

THE fourth annual meeting of the Board of Governors under the New Zealand Institute Act of 1903 was held in the Dominion Museum, Wellington, on the 31st January, 1907, and was attended by ten members, under the presidency of Sir James Hector. The representatives of the Governor in Council were Messrs. A. Hamilton, J. W. Joynt, E. Tregear, and J. Young. The representatives of the various incorporated societies who were elected in accordance with the Act were: Auckland Institute—Professor Thomas and Mr. J. Stewart; Wellington Philosophical Society—Professor Easterfield and Mr. M. Chapman; Philosophical Institute of Canterbury—Professor Chilton and Dr. Farr; Otago Institute—Professor Benham and Mr. G. M. Thomson; Hawke's Bay Philosophical Institute—Mr. H. Hill; Nelson Institute—Dr. Cockayne; Westland Institute—Mr. T. H. Gill; Manawatu Philosophical Society—Mr. W. J. O'Donnell.

The following officers were elected for the year: President—Mr. G. M. Thomson, F.L.S., F.C.S.; Treasurer—Mr. Martin Chapman, K.C.; Editor of the Transactions, and Librarian—Mr. A. Hamilton; Secretary—Mr. T. H. Gill, M.A., LL.B.

The honorary members elected were Messrs. F. E. Beddard, F.R.S.; J. Milne, F.R.S.; G. R. Brady, F.R.S.; and Dr. A. Dendy, F.R.S. During the year three honorary members have died—viz., Mr. Alfred Newton, F.R.S.; Mr. Robert J. Ellery, F.R.S.; and Lord Kelvin, F.R.S.—leaving twenty-six on the roll. It will, therefore, be necessary to elect four new members.

The world of science in general and the New Zealand Institute in particular have sustained a great loss by the death of Sir James Hector, F.R.S., a former President of this Institute. His additions to the knowledge of the botany and zoology of the Dominion, especially in the earlier years of his work here, were extensive and valuable; but it was chiefly in his position as first Director of the Geological Survey of these Islands that he made his mark as a scientific man. He acted as chief scientific adviser of successive Governments during a period of over thirty years; while the Senate of the New Zealand University showed their appreciation of his work in education by electing him Chancellor, a position he held for many years. The question of considering what steps should be taken to perpetuate his memory in a suitable manner will be brought up at the annual meeting.

Two years ago the Philosophical Institute of Canterbury took the initiative in the matter of instituting the Hutton Memorial Research Fund. The New Zealand Institute set up a committee, consisting of Drs. Chilton (convener) and Cockayne. Messrs. R. M. Laing and Speight, to deal with the question and to report. That committee was reappointed at the last annual meeting, when general and also detailed regulations were submitted and agreed to. It will be necessary for this coming meeting to determine when the fund shall become operative.

The members now on the roll of the various incorporated societies are as follows: Auckland Institute, 164; Wellington Philosophical Society, 101; Philosophical Institute of Canterbury, 147; Otago Institute, 116; Hawke's Bay Philosophical Institute, 46; Nelson Institute, 30; Westland Institute, 46; Manawatu Philosophical Institute, 63: total, 713.

Transactions.—The volumes of Transactions at present on hand are—Vol. I (second edition), 315; Vol. V, 31; Vol. VI, 22: Vol. VII, 144; Vol. IX, 215; Vol. X, 139; Vol. XI, 392; Vol. XII, 305; Vol. XIII, 142; Vol. XIV, 107; Vol. XV, 280; Vol. XVI, 270; Vol. XVII, 530; Vol. XVIII, 308; Vol. XIX, 555; Vol. XX, 452; Vol. XXI, 454; Vol. XXII, 560; Vol. XXIII, 570; Vol. XXIV, 670; Vol. XXV, 626; Vol. XXVI, 613; Vol. XXVII, 605; Vol. XXVIII, 688; Vol. XXIX, 591; Vol. XXX, 685; Vol. XXXI, 695; Vol. XXXII, 518; Vol. XXXIII, 611; Vol. XXXIV, 564; Vol. XXXV, 526; Vol. XXXVI, 686; Vol. XXXVII, 604; Vol. XXXVIII, 750.

The volume just published, Vol. XXXIX, contains 576 pages and 26 plates, in addition to a photograph and an "In memoriam" notice of the late Sir Walter Buller. The contents of the last two volumes are compared as follows:—

	Vol. XXXVIII (1905). Pages.	Vol. XXXIX (1906). Pages.
Miscellaneous	130	76
Zoology	173	210
Botany	86	189
Geology	135	47
Chemistry and physics	50	Nil.
Records of Milne seismographs	6	Nil.
Proceedings	33	31
Appendix	21	23
	634	576

The whole of the work was done, as formerly, at the Government Printing Office. It is matter for regret that, owing to the pressure at the office, the publication of the last volume was delayed so late in the year.

Three years ago the New Zealand Institute obtained permission from the Colonial Secretary to store back numbers of the Transactions in the cellar of the Library in the Parliamentary Buildings. There are now about fifteen thousand volumes stored there. Fortunately, in the great conflagration which recently destroyed the greater part of those buildings the Library was saved, and the volumes are not damaged.

Carter Bequest.—The amount standing to the credit of the fund on the 31st December, 1907, was £2,617 11s. 10d. In addition, there is a quantity of scrip in the New Zealand Loan and Mercantile Agency Company at face value. The money is invested by the Public Trustee, and is earning interest at the rate of 4 per cent. per annum. This fund represents a bequest by the late C. R. Carter to the New Zealand Institute for the purpose of establishing an astronomical observatory. The fund has been accumulating for some years, and on the 31st December last was as stated above.

Financial.—Herewith is presented the balance-sheet for the year just ended. From this it will be seen that the credit balance amounts to £361 5s. 11d.

Receipts.	£	s.	d.
Jan. 1.—Balance forward	344	14	8
Sale of Transactions	6	11	1
Sale of "Maori Art"	8	8	0
Contribution, Wellington Philosophical Society ..	16	5	6
Government grant	500	0	0
	£875	19	3

Expenditure.	£	s.	d.
Printing Transactions	359	18	6
Expenses of members (three)	8	14	4
Services—			
W. McKay	6	1	0
C. Freyberg	10	0	0
Editor	50	0	0
Secretary	25	0	0
Library	30	12	9
General expenses—			
Express Company	6	11	11
Andrews	1	10	0
Whitcombe and Tombs	2	7	6
Small accounts, postage, &c.	13	7	4
Bank charge	0	10	0
	514	13	4

	£	s.	d.	£	s.	d.
Balance in bank, 28th January, 1908 ..	415	8	11			
Petty cash in hand	2	7	0			
	417	15	11			
Less unpresented cheques ..	56	10	0			
				361	5	11
				£875	19	3

MINUTES OF FIFTH ANNUAL MEETING.

30th January, 1908.

The fifth annual meeting of the Board of Governors of the New Zealand Institute was held in the Dominion Museum on Thursday, the 30th January, 1908, at 10.30 a.m.

Present: Mr. G. M. Thomson, President (in the chair); Professors Charles Chilton, T. H. Easterfield, and W. B. Benham; Dr. C. C. Farr; Messrs. D. Petrie, E. Tregear, J. Young, K. Wilson, Martin Chapman, J. Stewart, H. Hill, A. Hamilton, and T. H. Gill (Secretary).

The Secretary read the letters received from the several societies affiliated to the Institute, nominating members of the Board of Governors, the nominations being as follows: Auckland Institute—Messrs. D. Petrie and J. Stewart; Wellington Philosophical Society—Professor T. H. Easterfield and Mr. Martin Chapman; Philosophical Institute of Canterbury—Professor Charles Chilton and Dr. C. C. Farr; Otago Institute—Professor W. B. Benham and Mr. G. M. Thomson; Hawke's Bay Philosophical Institute—Mr. H. Hill; Nelson Philosophical Institute—Dr. L. Cockayne; Westland Institute—Mr. T. H. Gill; Manawatu Philosophical Society—Mr. K. Wilson.

The minutes of the previous annual meeting and of the three meetings of the Standing Committee were read, and the minutes of the previous annual meeting were confirmed.

A letter, dated the 29th January, 1908, from Messrs. T. R. Fleming and H. D. Bell, members of the Victoria College Council, Wellington, was read, in reference to the establishment of an astronomical observatory in Wellington. Moved by Mr. Hill, seconded by Mr. Chapman, "That the Board of Governors meet a deputation from the College Council at noon this day." Carried.

The President referred to the death of Sir James Hector, and moved the following resolution, which was seconded by Mr. Stewart, and carried unanimously, the members standing: "That the Board of Governors of the New Zealand Institute desires to express its profound regret at the great loss sustained by the scientific world through the death of the late President, Sir James Hector. By his own researches in geology, zoology, and botany in the Dominion of New Zealand he added greatly to the knowledge of those branches of science; as head of the Geological Survey, of the Meteorological Department, and of the Colonial Laboratory, and as Director of the Colonial Museum, he was the scientific adviser of successive Governments for a long period of years; while as Chancellor of the New Zealand University he was closely associated with the highest education of the Dominion. The Board wishes to express its high appreciation of these eminent services to science, especially in New Zealand. That a copy of this resolution be sent to Lady Hector."

The annual report and annual statement of receipts and expenditure were read and adopted.

Mr. Hamilton moved, and Dr. Farr seconded, "That the matter of obtaining 4½ per cent. instead of 4 per cent. for money deposited with the Public Trustee in the Carter bequest be remitted to the Treasurer." Carried.

Librarian's Report.—The Librarian's report, as follows, was read and adopted:—

The Honorary Librarian reports that the number of pieces received during the year as exchanges and presentations number 737. Large numbers of duplicates which remained after Mr. Ross had picked out the most complete set for binding have been sorted and arranged under their respective countries.

There is still a very large number of publications in languages other than English not sorted or arranged.

A great deal of binding is still necessary, and modern book-cases arranged in bays would be much more useful than the present system of shelving.

Very little use has been made of the library, the number of entries by those taking books being only seventy-eight.

No progress has been made with the card catalogue.

Carter Library.—None of the books reported last year as missing have been recovered.

The storage of the stock of the Transactions must be seen to, as there are now in the Museum building three years' accumulations to be transferred to the cellar of the Parliamentary Buildings. A steel embossed stamp has been provided, and will be used in future for the books, as being much superior to the old rubber stamp, and it is suggested that when the ownership question is determined a book-plate shall be pasted in each volume.

One of the Museum rooms has been set aside temporarily for the papers, &c., of the New Zealand Institute, and the parcels of the original papers for the whole of the thirty-nine years have been collected and freshly tied up.

I suggest that some members of the Council be appointed to act on its behalf in an examination of the books in the library, as it is found that the stamps have been applied erratically in the past, and that all three stamps—Institute, Museum, and Philosophical Society—may be found in one set of books. The Philosophical Institute have already appointed a representative to act in this matter.

It is very desirable that the present exchange list should be carefully revised, with a view to giving a more definite character to the collection in the New Zealand Institute library.

I also recommend that in future two books instead of one be used for recording books taken out of the library of the Institute and the library of the Wellington Philosophical Society by members.

A. Hamilton,
Librarian.

The Board of Governors received a deputation, consisting of Messrs. T. R. Fleming and H. D. Bell, members of Victoria College Council, and Mr. C. P. Powles, Secretary of the Council, which urged upon the Board the necessity of establishing an astronomical observatory on a site on the Victoria College grounds, and of handing over the Carter Bequest funds to the College for this purpose. The President expressed pleasure to the deputation at its attendance. Mr. Fleming suitably replied. The deputation then withdrew.

Mr. Hamilton moved, and Mr. Chapman seconded, "That a committee be appointed to act on behalf of the Institute in an examination of the books in the library, with a view to determining their ownership." Carried.

Mr. Hamilton moved, and Mr. Hill seconded, "That Professors Benham, Chilton, and Easterfield, and Mr. Chapman, with the mover, be a committee to examine the books in the library, in conjunction with representatives appointed by the other bodies interested, to determine the ownership question." Carried.

Mr. Chapman moved, and Mr. Young seconded, "That the Board will agree to the expenditure of the Carter bequest in the purchase, erection, &c., of an astronomical telescope and accessories, as proposed by the deputation from the Victoria College, and allow the same to be under the control of the governing body of the College, on the following conditions: (1) That the observatory and other necessary buildings be erected out of other funds; (2) that a professor of astronomy and staff be appointed and maintained by the Victoria College out of funds other than the Carter bequest; (3) that the Board be advised that the expenditure is legal." Carried.

Mr. Hamilton moved, and Mr. Young seconded, "That a committee be appointed carefully to revise the exchange list, and to report to the next annual meeting on the library and the present state of the collections." Carried.

Mr. Hamilton moved, and Mr. Young seconded, "That the same committee as in the previous case be appointed to revise the exchange list." Carried.

Mr. Petrie moved, and Mr. Tregear seconded, "That Mr. T. F. Cheeseman's name be added to the previous committee." Carried.

Mr. Hamilton moved, and Professor Chilton seconded, "That the volumes of the Transactions not required at present be stored with the earlier volumes in the Parliamentary Library." Carried.

Mr. Chapman moved, and Professor Easterfield seconded, "That the stored numbers of the Transactions be insured." Carried.

Mr. Chapman moved, and Mr. Hamilton seconded, "That the amount of such insurance be £500." Carried.

Mr. Hill moved, and Mr. Young seconded, "That the books belonging to the New Zealand Institute now stored in the Museum buildings be insured for a sum not exceeding £2,000, at a rate to be approved by the Library Committee." Carried.

Report of Publication Committee and of Editor.—The Publication Committee's report was read and adopted. The Editor's report was also read and received. The Publication Committee's report was as follows:—

The Publication Committee report that they held three meetings for the consideration of various matters connected with the Transactions. Two papers were referred back to their authors for revision and alteration of plates, and the committee suggest that authors be requested to make their papers as concise as possible.

At the annual meeting of the New Zealand Institute the Publication Committee were requested to draw up a series of "hints for authors" for the information of members of the Institute. A copy of this circular has been placed at the beginning of each volume of the Transactions.

The question of printing the Proceedings in pamphlet form during the course of the session, together with abstracts of scientific papers relating to various branches of science in the colony, was referred to the committee. The committee have considered the matter, and they are of the opinion that it would be highly desirable to have summaries of scientific papers appearing in various publications prepared for circulation, provided that experts in each branch of science would undertake to provide the proposed abstracts, and if they were done on the same lines as the "International Rules of Botanical Nomenclature" prepared by Mr. Maiden, in the last volume of the "Journal of the Royal Society of New South Wales."

With regard to the publication during the course of the session of the Proceedings of the various societies, the committee is of opinion that the local Press usually publish all the information which it would be desirable to print for distribution.

Taking into consideration the cost of printing the plates and tables, the committee decided not to publish in the volume the seismological returns, and, in accordance with the views of the Council expressed at the last annual meeting, it suggested to the Government that the seismological returns be published in the *Gazette.*

Mr. Hamilton moved, and Mr. Petrie seconded, "That a committee be set up to go into the matter of the delay in the issue of the 39th volume of the Transactions; to interview the Government Printer and the Minister, if necessary, and to report to the Standing Committee." Carried.

Mr. Hamilton moved, and Professor Easterfield seconded, "That the committee consist of the President, Dr. Farr, Professor Chilton, Professor Benham, and Mr. Stewart." Carried.

Mr. Hamilton moved, and Mr. Young seconded, "That the Board of Governors appoint a committee to make arrangements for the preparation of an index to the forty volumes of the 'Transactions of the New Zealand Institute,' the index to cover author's index, subject index, index of plates and figures, and to include the Proceedings as well as the Transactions; and that the Government be asked to make a grant for the printing of the index." Carried.

Mr. Hamilton moved, and Mr. Gill seconded, "That the President and Professors Benham, Easterfield, and Chilton be the committee to make arrangements for the preparation of an index to the forty volumes of the Transactions." Carried.

Proposed by Mr. Hamilton, seconded by Dr. Chilton, "That the 41st volume be the first of a new series. That the 41st volume consist of two separately published parts: Part I to contain the scientific papers, plates, and index: Part II to contain—(*a*) Annual address of the President of the Institute; (*b*) the Proceedings of the societies and presidential addresses; (*c*) short abstracts of papers not printed in full; (*d*) summaries of scientific papers appearing in other publications on matters of interest to New Zealand science, prepared by specialists, and lists of the scientific publications issued by the Departments of Agriculture, Chemistry, &c., during the year; (*e*) instructions to writers of papers; (*f*) report of the annual meeting of the Institute, with balance-sheets; (*g*) the New Zealand Institute Act; (*h*) regulations of the Hutton Memorial Fund, annual report of the same, report on the Hector Memorial Fund, report on Carter bequest; (*i*) obituary notices of honorary members and members of local societies; (*j*) meteorological returns and diagrams; (*k*) seismological returns and diagrams." Carried.

Mr. Hamilton moved, and Mr. Petrie seconded, "That it be an instruction to the Editor of the Transactions to follow the rules of botanical nomenclature agreed upon at the Vienna Congress of 1905 in the printing of the 'Transactions of the New Zealand Institute.'" Carried. A letter, dated Auckland, the 13th January, 1908, from Mr. T. F. Cheeseman, bearing on this subject, was received.

Mr. Hamilton moved, and Mr. Chapman seconded, "That the Board take into consideration the question of the advisableness of reprinting papers which have appeared in the Transactions." Carried.

Hutton Memorial Fund.—Professor Chilton read the report and statement of receipts and expenditure of the Hutton Memorial Research Fund Committee, as follows. The report and statement were adopted:—

The committee begs to submit a statement of the receipts and expenditure in connection with the fund, which shows that since the last report was made further subscriptions to the amount of £12 9s. have been received, and the sum of £18 1s. 5d. earned as interest, and that the amount now standing to the credit of the fund is £663 2s. 3d. The bulk of this is at present deposited in the Post-Office Savings-Bank, but the committee recommends that arrangements for more profitable investment be made without delay.

No application for grants from the fund have been received by the committee, probably because the regulations dealing with the matter were not published in the "Transactions of the New Zealand Institute"; the committee therefore recommends that the interest at present accrued be added to the principal.

The committee also suggests that until the fund reaches the sum of £1,000 a small proportion of the interest—say, 1 per cent. of the amount invested—be added to the capital every year.

Full instructions have been sent to London for the striking of the Hutton Memorial Medal, and Professor Arthur Dendy, of King's College, London, has kindly undertaken to attend to the matter on behalf of the committee, and it is hoped that copies of the medal will be received before long.

The committee is of opinion that it is now necessary to make some arrangements for awarding the medal, and begs to suggest that a small committee be formed of persons living outside New Zealand who are conversant with the science of geology, zoology, and botany, and that they be asked to make suggestions to the Board of Governors from time to time as to the person who in their opinion is best entitled to receive the medal.

On behalf of the committee,

C. Chilton, Hon. Treasurer.

Statement of Receipts and Expenditure from 1st February, 1907, to 31st December, 1907.

Receipts.

	£ s. d.	£ s. d.
Balance on 1st February, 1907—		
In Savings-Bank	319 10 4	
In Bank of New Zealand, Christchurch ..	311 9 6	
Cash in hand	3 3 0	
		634 2 10
Subscriptions received		12 9 0
Interest for 1907		18 1 5
		£664 13 3

Expenditure.

				£	s.	d.
Design for Hutton Medal				1	1	0
Bank charges				0	10	0
Balance, 31st December, 1907—	£	s.	d.			
In Savings-Bank	617	11	9			
In Bank of New Zealand, Christchurch	45	10	6			
				663	2	3
				£664	13	3

Audited and found correct.—G. E. Way, F.I.A.N.Z., Auditor.
Christchurch, 29th January, 1908.

A letter, dated Christchurch, 29th August, 1907, from Mr. T. Iredale, was read, asking for a grant from the Hutton Memorial Research Fund. Moved by Mr. Petrie, seconded by Mr. Hill, "That the letter be received." Carried.

Mr. Chapman moved, and Mr. Young seconded, "That the Hutton Memorial Research Fund, now in the hands of the committee, be transferred to the New Zealand Institute, and the Hutton Memorial Committee be discharged." Carried.

The Board went into committee to consider the regulations of the Hutton Memorial Medal and Research Fund.

The Board resumed, and the amendments made in committee were reported and adopted, the regulations, as amended, being as follows:—

The Hutton Memorial Medal and Research Fund.

Resolved by the Board of Governors of the New Zealand Institute that—

1. The funds placed in the hands of the Board by the committee of subscribers to the Hutton Memorial Fund be called "The Hutton Memorial Research Fund," in memory of the late Captain Frederick Wollaston Hutton, F.R.S. Such fund shall consist of the moneys subscribed and granted for the purpose of the Hutton Memorial, and all other funds which may be given or granted for the same purpose.

2. The funds shall be vested in the Institute. The Board of Governors of the Institute shall have the control of the said moneys, and may invest the same upon any securities proper for trust moneys.

3. A sum not exceeding £100 shall be expended in procuring a bronze medal to be known as "The Hutton Memorial Medal."

4. The fund, or such part thereof as shall not be used as aforesaid, shall be invested in such securities as aforesaid as may be approved of by the Board of Governors, and the interest arising from such investment shall be used for the furtherance of the objects of the fund.

5. The Hutton Memorial Medal shall be awarded from time to time by the Board of Governors, in accordance with these regulations, to persons who have made some noticeable contribution in connection with the zoology, botany, or geology of New Zealand.

6. The Board shall make regulations setting out the manner in which the funds shall be administered. Such regulations shall conform to the terms of the trust.

7. The Board of Governors may, in the manner prescribed in the regulations, make grants from time to time from the accrued interest to

persons or committees who require assistance in prosecuting researches in the zoology, botany, or geology of New Zealand.

8. There shall be published annually in the "Transactions of the New Zealand Institute" the regulations adopted by the Board as aforesaid, a list of the recipients of the Hutton Memorial Medal, a list of the persons to whom grants have been made during the previous year, and also, where possible, an abstract of researches made by them.

Regulations under which the Hutton Memorial Medal shall be awarded and the Research Fund administered:—

1. Unless in exceptional circumstances, the Hutton Memorial Medal shall be awarded not oftener than once in every three years; and in no case shall any medal be awarded unless, in the opinion of the Board, some contribution really deserving of the honour has been made.

2. The medal shall not be awarded for any research published previous to the 31st December, 1906.

3. The research for which the medal is awarded must have a distinct bearing on New Zealand zoology, botany, or geology.

4. The medal shall be awarded only to those who have received the greater part of their education in New Zealand or who have resided in New Zealand for not less than ten years.

5. Whenever possible, the medal shall be presented in some public manner.

6. The Board of Governors may, at any annual meeting, make grants from the accrued interest of the fund to any person, society, or committee for the encouragement of research in New Zealand zoology, botany, or geology.

7. Applications for such grants shall be made to the Board before the 30th September.

8. In making such grants the Board of Governors shall give preference to such persons as are defined in regulation 4.

9. The recipients of such grants shall report to the Board before the 31st December in the year following, showing in a general way how the grant has been expended and what progress has been made with the research.

10. The results of researches aided by grants from the fund shall, where possible, be published in New Zealand.

11. The Board of Governors may from time to time amend or alter the regulations, such amendments or alterations being in all cases in conformity with resolutions 1 to 4.

Professor Chilton moved, and Professor Benham seconded, "That until the Hutton Memorial Fund reaches the sum of £1,000 not less than 1 per cent. on the capital invested be added each year to the principal." Carried.

Professor Chilton moved, and Mr. Hill seconded, "That the Board of Governors from time to time request a committee, consisting of a zoologist, a botanist, and a geologist, resident outside New Zealand, to suggest the name of some person as a suitable recipient of the Hutton Memorial Medal." Carried.

Professor Chilton moved, and Professor Benham seconded, "That Professor T. W. E. David, Professor W. A. Haswell, and Mr. J. H. Maiden, of Sydney, be asked to act as the committee defined in the preceding resolution." Carried.

Professor Easterfield moved, and Mr. Hamilton seconded, "That a committee of the Institute be appointed to co-operate with the committees already moving in the direction of collecting funds for a memorial to the late Sir James Hector, in order that a suitable memorial may be established." Carried.

The Secretary read the following letter received from Dr. Otto Klotz, of Ottawa, Canada, an honorary member of the New Zealand Institute:—

Dear Sir,— Ottawa, Canada, 7th November, 1907.

I have just seen in the telegraphic despatches that Sir James Hector has passed away, and I hasten to pay my tribute of respect and admiration for him who has "crossed the bar." To me it was a great privilege to have made the personal acquaintance of Sir James in Fiji in 1903, and later to have been welcomed at his home in New Zealand.

For us in Canada Sir James has left an indelible mark by his services in connection with the Palliser expedition of 1857–60; and though his work is more enduring than granite, yet some of his friends here have erected a shaft to his memory near the summit of the Rocky Mountains, which he knew so well.

To the world, however, his subsequent labours for fully twoscore years in his adopted home—New Zealand—are best known. Fortunate indeed it was for New Zealand that Dr. Hector turned his face from the Northern to the Southern Hemisphere, and devoted his life to the development of that land, so richly endowed by nature. One can truthfully say that Dr. Hector was your Nestor of science. In those early days, when science was not so differentiated as it is to-day, there was scarcely a branch, be it in geology, astronomy, natural history, ethnology, or meteorology, in which he did not take an active and enthusiastic part. Men of such many-sided parts are now difficult to find. To me the name "Hector" seems graven over the country from the North Cape to the Bluff.

Valuable as have been the services of many other distinguished men in connection with the New Zealand Institute, yet the name of him for whom we to-day mourn must ever be the prominent one for many years after its foundation. As His Excellency the Governor, Sir George F. Bowen, said in his inaugural address in August, 1868, "The Government has been very fortunate in securing for this important office the proved ability and judgment, the wide experience, and the untiring energy of Dr. Hector, F.R.S It is to him we are mainly indebted for the valuable collections of art and science already accumulated in these halls."

New Zealand has lost one of her great men, and the scientific world one of her most conspicuous and earnest workers.

In spirit I lay a laurel wreath on his grave.

Yours, &c.,
Otto Klotz.

Secretary, New Zealand Institute, Wellington, New Zealand.

Professor Easterfield moved, and Mr. Hamilton seconded, "That the committee referred to in the previous minute consist of Professor Benham, Dr. L. Cockayne, Messrs. Chapman, Petrie, Speight, Gill, and the mover." Carried.

Correspondence.—A letter, dated Wellington, the 29th January, 1907, from Mr. Henry H. Travers, was read, asking the Institute to arrange for the publication of a "Manual of New

Zealand Birds," to be prepared by him. The letter was received.

Election of Officers.—The following officers were elected: President—Mr. G. M. Thomson, F.L.S., F.C.S.; Treasurer—Mr. Martin Chapman, K.C.

At this stage Dr. Farr moved, and Professor Chilton seconded, "That it is not competent for members of the Board of Governors to hold any paid office under the Board." The motion was carried on division, two members refraining from voting.

The election of officers was then again proceeded with.

Professor Easterfield moved, and Mr. Chapman seconded, "That Mr. Thomas King be appointed Secretary, at a remuneration of £25 per annum." Carried.

The following officers were elected: Editor of Transactions—Mr. G. M. Thomson; Librarian—Mr. A. Hamilton; Publishing Committee—Professor Chilton, Professor Benham, Dr. Farr, and the Editor.

Honorary Members.—The following gentlemen were elected honorary members of the Institute: Dr. L. Diels, of Berlin; Rev. T. R. R. Stebbing, F.R.S., of Ephraim Lodge, The Common, Tunbridge Wells; Mr. E. Meyrick, B.A., F.R.S., F.Z.S., F.E.S., of Thornhanger, Marlborough, Wilts (Marlborough College, Wilts).

Mr. Hamilton moved, and Professor Benham seconded, "That the 40th volume of the Transactions include a list of past Presidents and honorary members." Carried.

Mr. Wilson moved, and Mr. Hamilton seconded, "That the Secretary be directed to send to each of the affiliated societies a copy of the minutes of this meeting." Carried.

Professor Benham moved, and Dr. Farr seconded, "That the minutes of the present meeting be printed in the forthcoming volume of the Transactions (Vol. XL)." Carried.

Dr. Farr moved, and Mr. Hamilton seconded, "That the Institute learns with surprise that there are no proper arrangements for the distribution of accurate time at the important port of Auckland, and strongly urges the Government to consider and carry out whatever is necessary for the regular dropping of a time-ball there." Carried.

The Board went into committee to consider the financial position of the Institute.

The Board resumed.

Professor Chilton moved, and Dr. Farr seconded, "That the hearty thanks of the Institute be accorded to Mr. Hamilton for his valuable services as Editor during the last four years." Carried.

Professor Benham moved, and Mr. Thomson seconded, "That a hearty vote of thanks be accorded to Mr. Gill for his valuable work as Secretary during the past four years." Carried.

Mr. Hamilton moved, and Professor Chilton seconded, "That the next annual meeting be held in Wellington on the 28th January, 1909, and that a special general meeting of the members of the Institute be held on Friday, the 29th January, 1909." Carried.

Mr. Hamilton moved, and Mr. Chapman seconded, "That the actual travelling-expenses of the members of the Board be paid out of the general fund." Carried.

PROCEEDINGS

WELLINGTON PHILOSOPHICAL SOCIETY.

FIRST MEETING: *1st May*, 1907.

Professor H. B. Kirk, President, in the chair.

New Member.—Mr. Esmond Atkinson.

Sir Walter Buller, K.C.M.G.—The President announced that a letter had been received from Mr. A. P. Buller, expressing thanks, on behalf of himself and relatives, for the resolution of sympathy passed at the meeting of the Society on the 1st August, 1906, in regard to the death of the late Sir Walter Buller.

Papers.—1. "Seiches on Lakes," by Martin Chapman

2. "A Surveying-camera," by C. E. Adams, B.Sc.

Mr. Adams exhibited a specimen camera of the sort described, and explained the mode in which the apparatus was used by the land-surveyor and the map-maker.

3. "Recent Observations on New Zealand *Macro-lepidoptera*, including Descriptions of New Species," by G. V. Hudson, F.E.S. (p. 104).

4. "Additional List of *Mollusca*: Minute Species found in Sand from Titahi Bay, New Zealand," by T. Iredale, Christchurch; communicated by R. L. Mestayer, for Miss Mestayer.

The accompanying list contains a number of minute species of *Mollusca* which were found by T. Iredale in some Titahi Bay sand which I sent him. These were not included in the list published in the Transactions last year: *Purpura scobina*, var. *albomarginata*, Desh.; *Trophon plebeius*, Hutt. (?), Jg.; *Lutonna mauritiana*, Lam.; *Cominella lucida*, Phil. (?), Jg.; *Risellopsis varia*, Hutt.; *Trochus traratus*, Q. and G., Jg.; *Mytilus canaliculus*, Martyn; *Modiolaria barbata*, Reeve; *Leiostraca murdochi*, Hedley; *Cæcum digitulum*, Hedley; *Rissoa incidata*, Trauerfeld; *Rissoa forcauxiana*, Suter; *Rissoa microstriata*, Murdoch; *Rissoina agrestis*, Webster; *Incisum lytteltonensis*, E. A. Smith; *Scissurella rosea*, Hedley; *Liotia polypleura*, Hedley; *Schismope brevis*, Hedley; some minute bivalves not yet satisfactorily placed, perhaps *Cura delta*, Tate and May, and *Thilobrya costata*, Bernard.

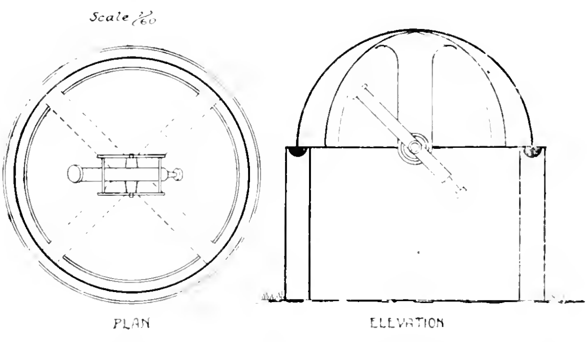
Second Meeting: *5th June*, 1907.

Professor H. B. Kirk, President, in the chair.

New Members.—Mr. H. Vickerman and Mr. A. G. Stuckey.

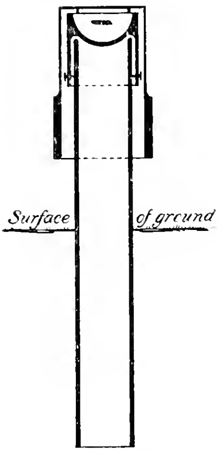
Papers.—1. "A Description of Two New and Improved Forms of the Almucantar," by C. W. Adams.

The following remarks apply chiefly to the method of flotation: This almucantar floats on mercury, which is in a circular cast-iron trough resting on a circular concrete wall 4 ft. high and 6 in. thick. The mean diameter of the circular trough, and of the wall which supports it, is 6 ft. The cross-section of the trough is a semicircle, diameter 6 in., and is capable of floating a weight of 14 cwt., or, say, 12 cwt. without any fear of the mercury spilling over. (By increasing the diameter of the circular trough to 9 ft., and making it of a similar cross-section and 1 ft. wide, it would float a weight of over 4 tons.) The telescope is suspended from a dome-shaped framework, the observer being free to move about inside the circular wall. The azimuth circle may be engraved on the inner or outer upper edge of the circular trough containing the mercury, the zero being placed wherever the observer prefers. The divisions are read by four



micrometers, as verniers are inadmissible on account of friction. These micrometers could be read by one or more assistants outside the concrete wall, if necessary. With four assistants a great many more observations could be made than when the observer had to read all the microscopes himself. The clamping should be done by electricity, so as to avoid disturbance of the floating instrument; also, the instrument should not be turned round by hand directly, but by means of apparatus attached to a vertical pillar under the centre of the instrument. Only a few pounds of mercury is required, as, if the inside of the trough and the bottom of the framework are turned in a lathe, so as to accurately fit each other, there will merely be a thin film of mercury between the two.

The pedestal of this almucantar is an ordinary cast-iron gaspipe, about 9 in. in diameter externally, and 6 ft. long, sunk 3 ft. in the ground. A cast-iron cylindrical cap fits on this, 12 in. in height and 12 in. in external diameter, with a hemispherical cup 10 in. diameter, turned out of the top, as a reservoir for the mercury. This cap is furnished with four adjusting-screws, pressing against the internal gaspipe, by which the top of the cap can be fixed in a horizontal plane. The platform on top is attached to a hemisphere, which fits into the hemispherical cup containing the mercury, a thin film of which supports the platform. The mercury can support a weight of 128 lb., or we may say 100 lb. without any fear of the mercury spilling over. The platform has a heavy cylindrical attachment which brings the centre of gravity below the bowl containing the mercury. The azimuth circle should be engraved on the upper edge of the hemispherical bowl, and the divisions read by a micrometer attached to the frame or platform on top. A portable almucantar should not be used for general azimuth-work, but the azimuth circle is required as a setting-circle when observing for time or latitude. An ordinary theodolite can be set up on the platform, or a special instrument constructed. In a small model that I constructed, in which the hemisphere and the bowl for it to float in were turned out of wood, the motion was beautifully smooth: the least touch with the little finger would suffice to turn the instrument round, and, if set spinning, it would make a good many revolutions before it came to rest.



SECTIONAL VIEW......Scale 1/32

2. "A New Method for the Preparation of Ketones," by Professor T. H. Easterfield.

Exhibits.—1. Mr. G. V. Hudson exhibited the following :—

(*a.*) Three parts of a work entitled "Australian *Lepidoptera* and their Transformation," by A. W. Scott, with hand-coloured plates ; published in 1864.

(*b.*) A series of *Dodonidia helmsii*, a rare New Zealand butterfly, taken at Silverstream in February, 1907.

(*c.*) Two female specimens of *Titanornis sisyrota*, a gigantic tineid moth not seen alive since 1886, and perhaps now extinct—one taken by Mr. Clement W. Lee, at Otaki, in March, 1886 ; the other taken in Nelson many years ago. The male is unknown.

(*d.*) Male and female specimens of *Macropathus maximus*, a gigantic tree-weta, captured at Kaitoke under the bark of dead birches on the 31st December, 1906 ; originally described by Sir Walter Buller from a single specimen.

THIRD MEETING : *3rd July*, 1907.

Professor H. B. Kirk, President, in the chair.

Exhibits.—Dr. A. K. Newman exhibited and described a Maori flute and a Maori conch-shell trumpet.

Messrs. C. Hill and W. H. Warren gave demonstrations of the musical possibilities of these instruments.

Paper.—"A Comparison of the Decimal and Sextal Scales of Notation," by C. W. Adams.

FOURTH MEETING: *7th August*, 1907.

Professor H. B. Kirk, President, in the chair.

New Members.—Dr. M. Pomare and Mr. W. G. Collington Swan.

Exhibits.—Mr. A. Hamilton, Director of the Colonial Museum, exhibited a number of recent additions to the Museum collections.

Papers.—1. "A Case of Coloured Hearing," by Mrs. H. M. Christie.

In vol. xxxii of the "Contemporary Science Series," entitled "Hallucinations and Illusions," may be found a short account of the somewhat obscure phenomenon of coloured hearing. For the benefit of those to whom the subject may be unfamiliar, I may explain that coloured hearing consists of the involuntary mental association of colours with sounds, or, to quote the scientific definition in Dr. Forel's work on hypnotism, "There is still one other sight, a mental vision—viz., the repercussion of these optical stimuli of the visual sphere in other associated areas of the cortex of the cerebrum. There are people who are able to see sounds coloured, inasmuch as they always associate certain colours with certain sounds or vowels." The special colour-sensations associated with particular sounds always remain constant in the same individual, but the relation is purely individual, and not referable to any known general law.

Letters of the alphabet (more particularly the vowel-sounds), notes of musical instruments, and numerals call up colour-sensations in the minds of persons possessed of this faculty, whether the sound of the letters, &c., be actually heard or only mentally presented.

It is found that a certain percentage of persons is possessed of this peculiarity, and that it is sometimes hereditary.

This sensation is designated a photism or chromatism by Professor Gruber, who has conducted some experiments with several subjects of the "hallucination," as it is described in the first-mentioned work. He tells us that few people can remember when their chromatisms began; and that deep tones or vowel-sounds seem generally to be associated with dark colours, and sharp tones or high-sounding vowels with lighter-colour sensations. The coloured alphabet which I have prepared in accordance with my own observations will show corroboration of the latter statement, the letter O being associated with deep-blue, while I and E are white and yellow respectively. Letters of the alphabet and numerals are, in my experience, productive of colour-impressions, but there are no distinct sensations with regard to music. Of the letters, the colours of the vowels are most prominent, a single vowel in a word often producing a colour-impression which will subordinate all the colours of surrounding consonants to itself. Thus, in considering the word "stop," the dark-blue of the vowel O predominates over all the other colours. The colour of a consonant is frequently modified by the colour of an adjoining vowel; in fact, the various colours represented by the different letters composing a word tend to modify each other in a greater or less degree. For example, in the word "book" the dark-blue associated with the letter O is the predominating colour in the word. The letter B is in my mind connected with varying shades of green. As the adjoining vowels are dark in hue, the green of the B will be dark-bluish-green. On the other hand, in the word "been" the two E's, which are yellow, cause the B to appear of vivid leaf-green. In another word, "bite," the juxtaposition of the I (white) renders the B dull-green in colour.

I may add that, while some persons experience coloured hearing as a fully developed objective sensation, I have it merely as a spontaneous mental association of colour with sound.

The account from which I obtained some information on this subject concludes with the statement that it is doubtful whether the occurrence is pathological or physiological. While I have made some conjectures, I will not trouble you with these, merely mentioning the fact that, while my own sense of colour is not, so far as I know, defective, I come of a family in which several cases of colour-blindness exist.

2. "On Family Marks," by Joshua Rutland; communicated by T. W. Kirk.

The following curious case of heredity has recently come under my notice. One of my neighbours, Mrs. R. S., has on the left side of her head, close to the ear, a small opening. Into this opening a pin can be inserted head foremost about ⅛ in. without causing pain. From the opening a small quantity of wax-like matter is at times discharged. Mrs. S. inherited the opening referred to from her mother, Mrs. M., now residing at Nebraska, U.S.A. In addition to the opening described, Mrs. M. has in the white of the left eye a round dark spot resembling a second pupil, but smaller than the true pupil. The second pupil and the opening near the ear Mrs. M. inherited from her mother, who died in Denmark. Of Mrs. S.'s large family, only one son, N., inherited the ear-opening; but he has two openings—one close to the left ear, like his mother, and the other close to the right ear. His infant son, three months old, has the opening near the left ear. Another of Mrs. S.'s sons, G., is the father of twin boys, one of whom has inherited the opening near the left ear. Mrs. S.'s daughter, Mrs. R., has two pupils in the left eye, like her grandmother, but she has not got the ear-opening. These are all the members of the family about whom I can get trustworthy information, though probably others have the family marks. It can be seen that for five generations, commencing with Mrs. M.'s mother, these marks have come down, missing the children and reappearing in the grandchildren. Mrs. M. and her granddaughter have both good sight in the left as well as in the right eye. The marks referred to do not affect them.

Dr. C. Monro Hector said that a case similar to the one described had recently come under his own notice.

3. "On Right-sidedness," by Joshua Rutland; communicated by T. W. Kirk (p. 339).

FIFTH MEETING: *4th September*, 1907.

Professor H. B. Kirk, President, in the chair.

Papers.—1. "Notes on the Development of a Polychæte," by the President (p. 286).

2. "Notes on the Spread of *Phytophthora infestans* [the Irish potato-disease], with Special Reference to Hybernating Mycelium," by A. H. Cockayne (p. 316).

3. "On the Occurrence of *Ceratitis capitata* [the Mediterranean fruit-fly] in New Zealand," by A. H. Cockayne.

Until this year there has been no record of the presence of larvæ of *Ceratitis capitata* in New-Zealand-grown fruit. During the past summer, however, this destructive dipteron has been found breeding in two widely separated localities in New Zealand—namely, in the vicinities of Napier and Blenheim. This fact has been widely circulated in the Press of the Dominion, but it seems desirable that it should be recorded in the Proceedings of a scientific society, for the benefit of entomologists in other lands. *Ceratitis capitata* appears to be on the increase in many parts of the world, and is gradually extending its geographical range in temperate climates. Entomologists are agreed that this Trypetidon has its native home in Brazil, and for this reason several well-known entomologists have visited that country in search of natural parasites, but up to the present but little in this line has been accomplished. Professor Hempel, of Sao Paulo, in Brazil, who has given this matter some considerable attention, has said that in his district the action of natural enemies has had no effect whatever on the control of *Ceratitis.*

Exhibits.—1. Mr. C. E. Adams exhibited three recent forms of calculating-machine, and gave illustrations of the modes in which various numerical operations were performed by each.

2. Mr. A. Hamilton, Director of the Colonial Museum, exhibited a collection of Maori implements recently received by the Museum from Southland.

Annual Meeting: *2nd October*, 1907.

Professor H. B. Kirk, President, in the chair.

New Member.—Professor Maurice W. Richmond.

The Chairman announced that Mr. Martin Chapman, K.C., and Professor T. H. Easterfield had been re-elected by the Council to represent the Society for two years on the Board of Governors of the New Zealand Institute.

The Council's annual report and annual statement of receipts and expenditure were read and adopted.

The report stated (*inter alia*) that at the five ordinary meetings held during the 1907 session sixteen papers in all had been read.

Exhibits had been shown by Dr. A. K. Newman, and by Messrs. G. V. Hudson, A. Hamilton, C. W. Adams, and C. E. Adams.

It had been found impracticable to have any popular lectures during the session, but the Council expected to arrange for one or two good lectures to be delivered next year.

Regret was expressed at the death of two members of the Society—Mr. Thomas Turnbull, of Wellington, and the Rev. J. McWilliam, of Epsom, Auckland.

Six members had resigned, and five new members had been elected. The total number of members on the roll was now 103.

The Council recorded its satisfaction that the Government had decided to institute botanical surveys in certain parts of the colony, and to afford facilities for a scientific expedition to the outlying islands in the south.

The statement of receipts and expenditure showed that, inclusive of a balance of £43 14s. 10d. brought forward from the previous financial year, the receipts amounted to £141 7s. 10d. The expenditure came to £94 6s. 8d., leaving a credit balance of £47 1s. 2d. The Research Fund now stood at £43 12s. 9d.; so that the total sum in hand was £90 13s. 11d.

ELECTION OF OFFICERS FOR 1908.—*President*—Professor H. B. Kirk; *Vice-Presidents*—Mr. G. V. Hudson and Mr. A. Hamilton; *Council*—Mr. C. E. Adams, B.Sc., Mr. J. W. Poynton, Mr. T. W. Kirk, F.L.S., Dr. A. K. Newman, Dr. J. M. Bell, Professor T. H. Easterfield, and Mr. Martin Chapman, K.C.; *Secretary and Treasurer*—Mr. Thomas King; *Auditor*—Mr. E. R. Dymock, A.I.A.N.Z.

Papers.—1. "On Phagocytes" (illustrated by microscopic preparations), by Dr. C. Monro Hector.

2. "Preliminary Note on a Metaphysical Hypothesis," by Professor Maurice W. Richmond (p. 538).

3. "The Bipolar Theory," by H. Farquhar; communicated by Professor H. B. Kirk (p. 259).

4. "Description of a New Ophiurian," by H. Farquhar; communicated by Professor H. B. Kirk (p. 108).

Exhibit.—Mr. R. Coupland Harding showed a very early account (illustrated with excellent woodcuts), by the late Jonathan Pereira, M.D., F.R.S., of the vegetable caterpillar of New Zealand (*Sphæria robertsii*).

The account was contained in an article in the first volume of "The Pharmaceutical Journal" (1842), page 591. The article was chiefly concerned with a species (unnamed) found in China and Thibet, closely resembling *S. entomorrhiza*. This species (also illustrated) is much smaller than the New Zealand *Sphæria*, averaging only 3 in. in length. It was very rare, and was described by the author for the reason that it was one of the most valued articles in the Chinese pharmacopœia. Its Chinese name was "Hia tsao tong tchong," or "Summer plant, winter worm." In Japan it was called "Totsu-kaso."

AUCKLAND INSTITUTE.

First Meeting: *10th June*, 1907.

Mr. E. V. Miller, President, in the chair.

New Members.—L. Birks, C. E. Clarke, H. B. Devereux, E. B. Moss, J. M. Somerville.

The President delivered the anniversary address, taking as his subject the molecular theory of matter.

During the course of his address he showed how by the aid of this theory certain properties of matter, some of them widely known, others not so widely, may be explained, and how certain facts which seem at first sight to be opposed to the theory appear on closer study to support it. He explained the reason why the molecular theory has obtained such a strong hold on the imagination of scientific workers, and in what sense and subject to what reservations it may be regarded as substantially true.

The address was fully illustrated with experiments.

Second Meeting: *8th July*, 1907.

Mr. E. V. Miller, President, in the chair.

Paper.—"The Passing of the Maori," by the Rev. Archdeacon Walsh (p. 154).

A lengthy discussion arose.

Dr. Pomare, Chief Native Health Officer, admitted that Archdeacon Walsh's contention was, in the main, correct. He considered that the Maori is doomed not to extinction, but to absorption. It was inevitable that where a more numerous and more vigorous race came into contact with a weaker one that the weaker one must be absorbed. Already a very large percentage of the Maoris in the South Island had European blood in them, and the North Island Natives were rapidly becoming tinctured with pakeha blood. He did not believe that the Maoris would entirely die out, but in the future they should find a new race in whose veins would be commingled the blood of the Anglo-Saxon and the Maori. It had taken the European races hundreds—nay, thousands—of years to reach their present standard of civilisation. The Maori race had been suddenly brought into the dazzling light of this civilisation, and required time to adapt themselves to their new surroundings. It was a matter for great regret that when the Gospel was first preached to the Maoris the laws of health and cleanliness had not also been preached to them.

Dr. Buck, Assistant Native Health Officer, supported the views expressed by Dr. Pomare. As for the education of the Maoris, it must be borne in mind that until lately the class of teachers employed had not been good, and, in any case, there had not been time to produce a marked effect. He considered that the mental qualities of the Maori were quite equal to those of average Europeans. The Polynesian race, of which the Maoris were a branch, had lived for ages in a climate and under conditions where the means of subsistence were easily obtained. There was, therefore, no incentive to progress. The European races had for the most part to contend with an inhospitable climate, and had to fight for their existence with neighbouring races—their efforts were thus quickened and intensified; and the discovery of metals led to an enormous advance. Granted time and opportunity, the Maori race was capable of similar improvement.

Third Meeting: *5th August*, 1907.

Mr. E. V. Miller, President, in the chair.

New Members.—H. H. Metcalfe, C.E., H. Roche, Dr. Buck.

Dr. R. Briffault delivered a lecture on "Science and Metaphysics."

After illustrating the growth and characteristics of scientific method, and the standards of scientific demonstration, the lecturer proceeded to compare the conceptions held by the physicist on certain physical questions—as the nature of matter, the transmission of energy, ideas of motion, force, space, &c.—with the arguments of metaphysicians and others.

Fourth Meeting: *28th August*, 1907.

Mr. E. V. Miller, President, in the chair.

Papers.—1. "Notes on the Vegetation of Mount Hector, Tararua Range," by D. Petrie (p. 289).

2. "Description of a New *Veronica*," by D. Petrie (p. 288).

3. "Botanical Nomenclature," by T. F. Cheeseman (p. 447).

4. "Translation of Dumont D'Urville's Account of the Voyage of the 'Astrolabe,' Part I," by S. Percy Smith (p. 416).

Fifth Meeting: *2nd September*, 1907.

Mr. E. V. Miller, President, in the chair.

Mr. F. P. Worley, M.A., delivered a popular lecture, with experimental illustrations, on "The Composition of the Sun."

Sixth Meeting: *30th September*, 1907.

Mr. E. V. Miller, President, in the chair.

Mr. W. E. Bush, C.E., City Engineer, delivered a popular lecture on "The Disposal of City Sewage."

The lecture was profusely illustrated with limelight views and diagrams.

SEVENTH MEETING: *21st October*, 1907.

Mr. E. V. Miller, President, in the chair.

New Members.—W. Burnside, Miss E. M. Griffin, Dr. Purdy, T. W. Wells.

Professor H. A. Segar delivered a popular lecture on "The Struggle for Foreign Trade." (Abstract, p. 520).

After the close of the lecture a lengthy discussion arose, in which many members took part.

EIGHTH MEETING: *30th October*, 1907.

Mr. E. V. Miller, President, in the chair.

Papers.—1. "Maori Forest Lore," by Elsdon Best (p. 185).

2. "Contributions to a Fuller Knowledge of the New Zealand Flora: No. 2," by T. F. Cheeseman (p. 270).

NINTH MEETING: *4th November*, 1907.

Mr. E. V. Miller, President, in the chair.

Mr. K. Watkins delivered a popular lecture, entitled "The Canoe that brought the Maoris to New Zealand; or, a Glimpse of Polynesia in the Past."

An armada of at least six canoes, called by the ancient Maoris the "Great Heke," left Tahiti about the year 1350, and, after a rendezvous at Rarotonga, left Ngatangiia Harbour for New Zealand direct. From various traditions and legends it could be gathered that the canoes were double canoes, that they had masts, a deck-house, and a stage above it. Mr. Watkins exhibited a model of a canoe of this kind which had been lent to him by Mr. J. L. Young, and which he considered was a close approximation to the canoe used by the Polynesians for their longer voyages There was every reason to believe that the Maori war-canoe as seen by Europeans when New Zealand was first discovered was a comparatively recent invention, and was adopted by the Maori colonists to meet the new conditions they were placed in when they finally settled down in New Zealand, and when communication with Polynesia ceased. Mr. Watkins considered that voyages to and from Polynesia and New Zealand must not be considered extraordinary, seeing that there was ample proof that at one time voyages were regularly made between localities in the north, west, and east of Polynesia thousands of miles apart, and that there were traditions of voyages having been made as far south as the antarctic regions.

TENTH MEETING: *12th December*, 1907.

Mr. E. V. Miller, President, in the chair.

New Member.—J. Clement Cuff.

Papers.—1. "Additions to the New Zealand Molluscan Fauna," by Rev. W. Webster (p. 254).

2. "Notes on the Destruction of Kumaras by Beetles," by Major T. Broun (p. 262).

3. "Remarks on a Parasitic Fungus allied to *Cordyceps clavatula*," by Major T. Broun.

In a report for the Agricultural Department, dated the 30th June, 1897, when dealing with a fungus found destructive to the codlin-moth, I also mentioned the discovery, in 1895, of another fungus which still continues doing valuable service in destroying some pernicious scale insects. As that report was a mere record of its discovery, it may prove interesting to gardeners and fruit-growers if I now add something more about it. It may be stated that this fungus is better known by the name applied to it by local nurserymen—*i.e.*, "Broun's fungus."

If the black scale (*Lecanium oleæ*) on an affected lemon or orange tree be carefully examined it will be seen that a few slender grey filaments stretch across it; these in time form a film over the surface, and ultimately a complete ring which wholly embraces the base of the scale as adhering to the leaf or branch. This greyish deadly circle forms a sort of cement around the waxy covering of the female insect and scale in such a manner that the eggs and young larvæ must remain under the scale itself. There is no possibility of escape, so they die, sealed up under their natural protective waxy shield or scale, and are thus prevented from spreading and injuring the tree or its fruit.

Some lemon-trees at Whangarei that were badly infested with this scale, accompanied by this natural enemy, were again examined within a year after my first visit to them, when I failed to detect a single *Lecanium oleæ*: all had been destroyed by this fungus. There had been no spraying and no artificial removal.

Lecanium hesperidum, often called the holly and ivy scale, besides being perforated by minute parasitic flies (*Encyrtus flavus*, for example) is also destroyed by this or a nearly related fungus.

4. "Notice of the Occurrence of the Lesser Frigate-bird in New Zealand," by T. F. Cheeseman (p. 265).

5. "On the Occurrence of certain Marine Reptilia in New Zealand," by T. F. Cheeseman (p. 267).

Annual Meeting: *24th February*, 1908.

Mr. E. V. Miller, President, in the chair.

The annual report and audited financial statement was read and adopted.

Abstract of Annual Report.

During the year seventeen new members have been elected, and fourteen names withdrawn from the roll, leaving a net gain of six. The total number on the roll is now 176. Among the members removed by death were Mr. T. H. Smith, who served for some years on the Council, and who was well known as a leading authority on the language, manners, and customs of the Maori race; and Mr. W. Will, late editor of the *Weekly News*.

Eulogistic reference was made in the report to the great services rendered to science, and especially to the New Zealand Institute, by the late Sir James Hector.

The balance-sheet showed a total revenue of £1,805 18s. 3d., exclusive of a balance in hand at the commencement of the year of £84 4s. 3d. This includes a Government subsidy of £660 on the amount raised by subscription for the erection of the Maori house and the purchase of Mr. Fenton's *pataka,* and also an item of £112 10s., balance of the Mackechnie bequest for the purchase of groups of animals. Deducting these sums, the ordinary revenue was £1,033 8s. 3d., and of this the receipts from the Museum endowment amounted to £419 13s. 2d. The invested funds of the Costley bequest yielded £355 12s.; interest on the Mackechnie library bequest, £96 10s.; and the annual subscriptions, £147. The total expenditure has been £1,236 2s. 4d., including £158 1s. 3d., balance of cost of the erection of the Maori house, and £139 18s. 3d. on account of the groups of animals for the Museum. The credit balance in the Bank of New Zealand is, therefore, £654 0s. 2d. The total amount of the invested funds of the Institute is £16,308 4s. 3d.

Ten meetings were held during the year, at which the following papers were read:—

1. Introductory address by the President, Mr. E. V. Miller.
2. "The Passing of the Maori," by the Rev. Archdeacon Walsh.
3. "Science and Metaphysics," by Dr. R. Briffault.
4. "On the Vegetation of Mount Hector, Tararua Range," by D. Petrie.
5. "Description of a New Species of *Veronica*," by D. Petrie.
6. "Botanical Nomenclature," by T. F. Cheeseman, F.L.S.
7. "Translation of Dumont D'Urville's Account of his Visit to Tasman Bay," by S. Percy Smith.
8. "The Composition of the Sun," by F. P. Worley, M.A.
9. "The Disposal of City Sewage," by W. E. Bush, C.E.
10. "The Struggle for Foreign Trade," by Professor H. A. Segar.
11. "Maori Forest Lore," by Elsdon Best.
12. "Contributions to a Fuller Knowledge of the New Zealand Flora," by T. F. Cheeseman.
13. "The Canoe that brought the Maoris to New Zealand; or, a Glimpse of Polynesia in the Past," by K. Watkins.
14. "Additions to the New Zealand Fauna," by the Rev. W. H. Webster.
15. "Notes on the Destruction of Kumaras by Beetles," by Major T. Broun.
16. "On a Fungus (*Cordyceps* sp.) destructive to Scale Insects," by Major T. Broun.
17. "Notice of the Occurrence of certain Marine Reptilia in New Zealand," by T. F. Cheeseman.
18. "Notice of the Occurrence of the Lesser Frigate-bird in New Zealand," by T. F. Cheeseman.

The attendance of the public at the Museum for the past year is estimated at 68,055, as against 62,551 for the previous year. After defraying the balance due for the erection of the Maori house, a sum of £500 remained for expenditure in the Museum, and of this amount about £400 is being spent in providing a properly equipped workroom. Provision is also being made for the exhibition of the collection of foreign (mainly Polynesian) ethnographical specimens. The Hon. E. Mitchelson has deposited his valuable collection of kauri-gum, probably the most complete ever formed, and likely to possess still greater interest when the trade in kauri-gum has become a memory of the past.

Election of Officers for 1908.—*President*—E. V. Miller; *Vice-Presidents*—Professor F. D. Brown, M.A., and Professor A. P. W. Thomas, M.A.; *Council*—L. J. Bagnall, H. Haines, H. D. M. Haszard, J. Kirker, T. Peacock, D. Petrie, J. A. Pond, J. Reid, Professor H. W. Segar, M.A., J. Stewart, C.E., J. H. Upton; *Trustees*—Professor F. D. Brown, M.A., T. Peacock, J. Reid, J. Stewart, C.E., J. H. Upton; *Secretary and Curator*—T. F. Cheeseman, F.L.S., F.Z.S.; *Auditor*—W. Gorrie.

PHILOSOPHICAL INSTITUTE OF CANTERBURY.

First Meeting : *1st May*, 1907.

The President, Dr. Hilgendorf, in the chair, and forty-six others present.

New Member.—T. H. Jackson.

On the motion of the President, resolutions of sympathy were carried with the families of the late Mr. R. Brown and Mr. T. W. Naylor-Beckett.

Dr. Chilton gave a *résumé* of the proceedings at the meeting of the New Zealand Institute in January.

Mr. R. Speight, the retiring President, gave an address on "Some Aspects of the Terrace-development in the Valleys of the Canterbury Rivers" (p. 16).

Second Meeting : *5th June*, 1907.

The President, Dr. Hilgendorf, in the chair, and thirty others present.

New Members.—W. J. O'Donnell, G. A. Sommers, A. Taylor, J. Ingram, and Rev. H. Adamson.

On the motion of the President, a resolution of congratulation was carried with Professor Benham on his election as a Fellow of the Royal Society.

A discussion then ensued on Mr. Speight's ex-presidential address, in which Dr. Cockayne, the President, Messrs. Hogg, Mulgan, Laing, and Page took part.

Third Meeting : *3rd July*, 1907.

The President, Dr. Hilgendorf, in the chair, and forty others present.

The President, referring to the death of Sir John Hall, moved "That the Philosophical Institute of Canterbury desires to place on record its sorrow at the death of Sir J. Hall, one of its oldest members, and its appreciation of his many public services."

This was carried, those present standing.

New Members.—Mrs. Waymouth, Miss Wilson, and Mr. J. C. Andersen.

A resolution of congratulation was carried with Sir Joseph Hooker, F.R.S., on the occasion of his ninetieth birthday.

Dr. Cockayne gave an address on "The Vegetation of Stewart Island."

Papers.—1. "On Simson's Line," by E. Hogg, M.A.

2. "On a Case of Variation in *Cotula Haastii*," by Dr. Cockayne.

Dr. Chilton shortly explained Mr. Kirkaldy's paper on a "Heteropterous Hemipteron" (p. 109).

Exhibits.—Dr. Symes exhibited the blue-gum scale, and the ladybird its natural enemy.

FOURTH MEETING: *7th August*, 1907.

Mr. R. Speight in the chair, and forty others present.

New Members.—Messrs. J. O. Jameson and N. L. McBeth.

Mr. Speight called attention to the letting of the contract for the Arthur's Pass Tunnel, and to the scientific questions which might be elucidated in the progress of this great work.

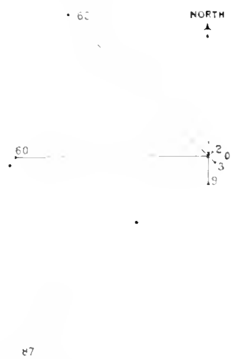
The matter was referred to the Council.

Mr. T. W. Adams read an address on the genus *Pinus*, which was illustrated by numerous exhibits.

A paper on "The Prevalent Wind of Kaikoura," by the late Dr. Gunn, was read by Mr. A. H. Cockayne, as follows:—

Upper clouds, and directions, for years 1902–4 (inclusive), as made at Kaikoura, Marlborough, New Zealand; situated ten miles south of Kaikoura Ranges, the altitude of which is 8,000 ft. Latitude, 42° 26′ 30″ S.; longitude, 173° 45′ E.; height above sea-level, 50 ft.; distance from sea, quarter of a mile.

Records of upper-cloud (cirrus, cirro-stratus, and cirro-cumulus) movement, which I have kept for ten years, although the three years 1902–4 have only so far been collated. During these three years, out of 224 observations the drift of cloud was from south-west on eighty-seven occasions, from north-west on sixty-two occasions, from west on sixty occasions, from south on nine occasions, from south-east on three occasions, from north-east on two occasions, from north on one occasion, and from east on no occasions. This almost invariable drift from the westward shows that to be the general motion of the higher atmospheric currents. They are, I consider, the anti-trades.



Mr. E. Hitchings showed some diagrams relating to sun-spot statistics.

FIFTH MEETING: *4th September*, 1907.

The President, Dr. Hilgendorf, in the chair, and forty others present.

New Member.—Mr. J. Dawes.

The business of the meeting was the discussion on theories of evolution, in which Dr. Hilgendorf, and Messrs. Laing, Mayne, Speight, and Waite, took part.

SIXTH MEETING: *2nd October*, 1907.

The President, Dr. Hilgendorf, in the chair, and forty others present.

Mr. J. Drummond gave an address on "The Little Barrier Island," illustrating it with lantern-slides (p. 500).

Mr. Waite showed some specimens of brown coal brought up in the "Nora Niven's" dredges off the coast of Canterbury at depths of from 25 to 30 fathoms.

Mr. Speight called attention to the interest of the specimens, as evidence of the continuation of the coal-measures under the Canterbury Plains.

SEVENTH MEETING: *23rd October*, 1907.

The President, Dr. Hilgendorf, in the chair, and fifty others present.

Professor A. W. Bickerton gave an address on "The Evolution of the Universe," which he illustrated with lantern-slides and diagrams.

A short discussion ensued, which was interrupted by the time of closing.

Dr. Coleridge Farr stated that, whilst going a certain distance with Professor Bickerton, he thought that gentleman was wrong in appealing to laymen to take up his theories, which should be put before the scientific world through the regular channels.

Mr. Hogg found difficulty in discussing the theory on account of the nebulous condition of the statements.

EIGHTH MEETING: *6th November*, 1907.

The President, Dr. Hilgendorf, in the chair, and thirty others present.

New Members.—Messrs. Farrow and Tripp.

Papers were read by Messrs. S. Speight, A. M. Wright, T. Iredale, and J. C. Anders n.

Mr. Hogg referred to the approaching departure of the sub-antarctic expedition, saying that the organization of such an expedition marked a new era in the history of the Institute.

Annual Meeting: 11*th December*, 1907.

Dr. Cockayne in the chair, and thirty others present.

The Chairman referred to the death of Sir James Hector, and moved a resolution of sympathy with his family. This was seconded by D·. Chilton, and carried, those present standing.

Mr. Hogg referred to the return of the subantarctic expedition, and, on behalf of the Institute, welcomed the Canterbury members of it.

The following annual report and balance-sheet were adopted:—

The number of Council meetings held during the year was eighteen, and the average attendance seven. Early in the year Mr. Hogg, who had been appointed Secretary at the last annual meeting, resigned, and Dr. C. Coleridge Farr took his place.

Apart from the regular work which the Council has to perform every year, the principal business this year has been the organization of the expedition to the Auckland and Campbell Islands, which has now been successfully carried through. In the early part of the year, owing to the contemplated marine survey of the coast of New Zealand, it appeared likely that it would be impossible to make arrangements with the Government for the conveyance of the expedition, but on the abandonment of the survey the Minister of Marine very readily fell in with your Council's proposals, and finally agreed to take a party of twenty-five, landing them in two sections, one at the Auckland Islands and the other at Campbell Island. The selection of gentlemen to form these parties fell to your Council, and they fully realised the responsibility thus cast upon them. The considerations which guided them in their choice were the efficiency of both parties in every branch of science likely to be advanced by a visit to these interesting islands, and the avoidance of overlapping. The Council issued invitations to gentlemen of recognised standing throughout New Zealand. It was inevitable that some of those whose names first occurred to the Council should be unable, from one reason or another, to go, and the Council much regretted that as the expedition left the Bluff it contained no representatives from the Auckland District, although five distinguished scientific men from the northern capital had been invited. This was mainly owing to circumstances over which neither the Council nor those gentlemen themselves had control.

Being acquainted with the work done by the members of the expedition in their several scientific capacities, the Council has no hesitation in saying that the results are of such a character as to lead to a considerable extension of our knowledge not only of these little-known islands in particular, but also of the subantarctic area in general. During the forthcoming year it is probable that papers dealing with the expedition will be brought before you, and it will be a matter for the Council to be elected this evening to decide as to most satisfactory means of publication of the results as a whole.

For the purposes of the expedition the Council voted £25 of the Institute's funds, and it has learnt since its return that the Parliament has, at the suggestion of the Government, voted £150 towards the expenses.

The Council notes with pleasure that an expedition has been organized by members of the Institute and others to visit the Kermadecs and to spend a year there for the purpose of making scientific collections. To aid this work the Council has made a grant of £10 from the Institute's funds, and has used its influence to endeavour to secure free passages for the members of the party, but unfortunately in this respect it was unsuccessful.

The Council in last year's report drew attention to the advisability of the appointment of a Government Botanist, and it is pleased now to state that, while such a post has not yet been created, arrangements have been made between the Government and Dr. Cockayne which are very satisfactory from a scientific point of view, and which enable that gentleman to continue and extend the work which he has so long and so successfully carried on at his own expense.

The signing of a contract for the construction of a tunnel at Arthur's Pass brought before the Council the problems of interest which might be elucidated in the progress of a work of so great a magnitude. A subcommittee has been appointed and the initial steps have been taken, and arrangements in connection with experiments proposed will form part of the business of the next Council.

The number of ordinary meetings of the Institute held during the year has been nine, and the average attendance at these has been forty. Addresses have been given as follows: Mr. R. Speight, "Some Aspects of the Terrace-development in the Valleys of the Canterbury Rivers"; Dr. L. Cockayne, "The Vegetation of Stewart Island"; Mr. T. W. Adams, "The Genus *Pinus*"; Mr. Jas. Drummond, "Little Barrier Island"; Professor Bickerton, "The Evolution of the Universe; and one evening was devoted to a discussion on "Theories of Evolution." Besides these, seventeen papers have been read before the Institute, which may be classified as follows: Mathematics and physics, 4; geology, 2; chemistry, 1; botany, 2; zoology, 7; literature, 1.

The number of members of the Institute is now 147.

The Hon. Treasurer's balance-sheet shows that during the year £122 1s. 6d. was received for members' subscriptions, that £54 2s. 10d. has been expended in the purchase of books and periodicals for the library, £25 has been contributed to the subantarctic expedition, and £10 to the Kermadecs expedition, leaving a credit balance, including the £50 placed on fixed deposit two years ago, of £83 4s. Of this amount, the sum of £10 has been allocated for expenses connected with the investigations made desirable by the cutting of the Arthur's Pass Tunnel.

Election of Officers for 1908.—*President*—Mr. E. G. Hogg; *Vice-Presidents*—Dr. Hilgendorf, Mr. R. M. Laing; *Hon. Secretary*—Mr. R. Speight; *Hon. Treasurer*—Dr. Chilton; *Council*—Dr. Cockayne, Mr. J. Drummond, Dr. C. C. Farr, Mr. J. B. Maine, Mr. Edgar R. Waite, Mr. A. M. Wright; *Hon. Auditor*—Mr. G. Way, F.I.A.N.Z.

Mr. Hogg, on taking the chair, referred to the advent of the antarctic ship "Nimrod," and to the approaching arrival of the Carnegie Institute's magnetic-survey yacht "Galilee."

OTAGO INSTITUTE

FIRST MEETING: 14*th May*, 1907.

The President, Dr. R. Fulton, in the chair.

New Members.—Professor Richard, Mrs. Stilling, Messrs. W. J. Morrell, M.A., Harold Hamilton, Robert Lee.

The President referred to the honour recently conferred on Dr. Benham by his election as a Fellow of the Royal Society.

Exhibit.—The Curator of the Museum exhibited a new variety of the common gecko, *Naultinus elegans*, and its two young ones born in captivity.

The mother was bright-green, with a pair of sulphur-yellow lines along its side; the young ones entirely different, being dark grass-green, with a series of white black-bordered spots in place of the yellow line.

Address.—The President delivered his address, entitled "The Disappearance of our Native Birds" (p. 485).

SECOND MEETING: 11*th June*, 1907.

The President, Dr. R. Fulton, in the chair.

New Member.—Mr. James Jeffrey.

Exhibits.—Dr. Benham exhibited and made some remarks upon instances of variation in colour-marks present in two species of *Chiton—Onithochiton undulatus* and *Ischnochiton longicymba.*

Paper.—"Some Littoral Hydrocorallines from New Zealand Waters," by Dr. Benham.

The author exhibited specimens of *Labiopora*, *Errina*, *Distichopora*, and *Stylaster*, some of which had been loaned by the Colonial Museum and by the Canterbury Museum.

Address.—Dr. Marshall gave an address on "The Volcano Ngauruhoe."

The speaker briefly outlined by means of diagrams the various changes that had taken place in the volcano since Mr. Bidwell's ascent, and also gave some remarkably interesting experiences of his own in the crater of the volcano. Ngauruhoe was more active now than it had been for fifteen years, but was nothing like what it used to be.

As an outcome of the presidential address the following resolution was read by the Chairman:—

That this Institute is of opinion that, in order to preserve our native birds from extinction, the adoption of the following measures is urgently required: Absolute protection of all our land-birds and most of our swimming-birds, with the following exceptions: Shags, when found near trout-streams; harriers, when found in or near our sanctuaries; grey ducks, during the season (close season every seventh year): pukeko and paradise ducks, when doing injury, for a limited season—say, one month—under supervision of a ranger: issue of bird-shooting license to any person over twenty-one years of age: limitation of total bag for the season: set apart sanctuaries of swamps, river-beds, lagoons, in every county and in the islands. In order to impress upon the public generally that we are actuated by a love for our native birds as well as a desire to encourage honest, clean sport, this Institute wishes to arrange a conference with the other bodies interested, the conference to consist of four members from the Institute, and four each from the Otago Agricultural and Pastoral Society, the Otago Gun Sportsman's Association, the Otago Branch of the New Zealand Farmers' Union, the Otago Acclimatisation Society, and, if possible, four *bona fide* Catlin's or Owaka residents. That our views be laid before the conference, a discussion to follow, and an earnest endeavour be made to get some workable laws which will protect equally the rights of the farmer, the sportsman, the bush-resident, and the bird-lover. That the results of the conference be made use of in either a memorial to Government or a deputation to the Minister of Lands, consisting of members of the various bodies concerned.

In speaking to this, the chairman wished his hearers to support him in the preservation of pukeko and paradise ducks. Sanctuaries—say, swamps, a mile or so of a river-bed here and there—ought to be instituted, and any one found carrying a gun within these precincts should be prosecuted. Small lakes should certainly be made into sanctuaries, as the "game-bags" frequented them with swivel guns until all bird-life was destroyed. Large lakes, on account of their size, might be left to look after themselves. Pigeon-shooting ought to be completely put a stop to.

In seconding the foregoing, Dr. Benham said he believed that the protection of birds was provided for by an Order in Council last May, but he could not say whether an Order in Council had the same value as a statutory law.

Mr. Bathgate said he believed the Act embraced all birds, whether named in the schedule or not, but if a statute was not enforced it was no good its being a statute. Then came scenery, for which heavy penalties were supposed to be inflicted for fire-lighting, &c., yet fires were repeatedly lit, often to the danger of timber, and no one was prosecuted. Native birds were rapidly disappearing.

The resolution was carried unanimously.

Mr. Chisholm, as a member of the Acclimatisation Society, said they had signally failed to get the Government to take adequate steps for the protection of native birds, and the society was obliged to Dr. Fulton for having brought up the subject.

It was decided that matters of detail be referred to a council, to be put in form prior to their presentation to the conference.

Third Meeting: *9th July*, 1907.

The President, Dr. R. Fulton, in the chair.

The President reported the results of the conference on bird-protection.

He expressed himself gratified at the manner in which the various suggestions were received by the bodies concerned. The resolutions would be forwarded to the Colonial Secretary, and it was hoped that action would be taken to embody them in a Bill.

Mr. A. Bathgate gave some historical notes, prompted by Mr. R. McNab's "Murihiku," and by Professor Macmillan Brown's "Maori and Polynesian."

In the discussion which followed, Dr. Hocken joined.

FOURTH MEETING: 13*th August*, 1907.

The President, Dr. R. Fulton, in the chair.

New Member.—Dr. Russell Ritchie.

Exhibits.—Professor Malcolm gave an account of certain optical illusions produced by lines drawn at various angles to one another, and by parallel lines crossed obliquely by lines at different angles, &c.

Professor Benham exhibited, on behalf of Mr. G. M. Thomson, cases made by the larva of the moth *Œceticus omnivorus*, in which black thread was woven with the usual materials.

Professor Benham also exhibited a method of mounting models of aquatic animals in glass cases in such a way as to represent water.

Dr. Hocken showed a Boyle's tube, for illustrating the method of formation of dew and rain.

Dr. Marshall gave an address on "The Volcanoes of the Taupo Region."

He prefaced his remarks by mentioning that he had spent some portion of last summer in this volcanic district, but he did not intend to enter into a full description of it. There were certain features connected with the district from which certain inferences could be drawn, and a comparison could be made with other areas, and to some extent a relationship traced between New Zealand and other parts of the world. There were many theories about the isolated position New Zealand occupied, but it was not so isolated as it was supposed to be. By the aid of the lantern he showed a large number of pictures of the volcanoes of the North Island, upon which he made a running commentary.

Dr. Fulton, by means of the lantern, showed a cock-pit, said to be several hundreds of years old.

In 1849 the sport was finally abolished, but in 1860 it was carried on in Dunedin by educated gentlemen.

Professor Park gave a description of visits he had made to the volcanic region of the North Island, and thought Dr. Marshall deserved a hearty vote of thanks for his address.

FIFTH MEETING: *10th September*, 1907.

The Vice-President, Dr. Marshall, in the chair.

Exhibits.—Dr. Marshall showed, and remarked upon, a large species of *Orthoceras* from the Hokonui Hills, Southland.

He expressed his opinion that the so-called phragmacone of *Belemnites otapirensis* of Hector was an *Orthoceras.*

Dr. Marshall exhibited fossils picked up on the beach at Napier, *Halysites* and *Favorites*, which, if native to New Zealand, are the first representatives of these genera to be recorded for this country.

Dr. Benham made remarks upon a cyclopean lamb's head.

Papers.—1. "The Early Visits of the French to New Zealand," by Dr. Hocken (p. 137).

2. "The Occurrence of *Comatula* in the Coastal Waters of New Zealand," by Dr. Benham.

The species was obtained in Preservation Inlet.

SIXTH MEETING: *8th October*, 1907.

The Vice-President, Dr. Hocken, in the chair.

New Members.—Messrs. J. Loudon, H. Massey, and W. Livingston.

Exhibits.—Mr. G. M. Thomson remarked upon the phenomenon of certain beech-trees producing leaves earlier than others, and indicated the relation to time of flowering.

Mr. G. M. Thomson read a note in reference to the orchid *Gastrodia*, as follows:—

The genus *Gastrodia* belongs to a tribe of *Orchideæ* (*Arethusæ*) which contains several leafless species, some of which have rather fleshy rhizomes or tubers, and are evidently saprophytic in growth, while the species of *Gastrodia* itself are said to be parasitic on roots. Three species occur in New Zealand—viz., *G. sesamoides*, R. Br., which is found in the North Island and in the botanically allied west-coast region of the South Island, and is also found along the eastern side of Australia from Queensland to Tasmania (it is the only Australian species); *G. Cunninghamii*, Hook. f., which is common in the bush throughout New Zealand, and is endemic; and the closely allied *G. minor*, Petrie, which has been found in only one locality, near Dunedin. *G. Cunninghamii* was formerly abundant in all bush-covered parts of Otago, and some twenty years ago was still to be met with in the Town Belt of Dunedin, but it has disappeared from many localities with the spread of cultivation, the inroads of cattle, and the competition of cocksfoot-grass and other aggressive introduced species of plants. It is now some years since any specimens have been found in the neighbourhood of this city.

In September last, Mr. F. Challis, of North-east Harbour, brought me a quantity of the rhizomes, which he had dug up in the bush at Catlin's, where the species is common. The starchy nature of the rhizome has long been known, and, according to Cheeseman, these thick rhizomes were formerly collected and eaten by the Maoris, especially in the Urewera country. I was curious to examine the starchy substance, and accordingly squeezed the cut end of a rhizome in a minute drop of water on the microscope-slide. I found the liquid was full of minute white granules, which were only about 0·0025 mm. in diameter. These were so abundant as to make the juice, when squeezed out, quite milky. Among them were a few larger rounded and usually oblong masses. On adding solution of iodine the larger masses stained a brown colour, showing the presence of proteids, but they very quickly disintegrated into amorphous brownish flocculent masses. The small granules remained uncoloured. On heating the semi-fluid material on the slide these small granules dissolved completely, but on addition of iodine-solution they were reprecipitated in a loosely flocculent form, and were stained a reddish-violet or port-wine colour. These reactions appear to show that the granules are probably erythro-dextrin, one of the cellulose-starch isomers ($C_6H_{10}O_5$). On heating a small quantity of the clear solution with Fehling's solution considerable reduction and deposition of cuprous oxide took place, showing the presence of dextrose. I estimated the amount of this dextrose in a portion of a rhizome which was shred down and completely extracted with hot water, and found it amounted to 1·38 per cent. of the whole. Unfortunately, the whole amount of erythro-dextrin and dextrose together was not estimated. I am inclined to think it will be found that the material stored up in these rhizomes in autumn is erythro-dextrin, but that as the spring growth starts this is converted into the soluble dextrose, and thus is immediately utilisable in the formation of stem-tissue. These rhizomes also contain a considerable amount of raphides, especially in the cells near the surface, and the amount of calcium-oxalate found amounted to 0·26 per cent. of the whole weight.

It is desirable that the parasitic habit of these orchids should be more closely investigated. I have no record of the roots on which they grow, nor can I find that any careful examination of these has been made. The casual collector has usually little time and few means to undertake such an investigation, but any one dwelling in a bush district where these plants are common could readily find out. This note is a preliminary one, as I hope to be able to look into the matter again.

P.S.—I placed a few portions of the rhizomes in damp moss in September last, covering them with leaves and humus, and keeping the whole mass moist. Now (16th December) they are throwing up stems with scale leaves and rudimentary flower-buds. But the growth is thin and stunted, and is evidently the product of the conversion of the material stored up, not the assimilation of new food-material. No roots are being developed, and presumably the specimens will die without coming to any full development.

Lecture.—Mr. G. M. Thomson gave a popular account, illustrated by diagram and lantern-slides, of the "Life-history of the American Lobster."

Papers.—1. "Fossils from Kakanui," by J. Allan Thomson, B.Sc.; communicated by G. M. Thomson (p. 98).

2. "The Scheelite of Otago," by A. M. Finlayson, M.Sc.; communicated by Dr. Marshall (p. 110).

3. "Some Observations on the Schists of Central Otago," by A. M. Finlayson, M.Sc.; communicated by Dr. Marshall (p. 72).

Seventh Meeting: *12th November*, 1907.

The President, Dr. R. Fulton, in the chair.

Dr. Hocken referred in feeling and appreciative terms to the recent death of Mr. A. Beverley, the inventor of the planimeter.

Mr. G. M. Thomson moved a resolution of regret at the death of Sir James Hector, and of condolence with the family. Dr. Hocken, in seconding, gave some interesting details of Sir James's early expeditions in the colony.

Paper.—"Some Alkaline and Nepheline Rocks from Westland," by Mr. J. P. Smith (p. 122).

Lecture.—Mr. W. G. Grave gave an illustrated lecture on "Explorations at the West Coast."

Annual Meeting.

The annual meeting was then held, the President, Dr. R. Fulton, being in the chair.

The following is a summary of the annual report for 1907:—

Three matters of importance have engaged the attention of the Council, each having for its aim the furtherance of science in the Dominion: (1) The repeated efforts of this and the other Institutes to have a botanical survey made by the Dominion have resulted in the appointment of Dr. L. Cockayne to survey and report upon the State forest of Wairoua. (2.) The successful outcome of the efforts of the Philosophical Institute of Canterbury, backed by this Institute, in the despatch of a scientific expedition to the southern islands, which leaves the Bluff on the 13th November. (3.) Representations have been made to the Colonial Secretary and to the Attorney-General as to the necessity of providing by law for further protection of birds: this was the outcome of a conference between bodies interested, held at the suggestion of Dr. Fulton.

The death of Sir James Hector, K.C.M.G., received fitting reference, expressive of the appreciation of the varied work performed by him in geology and zoology, and as manager of the New Zealand Institute.

A list of books added to the library and of the papers read before the Institute during this session were appended to the report.

The total number of members now stands at 116.

Strong dissatisfaction was expressed at the unreasonable delay in the issue of the Transactions for 1906.

The Hon. Treasurer, Mr. J. C. Thomson, submitted a balance-sheet, duly audited by Mr. D. Brent, from which it appeared that the income was £374 11s., and the expenditure £118 15s., showing a credit balance of £256 9s. 7d.

Election of Officers for 1908.—*President*—Dr. Hocken; *Vice-Presidents*—Dr. Fulton, Professor Park; *Hon. Treasurer*—Mr. J. C. Thomson; *Hon. Secretary and Librarian*—Dr. Benham; *Council*—Messrs. A. Bathgate, G. M. Thomson, D. B. Waters, Dr. Marshall, Professor Malcolm, Dr. Riley, and Mr. G. A. Rawson; *Hon. Auditor*—Mr. D. Brent, M.A.

HAWKE'S BAY PHILOSOPHICAL INSTITUTE.

Annual Report.

During the past year there have been seven meetings of the Institute—namely, the annual general meeting and six ordinary meetings. At the ordinary meetings thirteen papers were read, several of them being illustrated by lantern-slides. The Council held five meetings and transacted a large amount of general business.

Nine new members were elected during the year, making a total membership of sixty-seven.

The Council of the Institute has been approached by the Borough Council with regard to the transfer of the Museum to the latter body, and the opening of the Institute's library as a reference library. Nothing definite, however, has yet been done with regard to either of these matters.

Mr. Hill has again been elected the Institute's representative on the Board of Governors of the New Zealand Institute.

The Treasurer's balance-sheet shows a credit balance of £20 3s. 8d.

Papers read during the Session 1907.

7th May.—Inaugural address by the President, E. A. W. Henley, M.B.; subject, "Esperanto."

11th June.—Papers by Dr. Kennedy—(*a*) "The Climate of Napier compared with those of Other Places in New Zealand and Europe"; (*b*) "The Nine-inch Refractor of the Meeanee Observatory." Both papers illustrated by lantern-slides.

16th July.—Paper by J. L. Kayll. "The Criminal: His Evolution and Reform."

13th August.—Papers by H. Hill—(*a*) "Strange Stones," illustrated by a large number of specimens; (*b*) "An Experiment in Nature-study"; (*c*) "The Root-parasite *Dactylanthus Taylori*," illustrated by lantern-slides.

3rd September.—Papers by W. Kerr, M.A.—(*a*) "Experimental Education"; (*b*) "Some Optical Phenomena explained." Papers by H. Guthrie-Smith—(*a*) "Alien and Native Grasses of Tutira" (p. 506); (*b*) "Ferns of Tutira."

29th November.—Paper by Taylor White, "On Hybrid Ducks." Paper by H. Hill, B.A., F.G.S., "Evolution," illustrated by a large number of lantern-slides.

Election of Officers for 1908.—*President*—T. Tanner; *Vice-President*—J. P. Leahy, M.B., D.P.H.; *Council*—G. Clark, W. Dinwiddie, E. A. W. Henley, M.B., H. Hill, B.A., F.G.S., T. Hyde, T. C. Moore, M.D.; *Hon. Secretary*—James Hislop, District School; *Hon. Treasurer*—J. W. Craig; *Hon. Auditor*—J. S. Large; *Lanternist*—C. F. Pointon.

NELSON INSTITUTE.

Annual Report.

The receipts from members' subscriptions amounted to £170 6s. 6d., as against £175 5s. for the year 1906, and £186 for the year 1905; the rents of reserve, £58 3s.; Government subsidy, £17 1s. 2d.; and miscellaneous receipts, £1: making a total income for the year 1907 of £246 10s. 8d., as against £249 8s. for 1906, and £285 11s. 3d. for the year 1905, thus showing a considerable falling-off in revenue during the past two years. The number of subscribers to the library for the year 1907 has been 198, 134 of whom were annual members, 27 half-yearly, and 37 quarterly; total, 198, as against 212 in 1906, and 210 in 1905.

New books to the number of 319 volumes have been added to the library during the past year, a very much larger number than in previous years. The sum of £75 10s. has been expended on new books, periodicals, and newspapers during the year. The total number of books now in the library is 8,540.

Twelve ladies and gentlemen were elected at the last annual meeting as an Advisory Building Committee to co-operate with the Institute Committee in the matter of erection of a new library building.

A number of meetings have been held during the past year and plans and proposals discussed, but no definite result has so far ensued.

Your committee have to record with very great regret the resignation of Mr. Redgrave as Hon. Secretary and Treasurer, a position he held for over thirteen years, and during which period he rendered very valuable services to the Institute. Mr. G. C. Gilbert has been appointed to act as his successor.

Under the auspices of the scientific branch, a most interesting lecture was recently given by Dr. Marshall on the subject of "The Mountains of New Zealand," but no other meetings have been held. The Museum still remains closed, and is not likely to be opened until a new Institute is built. The Atkinson Observatory has been opened periodically, and has been well patronised by the public. Dr. Cockayne has been re-elected as our representative on the governing body of the New Zealand Institute.

MANAWATU PHILOSOPHICAL SOCIETY.

Abstract of Annual Report.

Fifty-nine members have paid their subscriptions this year, as compared with thirty-six last year.

Nine meetings of the Council have been held, and eight general meetings, at which the following papers were read: "Solidity of the Earth," by Mr. Eliott Warburton; "Astronomy," by Dr. Kennedy; "Magnetism," by Mr Merritt; "Explanation of the Telescope," by Captain Hewitt; "Some Impressions of the East," by Mr. Cohen; "Explanation of Meteorological Instruments," by Mr. Vernon; "Alcohol in Health and Disease," Dr. Martin; "Early Stages of New Zealand Tree-ferns," by the Rev. G. B. Stephenson (p. 1).

At the request of the Society, Palmerston North has been made a second-class meteorological station, and a complete set of instruments has been supplied by the Government and placed in charge of Dr. Martin.

The Museum now includes nearly a thousand exhibits, over two hundred and fifty having been received during the past year, including valuable collections illustrating the mineralogy of New South Wales and the west coast of the South Island, and presented to the Society by the Commissioners for those districts at the Christchurch Exhibition. The attendance during the ten months that the Museum has been open has been over two thousand five hundred.

During the year a 6 in. reflector telescope, with all the necessary fittings, has been bought from the Rev. Dr. Kennedy, of Meeanee, and put up in a small Observatory in the Square. The telescope has been placed in the care of Captain Hewitt, R.N., who is assisted by Messrs. Vernon, Foote, Durward, and Elliott; and the Observatory is open on all Wednesday evenings, when the weather is fine.

The Council expresses its gratitude to the Mayor and Borough Council for the generous manner in which they have met the wishes of the Society; to the numerous donors of gifts and loans to the Museum; to Captain Hewitt and his colleagues for the time and trouble which they have devoted to the Observatory; to Mr. Gerand for assistance in the adjustment of the machinery; and to the caretaker of the Museum for the zeal and attention which he has devoted to his work.

The balance-sheet shows that the total receipts were £80 1s. 9d., and the expenditure £159 2s. 4d., leaving a debit balance of £79 0s. 7d.

Election of Officers for 1908.—*President*—Mr. M. Cohen; *Vice-Presidents*—Messrs. A. A. Martin, M.D., and M. A. Eliott; *Council*—Messrs. J. L. Barnicoat, F. H. Cooke, W. F. Durward, F. Foote, B.A., E. Larcomb, C.E., and J. E. Vernon, M.A.; *Secretary and Treasurer*—K. Wilson, M.A.; *Auditor*—R. N. Keeling.

APPENDIX

NEW ZEALAND INSTITUTE.

HONORARY MEMBERS.

1870.

Finsch, Otto, Ph.D., of Bremen, Leiden, Holland.

Hooker, Sir J. D., G.C.S.I., C.B., M.D., F.R.S., Royal Gardens, Kew.

1873.

Günther, A., M.D., M.A., Ph.D., F.R.S., Litchfield Road, Kew Gardens, Surrey.

1875.

Sclater, Philip Lutley, M.A., Ph.D., F.R.S., Zoological Society, London.

1876.

Berggren, Dr. S., Lund, Sweden.

1877.

Sharp, Dr. D., University Museum, Cambridge.

1885.

Sharp, Richard Bowdler, M.A., F.L.S., British Museum (Natural History), London.

Wallace, A. R., F.L.S., Broadstone, Wimborne, England.

1890.

Nordstedt, Professor Otto, Ph.D., University of Lund, Sweden.

Liversidge, Professor A., M.A., F.R.S., Sydney.

1891.

Goodale, Professor G. L., M.D., LL.D., Harvard University, Massachusetts, U.S.A.

1894.

Dyer, Sir W. T. Thiselton-, K.C.M.G., C.I.E., LL.D., M.A., F.R.S., Royal Gardens, Kew.

Codrington, Rev. R. H., D.D., Wadhurst Rectory, Sussex, England.

1896.

Lydekker, Richard. B.A., F.R.S., British Museum, South Kensington.

1900.

Avebury, Lord, P.C., F.R.S., High Elms, Farnborough, Kent.

Massee, George, F.L.S., F.R.M.S., Royal Botanic Gardens, Kew.

1901.

EVE, H. W., M.A., 37 Gordon Square, London.

GOEBEL, Dr. CARL, University of Munich.

1902.

SARS, Professor G. O., University of Christiania, Norway.

1903.

KLOTZ, Professor OTTO J., 437 Albert Street, Ottawa, Canada.

1904.

RUTHERFORD, Professor E., F.R.S., McGill University, Canada.

DAVID, Professor T. EDGEWORTH, F.R.S., Sydney University, N.S.W.

1906.

BEDDARD, F. E., F.R.S., Zoological Society, London.

MILNE, J., F.R.S., Isle of Wight, England.

BRADY, G. S., F.R.S., University of Durham, England.

1907.

DENDY, Dr., F.R.S., University College, London.

DIELS, L., Ph.D., Berlin.

MEYRICK, E., B.A., F.R.S., Marlborough College, England.

STEBBING, Rev. T. R. R., F.R.S., Tunbridge Wells, England.

ORDINARY MEMBERS.

WELLINGTON PHILOSOPHICAL SOCIETY.

[* Honorary and life members.]

Adams, C. E., B.Sc.
Adams, C. W.
Allen, Frank
Atkinson, Edmond H.
Barraud, W. F.
Beetham, W. H., Masterton
Bell, E. D.
Bell, H. D., K.C.
Bell, Dr. J. M.
Blair, J. R.
Brandon, A. de B.
Campbell, J. P.
Chapman, Martin, K.C.
Christie, Mrs. Henry M.
Chudleigh, E. R., Chatham Islands
Cockayne, A. H.
Denton, George
Downes, Thomas William, Wanganui
Dymock, E. R.
Easterfield, Professor T. H., M.A., Ph.D.
Ewen, Charles A.
Ferguson, W., M.Inst.C.E.
Field, H. C., Aramoho, Wanganui
FitzGerald, Gerald, A.M.Inst.C.E.
Fleming, T. R.
Fletcher, Rev. H. J., Taupo
Fraser, Hon. F. H., M.L.C.
Freeman, H. J.
Freyberg, Cuthbert
Gifford, A. C.
Hadfield, E. F.
Hamilton, Augustus*
Hanify, H. P.
Harding, R. Coupland
Hastie, Miss J. A., London*
Hector, Charles Monro, M.D.
Hogben, G., M.A.
Holmes, R. L., F.R.Met.Soc., Bua, Fiji*
Hudson, G. V., F.E.S.
Hunter, Thomas A.
Hurley, G. A.
Hustwick, T. H.
Ilott, J. M. A.
Izard, Dr. Arnold W.
Johnson, Hon. G. Randall*
Joseph, Joseph
Joynt, J. W., M.A.
King, Thomas
Kingsley, R. I., Nelson
Kirk, Professor H. B., M.A.
Kirk, Thomas W., F.L.S.
Krull, F. A., Wanganui
Lambert, T. S.
Lewis, John H., Broken River, Christchurch
Liffiton, E. N.
Litchfield, A. J., Blenheim
Lomax, Major H. A., Aramoho, Wanganui
MacDougall, Alexander
Maclaurin, Dr. J. S., F.C.S.
Maclaurin, Prof. R. C., M.A.
McKay, Alexander, F.G.S.
McLeod, H. N.
Mason, George Morris
Mason, Mrs. Kate
Maxwell, J. P., M.Inst.C.E.
Mestayer, R. L., M.Inst.C.E.
Moore, George, Eparaima, Masterton
Moorhouse, W. H. Sefton
Morison, C. B.
Murdoch, R., Wanganui
Newman, Alfred K., M.B M.R.C.P.
Orr, Robert

Park, Robert George, Blenheim
Paterson, Dr. Alexander
Pearce, Arthur E.
Petherick, E. W.
Phillips, Coleman, Carterton
Phipson, Percy B.
Pollen, Hugh
Pomare, Dr. M.
Powles, Charles P.
Poynton, J. W.
Reid, W. S.
Richardson, C. T.
Richmond, Professor M. W.
Rix-Trott, Henry
Roy, R. B., Taita*
Rudman, R. Edgar
Smith, Charles, Makirikiri, Wanganui
Stewart, J. T., Aramoho, Wanganui
Stuckey, A. G.
Swan, W. G., Collington
Tennant, J. S.
Tripe, Joseph A.
Tripe, Mrs. Joseph A.
Turnbull, Alexander H.
Turnbull, Robert T.
Wallis, Rt. Rev. Dr. Frederic, Bishop of Wellington
Wilton, G. W.
Woodhouse, Alfred James, London

AUCKLAND INSTITUTE.

[* Honorary and life members.]

Aickin, G., Auckland
Arnold, C., "
Aubin, E. D., M.B., Thames
Bagnall, L. J., Auckland
Ball, W. T., "
Bankart, A. S., "
Bartley, E., Devonport
Bates, T. L., Newcastle, N.S.W.*
Batger, J., Auckland
Beere, D. M., C.E., Auckland
Benjamin, E. R., "
Best, Elsdon, Te Whaiti
Birks, L., Rotorua
Brett, H., Auckland
Briffault, R., M.D., Auckland
Broun, Major T., F.E.S., Drury
Brown, E. C., Taumarunui
Brown, Prof. F. D., Auckland
Buchanan, J., Auckland
Buck, Dr., "
Buddle, T., "
Burgess, E. W., Devonport
Burnside, W., Auckland
Burton, Colonel, Lake Takapuna*
Bush, W. E., C.E., Auckland
Buttle, J, Auckland
Cameron, R., "
Campbell, Sir J. L., M.D., Auckland*
Carr, R. A., Auckland
Casey, M., "
Cheal, P. E., "
Cheeseman, T. F., F.L.S., Auckland
Ching, T., Remuera
Clark, A., Auckland
Clark, H. C., "
Clark, M. A., "
Clarke, C. E., Parnell
Clarke, E., Auckland
Coates, T., Orakei
Cochrane, W. S., Auckland
Combes, F. H., "
Cooper, C., "
Cooper, Mr. Justice, Wellington
Cousins, H. G., Auckland

Cozens, G., Auckland
Craig, J. J., „
Crosher, W., „
Cuff, J. C., „
Darby, P., „
Devereux, H. B., Waihi
Devore, A. E. T., Auckland
Douglas, W. S., „
Duthie, D. W., „
Edson, J., Devonport
Egerton, Professor C. W., Auckland
Ewington, F. G., Auckland
Florance, R. S., Russell
Fowlds, G., M.P., Auckland*
Fox, Rev. E. E., Ponsonby
George, G., Auckland
Gilbert, T., Parnell
Girdler, Dr., Auckland
Given, W. A., Thames
Goldie, D., Auckland
Gordon, H. A., „
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Geological Society, Edinburgh.
" London.
Geological Survey of the United Kingdom, London.
High Commissioner for New Zealand, London.
Imperial Institute, London.
Institution of Civil Engineers, London.
International Catalogue of Scientific Literature, London.
Kegan, Paul, Trench, Trübner, and Co., London (Agents).
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Marine Biological Association of the United Kingdom, Plymouth.
Natural History Society, Glasgow.
" Marlborough College, England.
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Ottawa Literary and Scientific Society, Ottawa.

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Geological Survey of India, Calcutta.
Natural History Society, Bombay.
Raffles Museum, Singapore.

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Royal Society of Queensland, Brisbane.

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Victorian Institute of Surveyors.

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" San Francisco.
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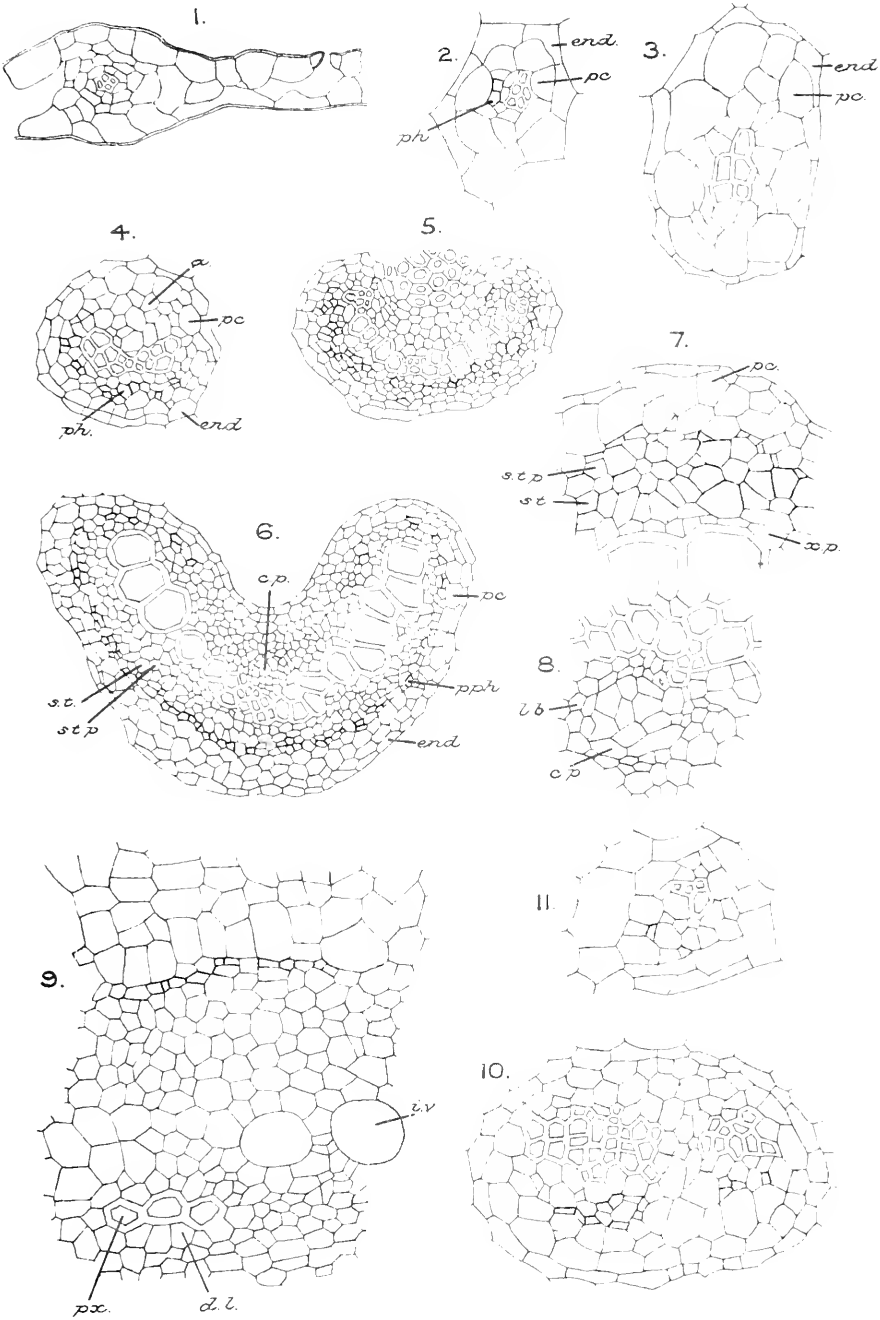

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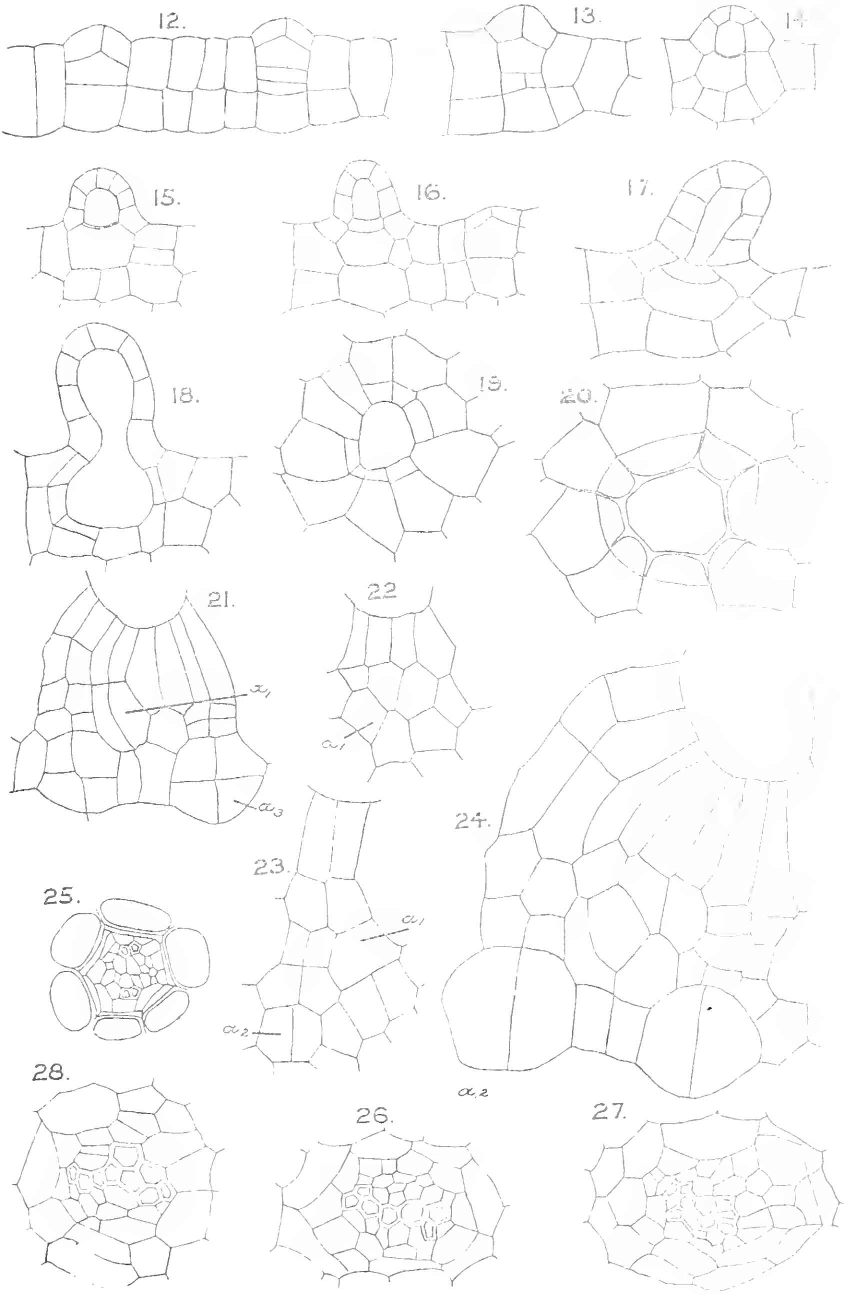

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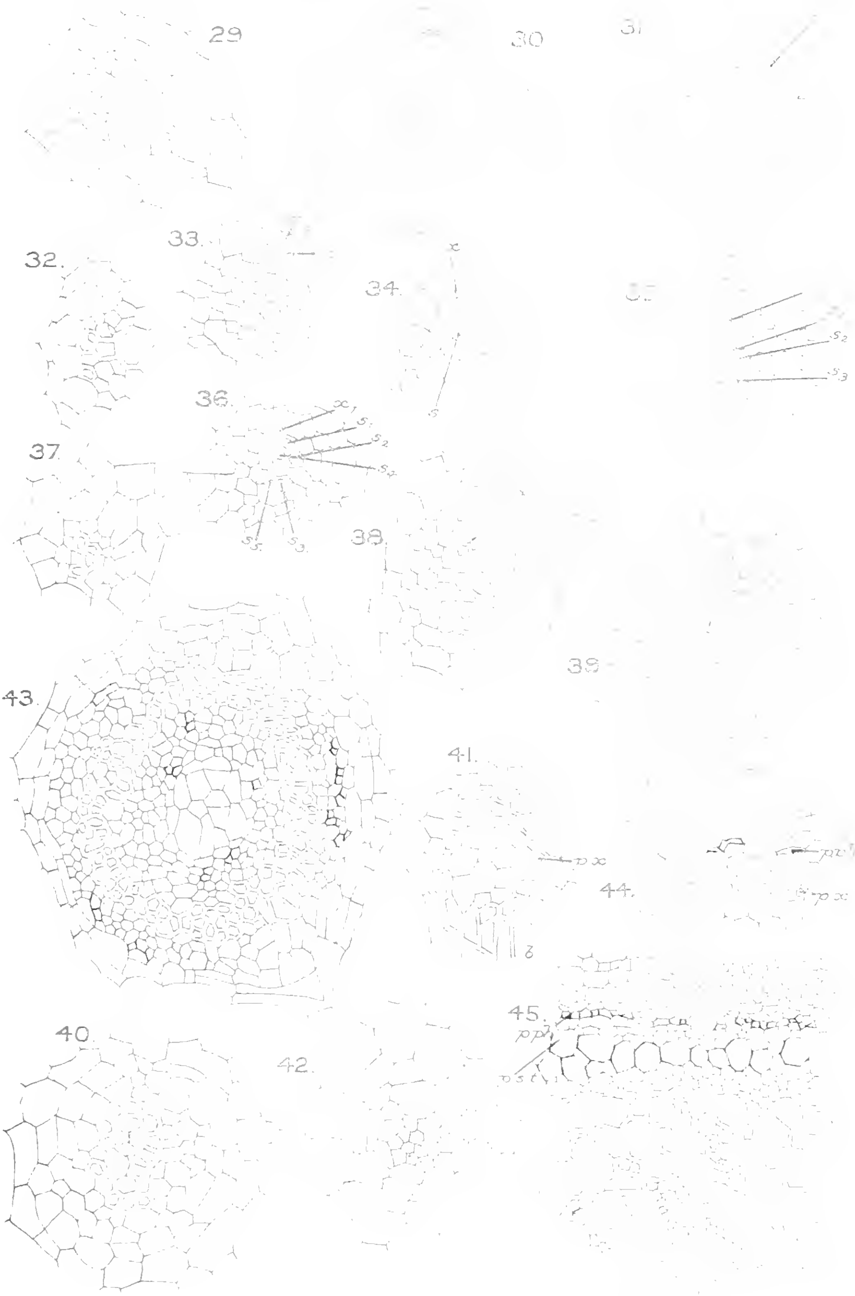

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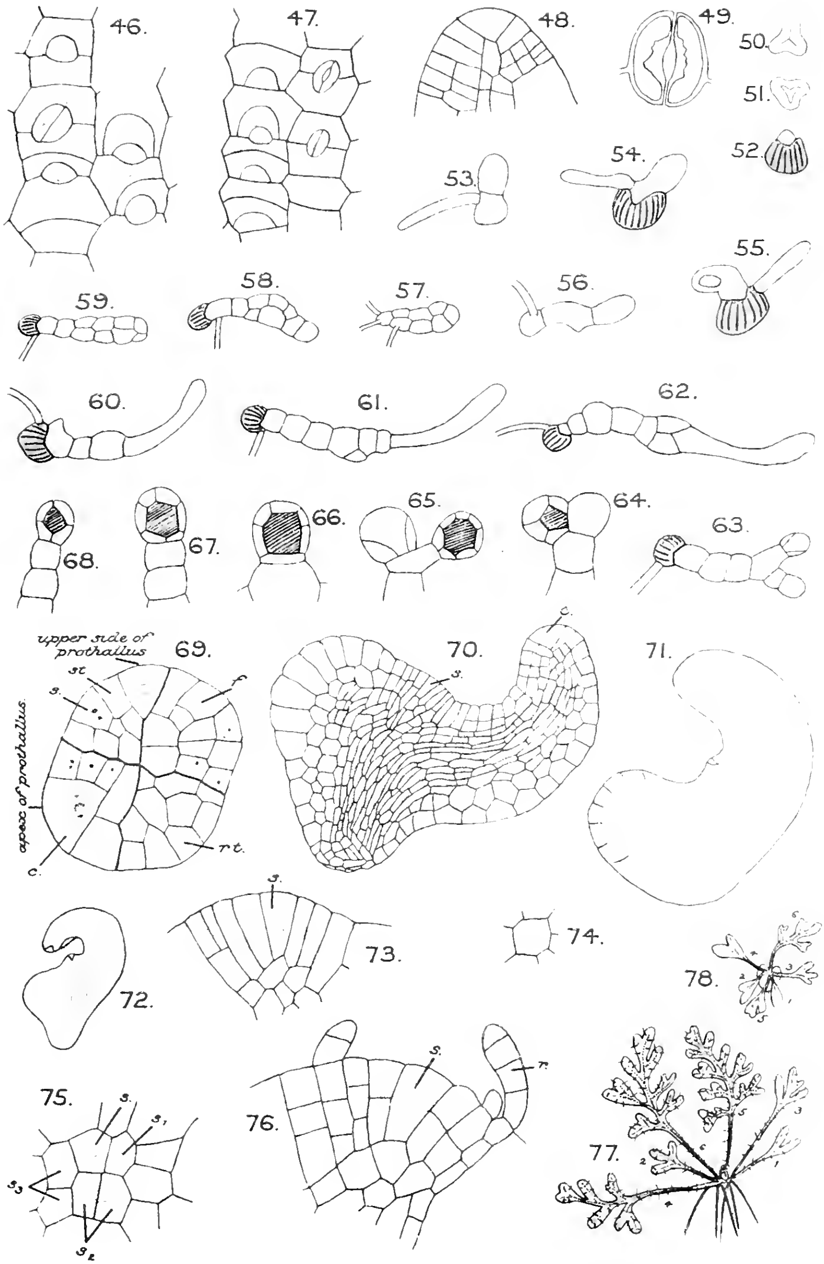

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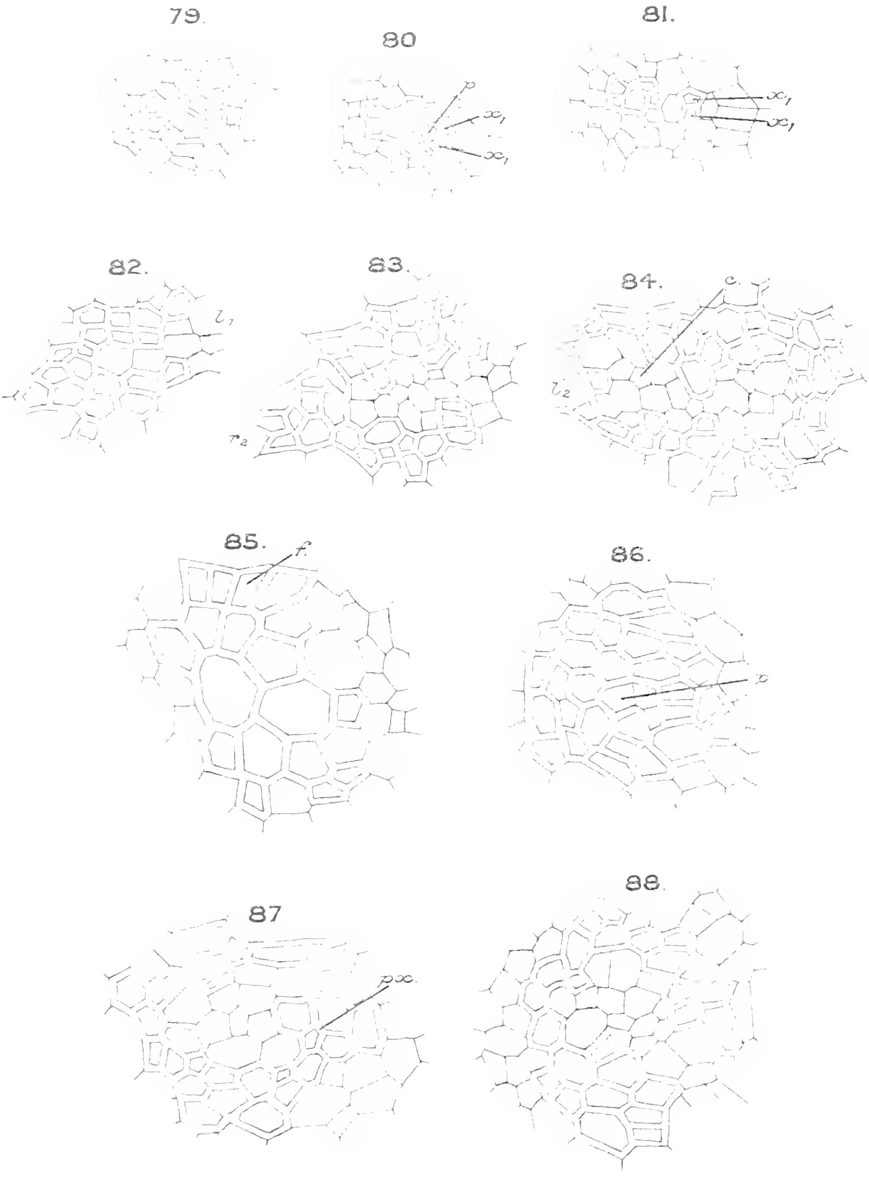

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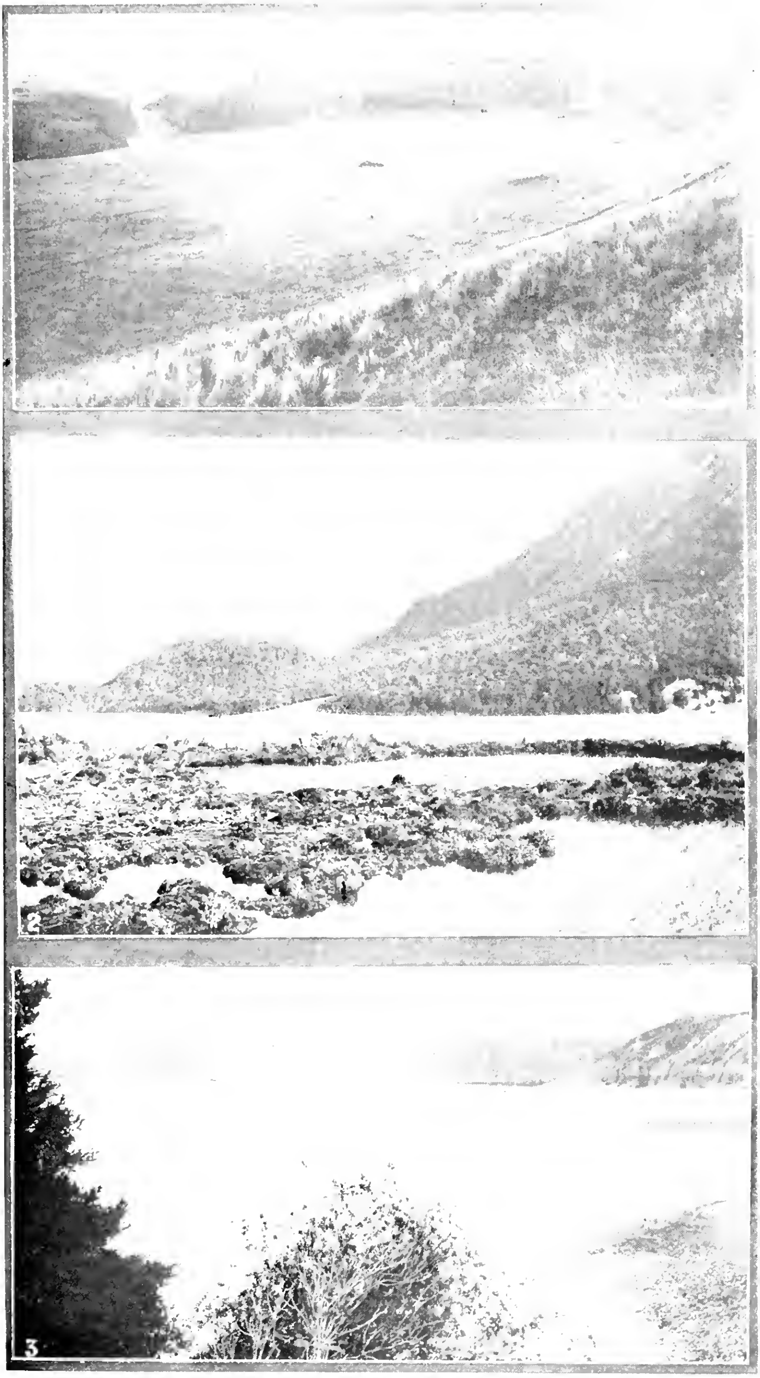

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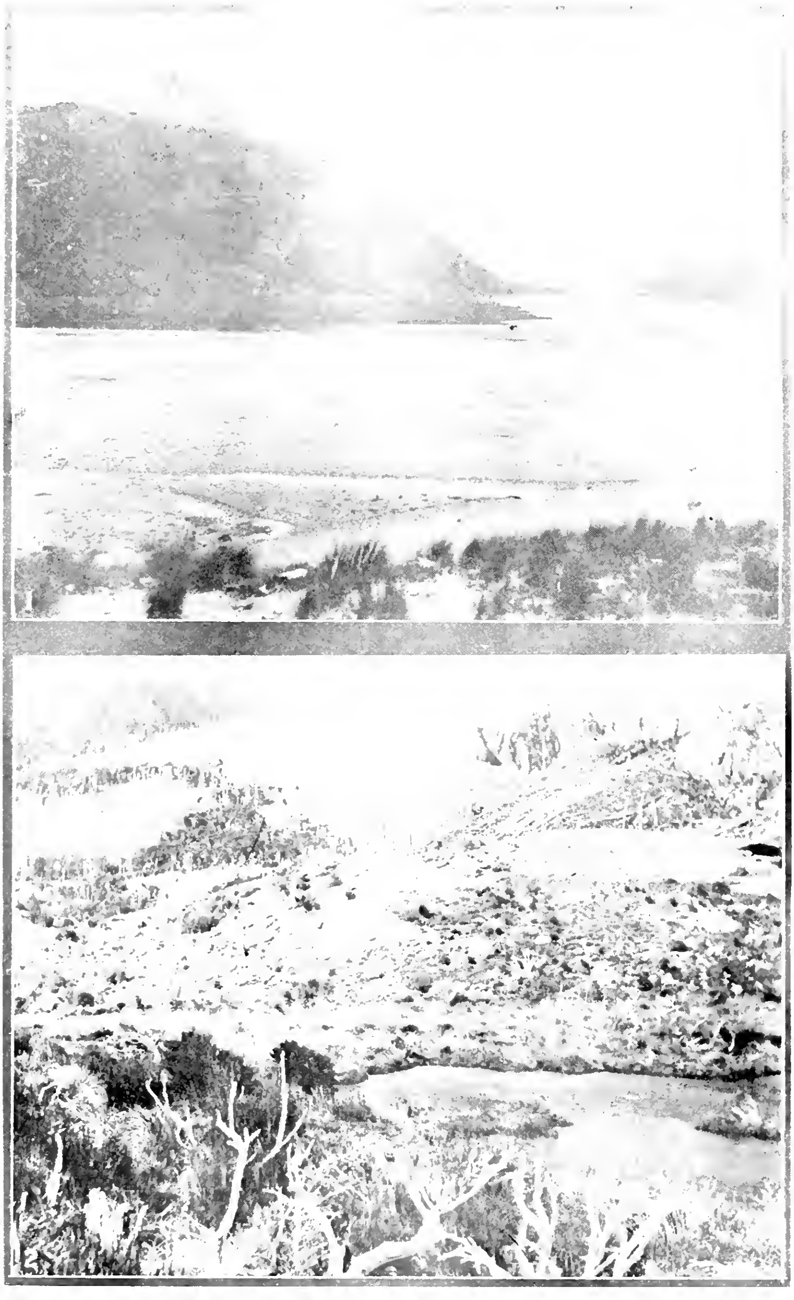

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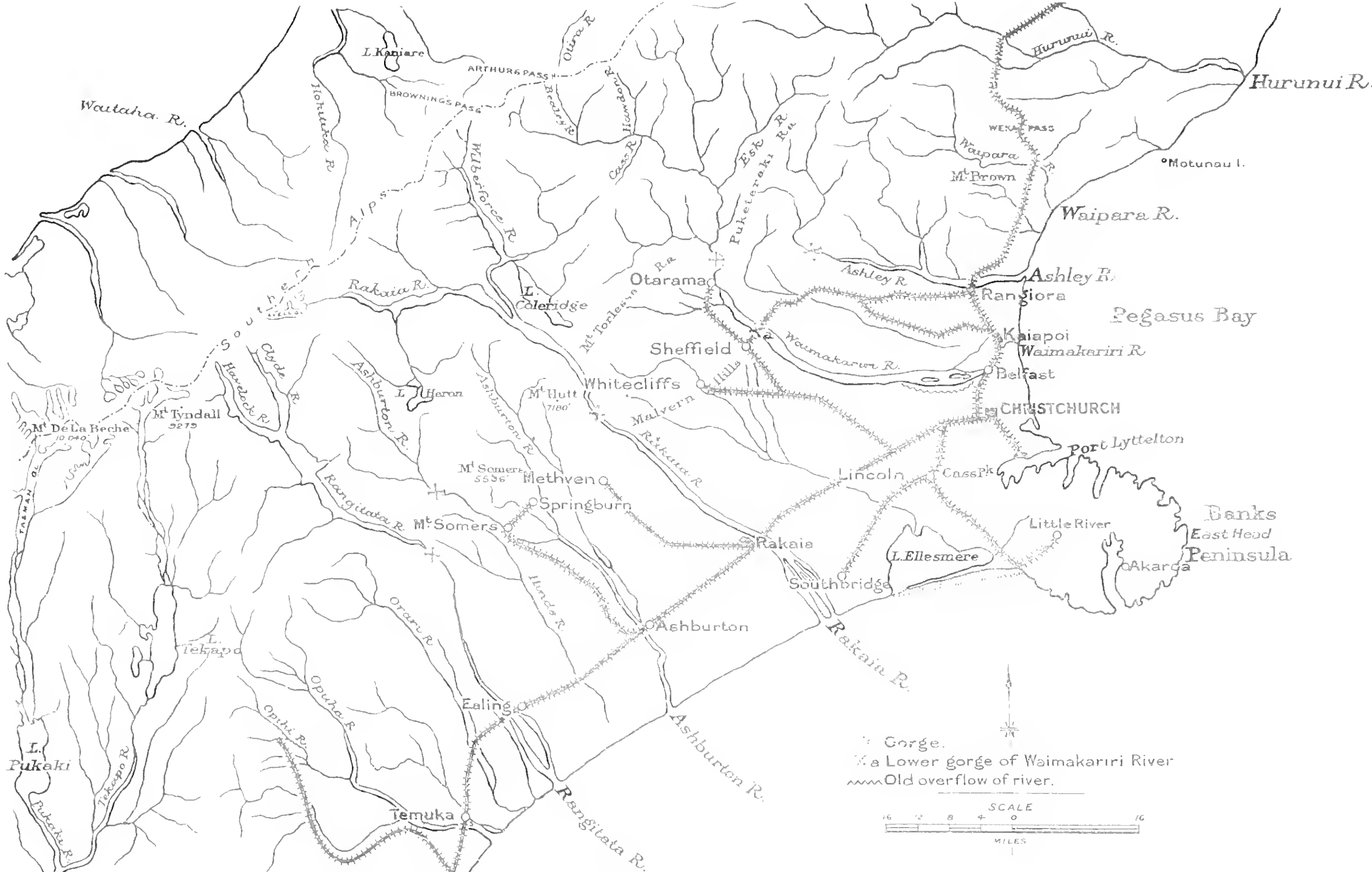

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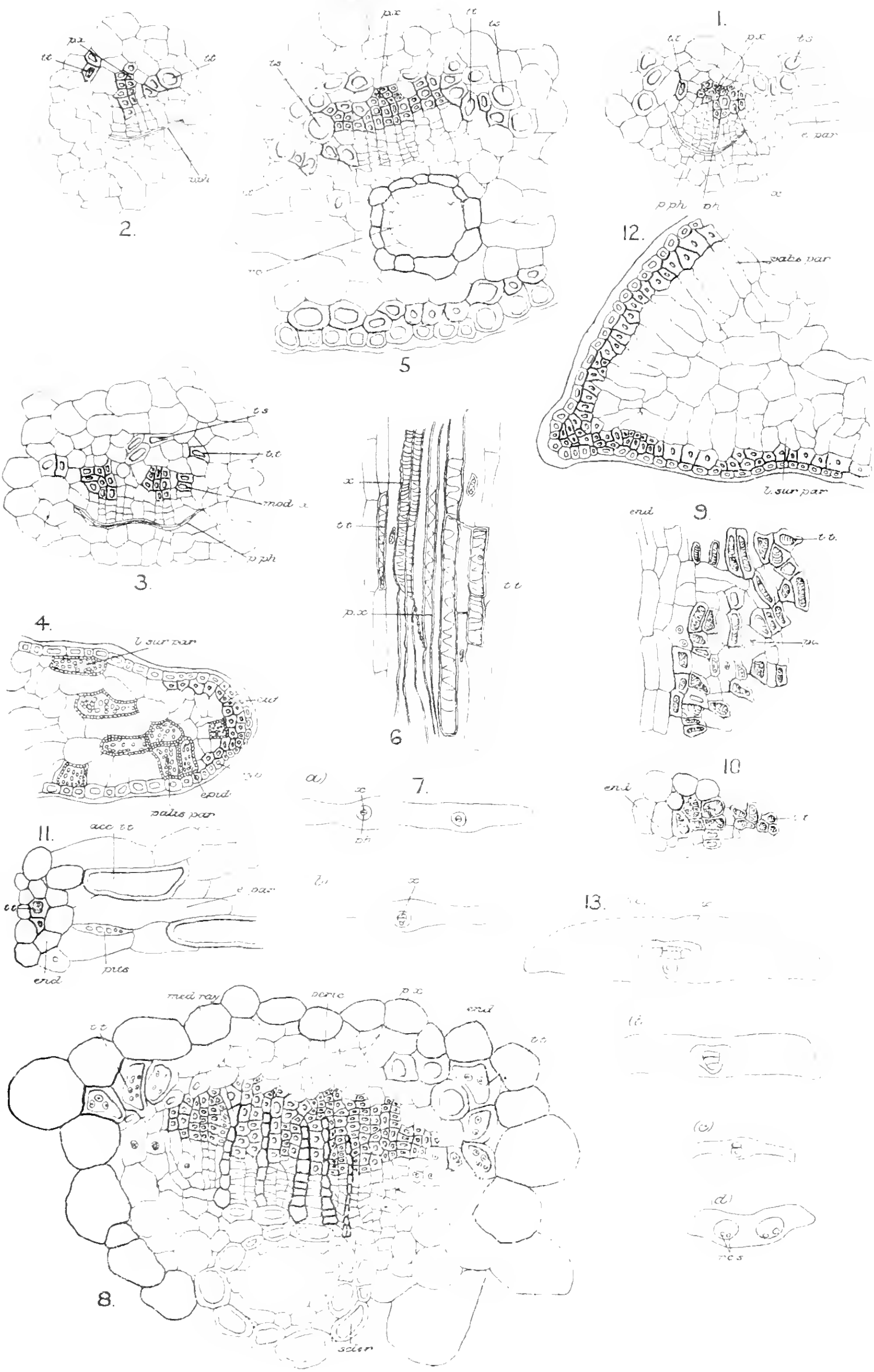

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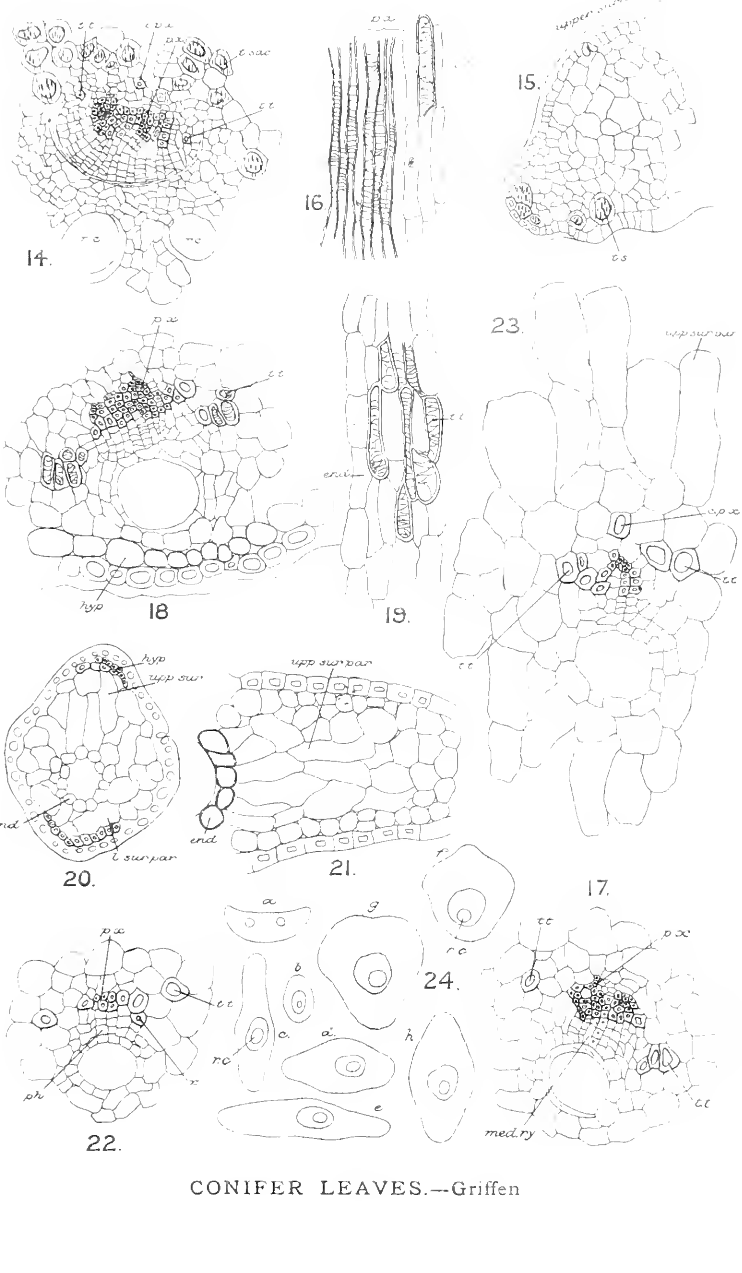

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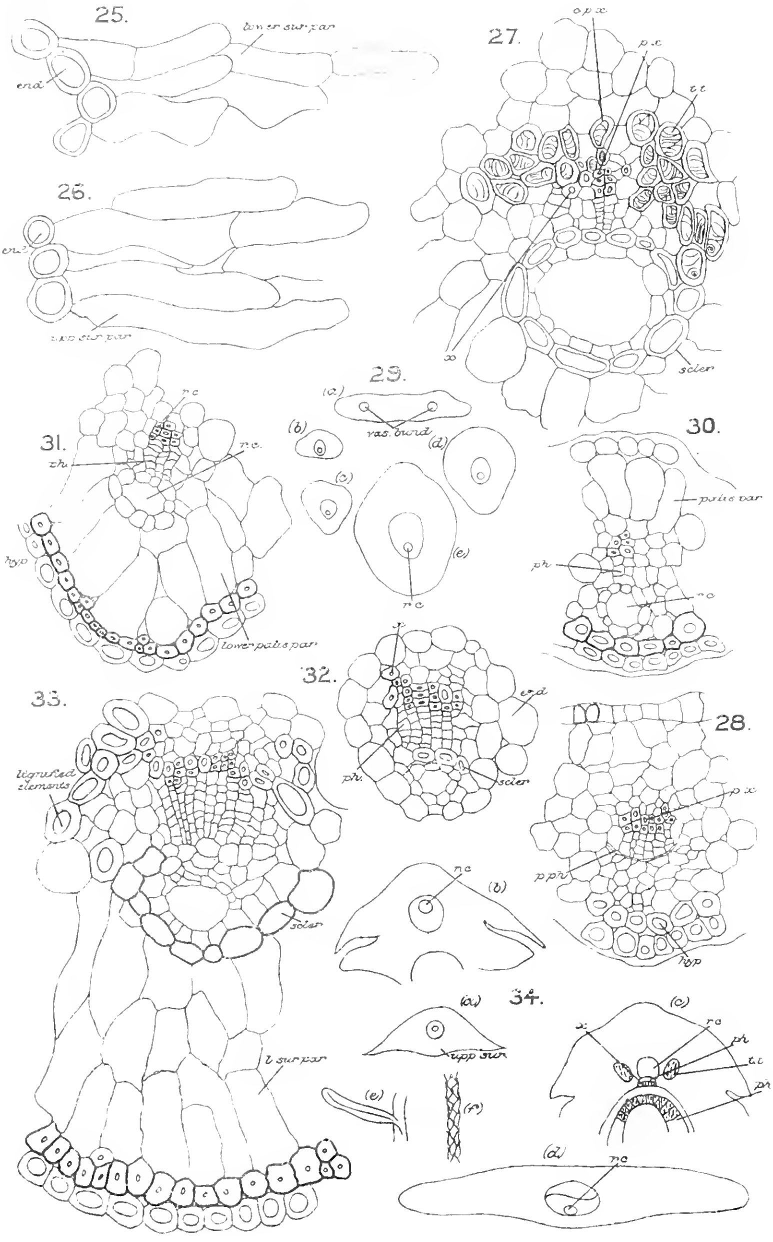

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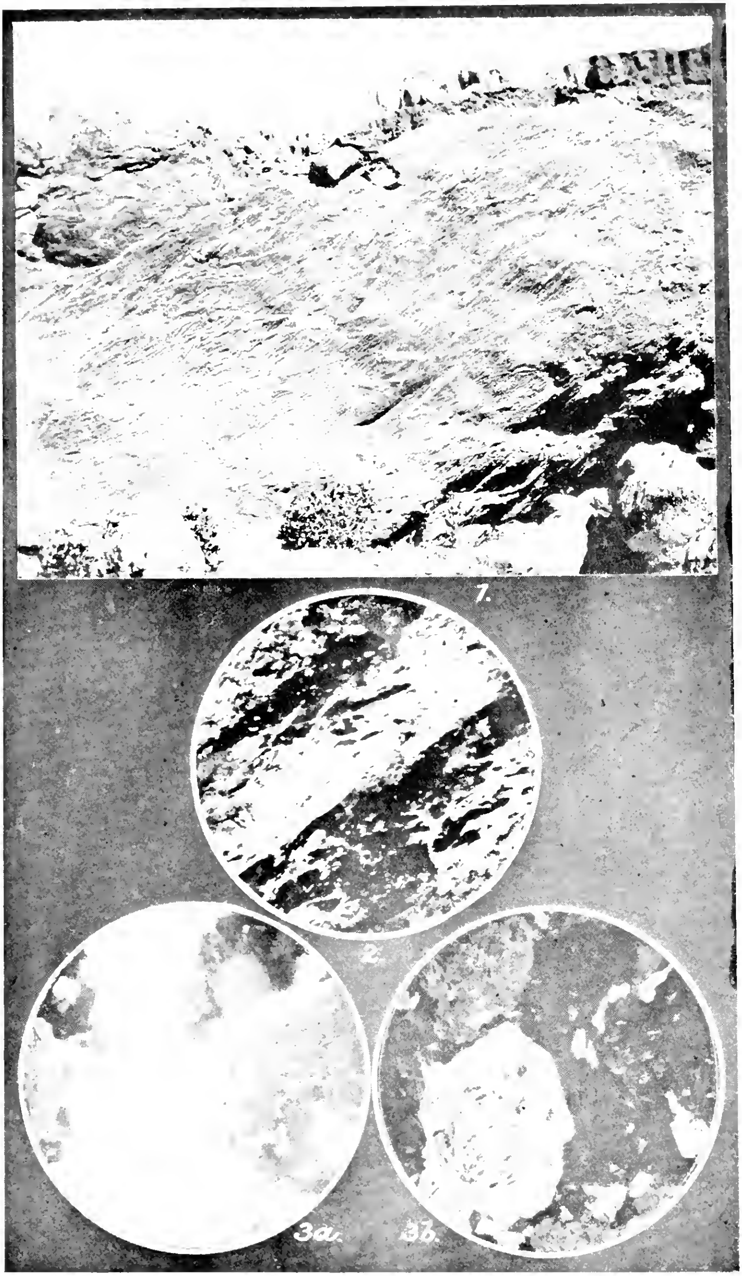

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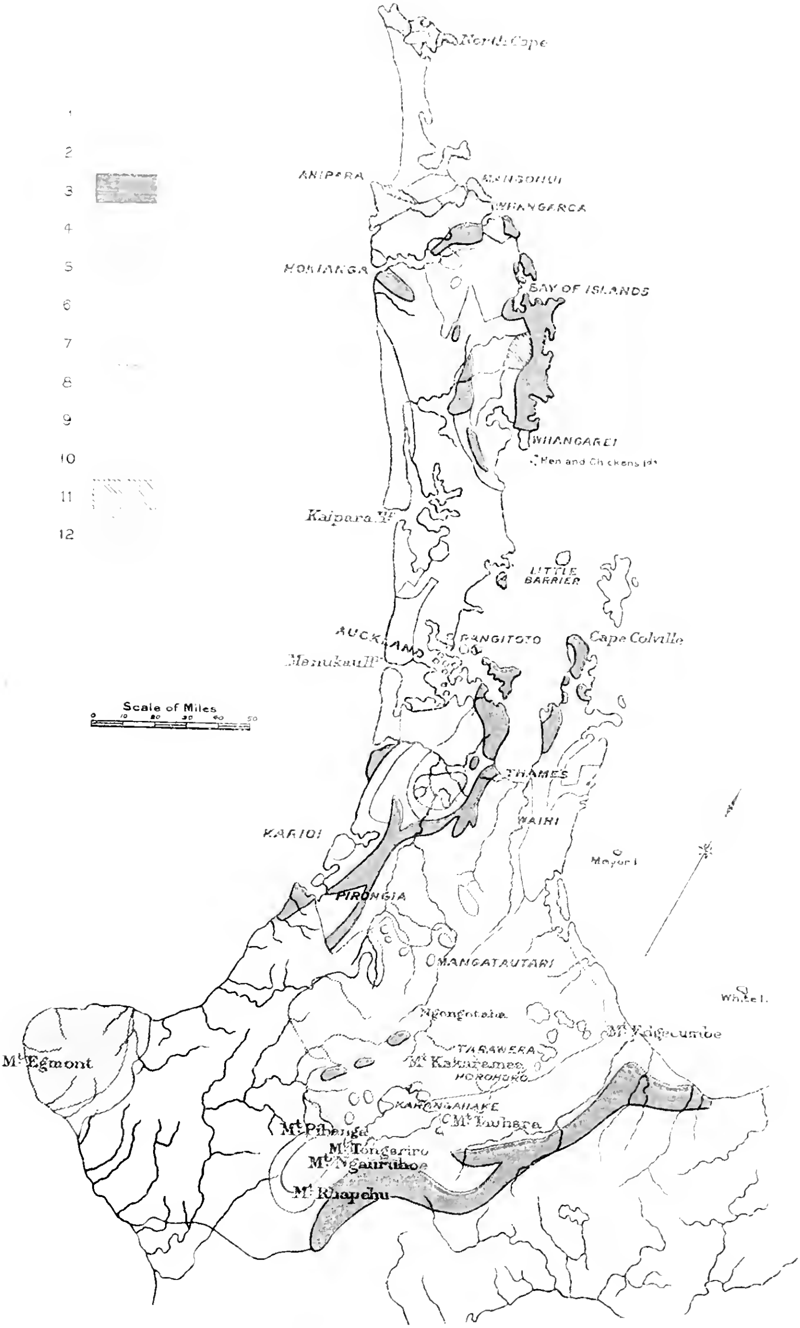

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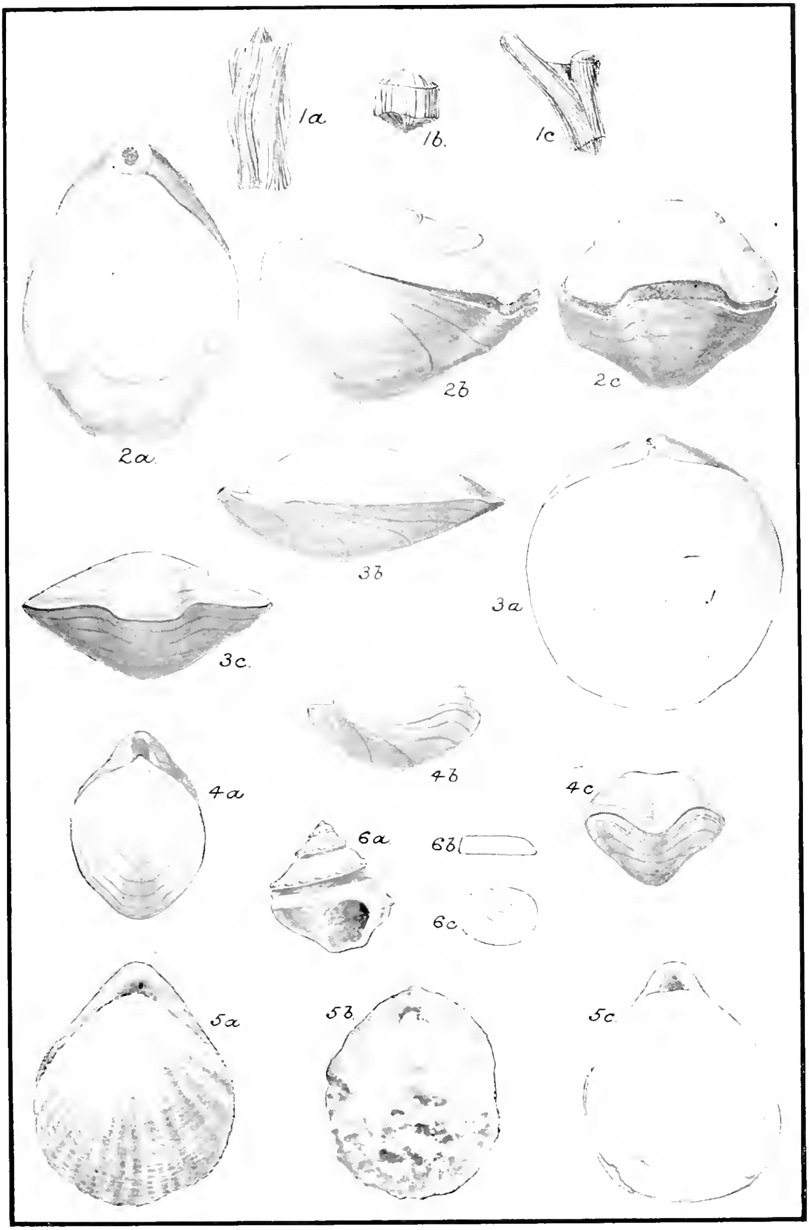

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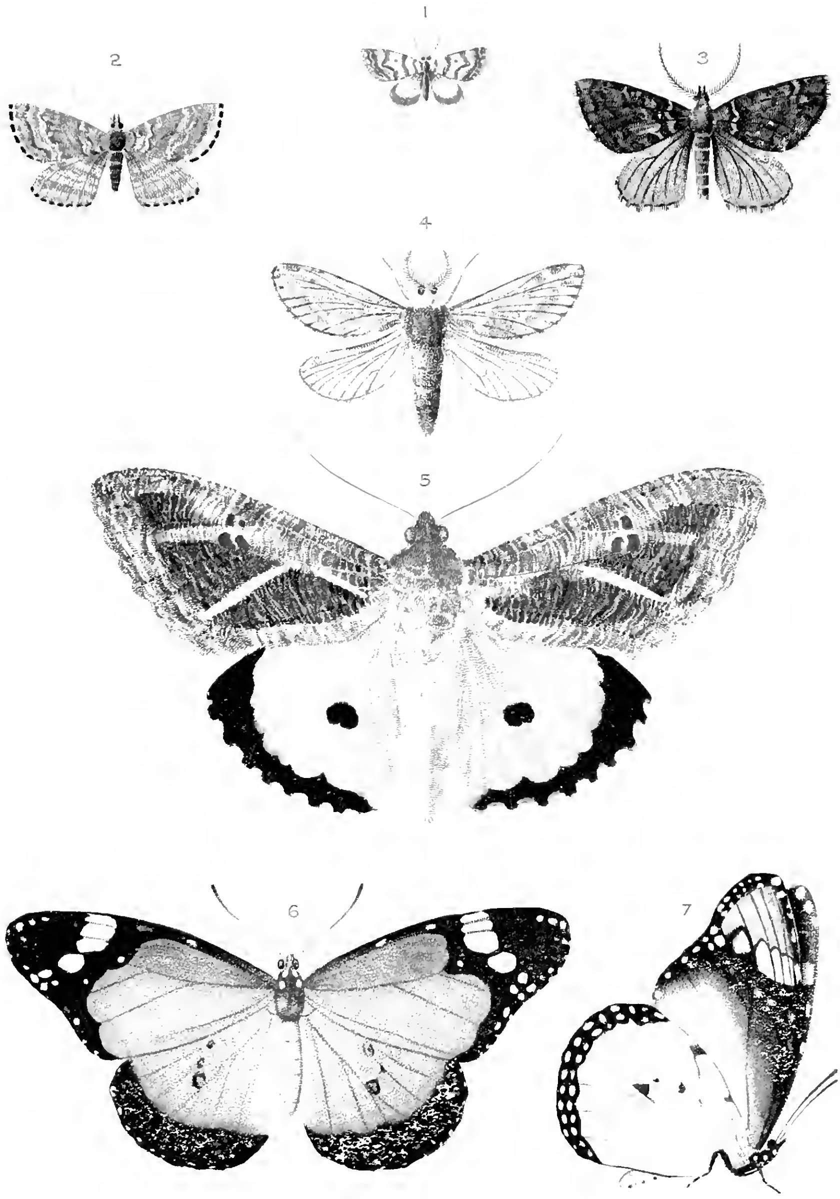

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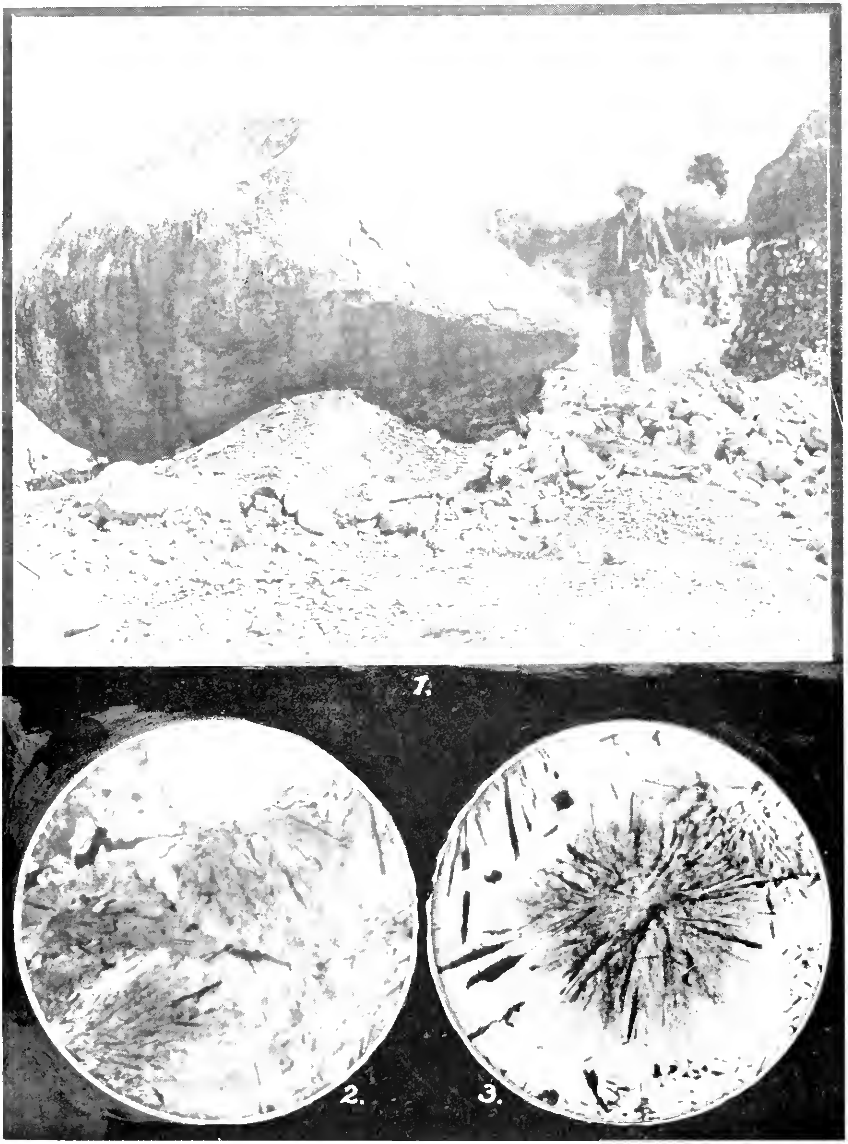

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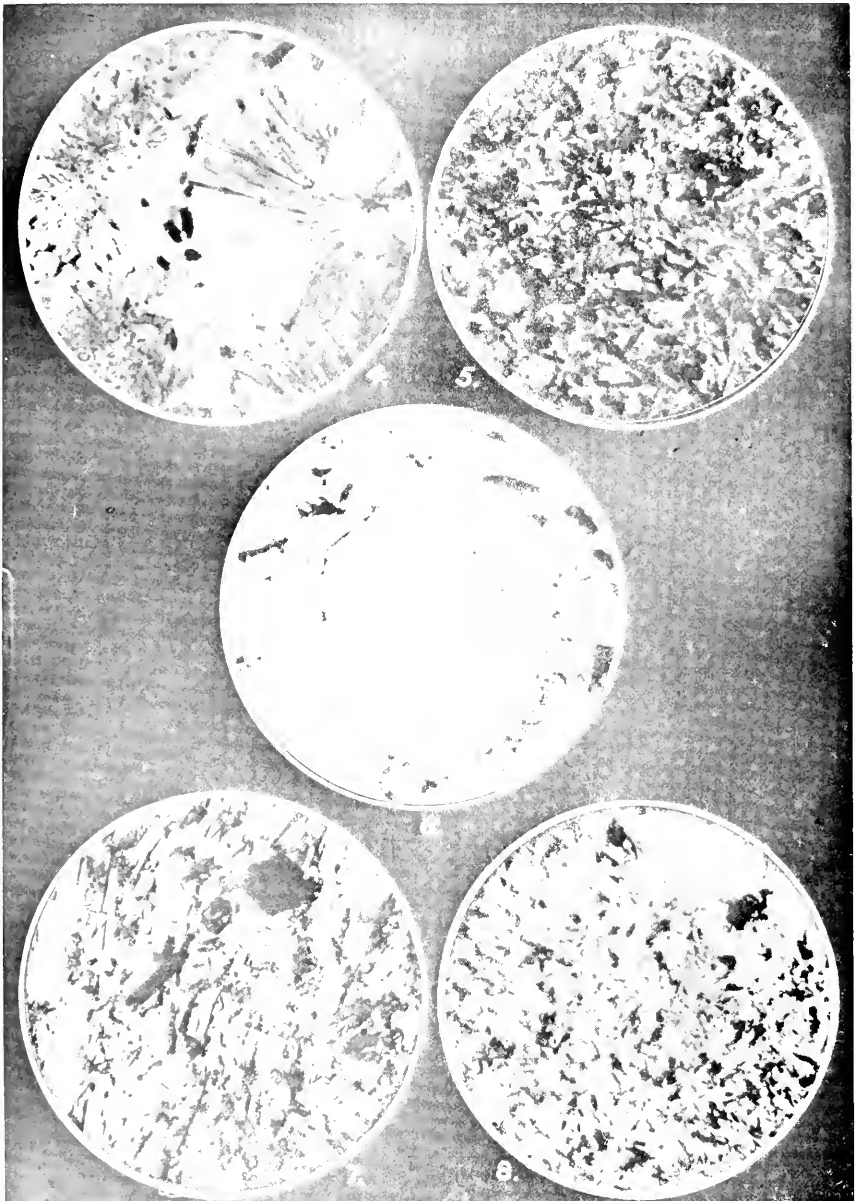

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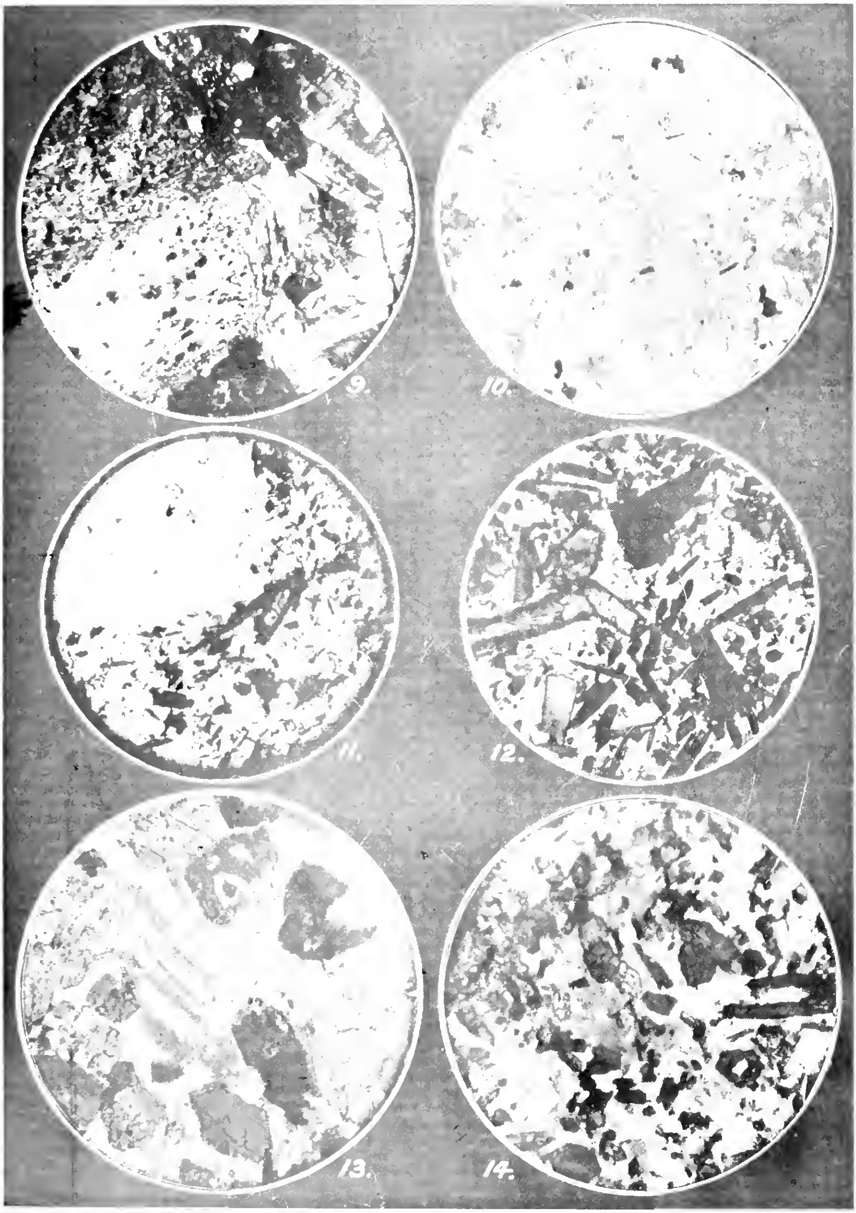

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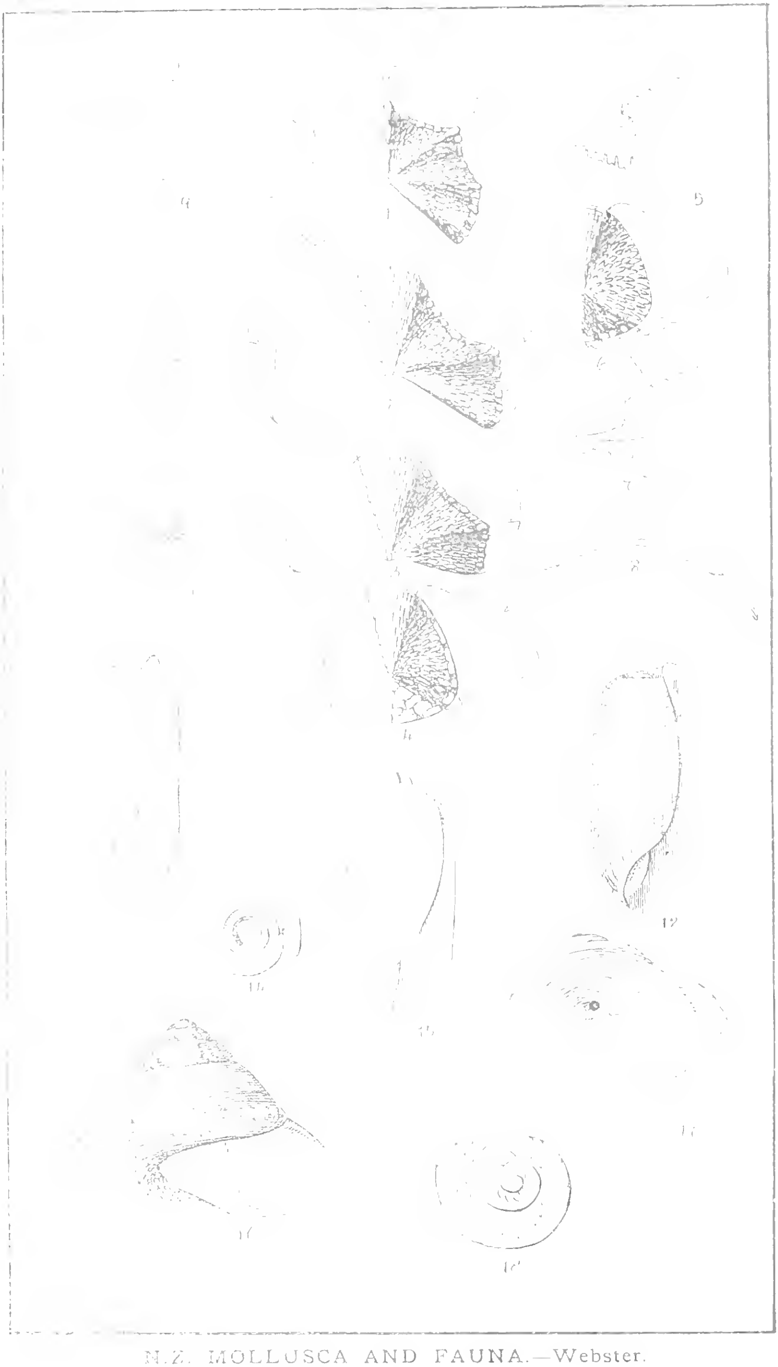

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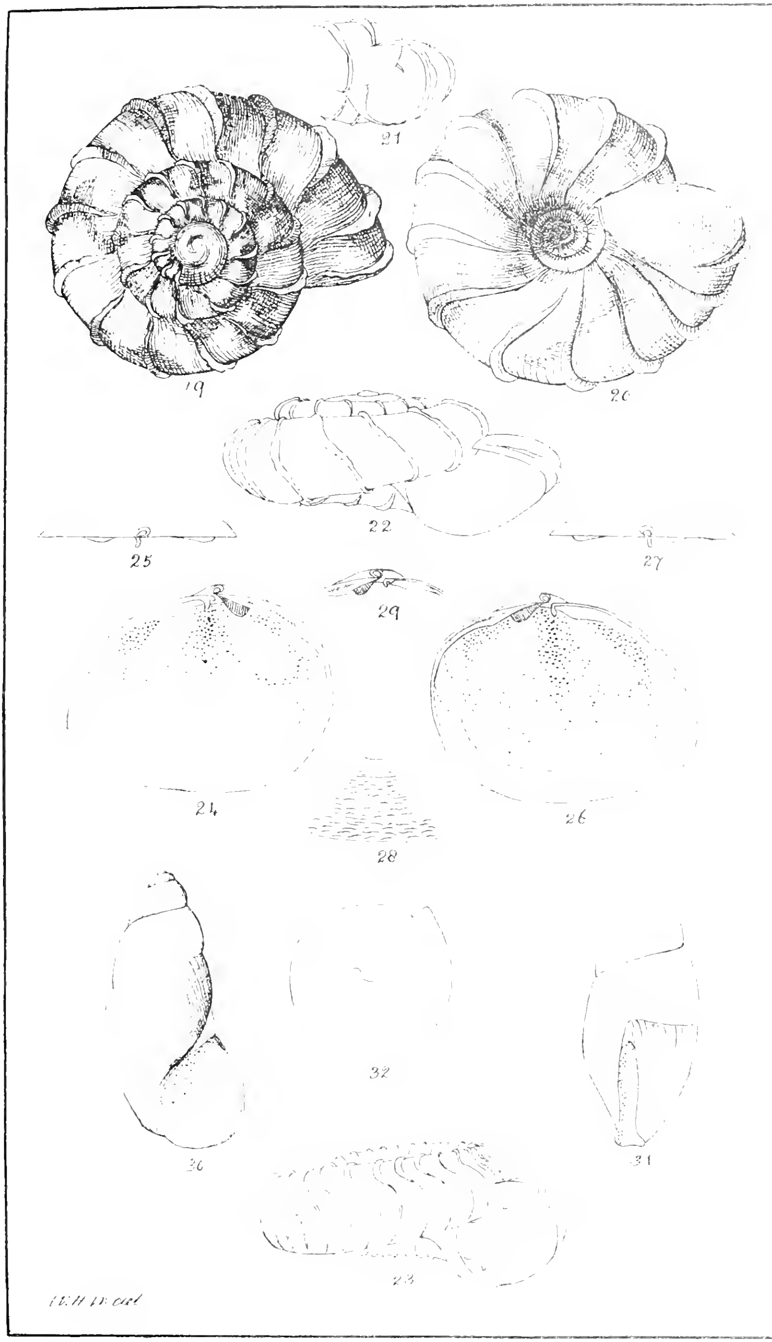

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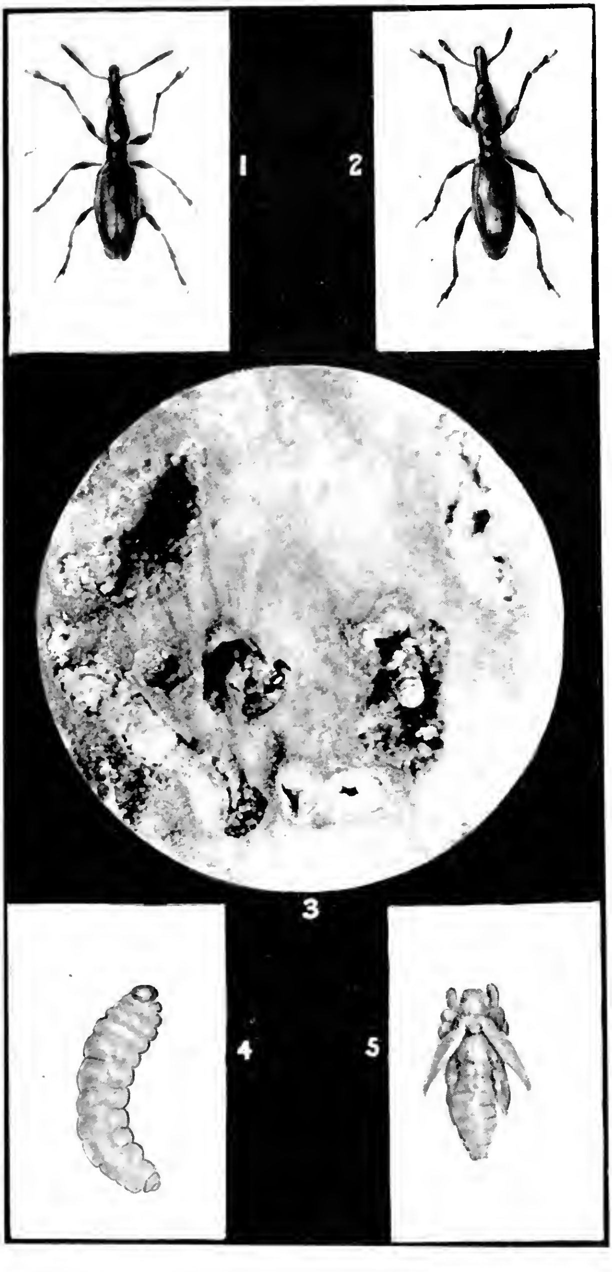

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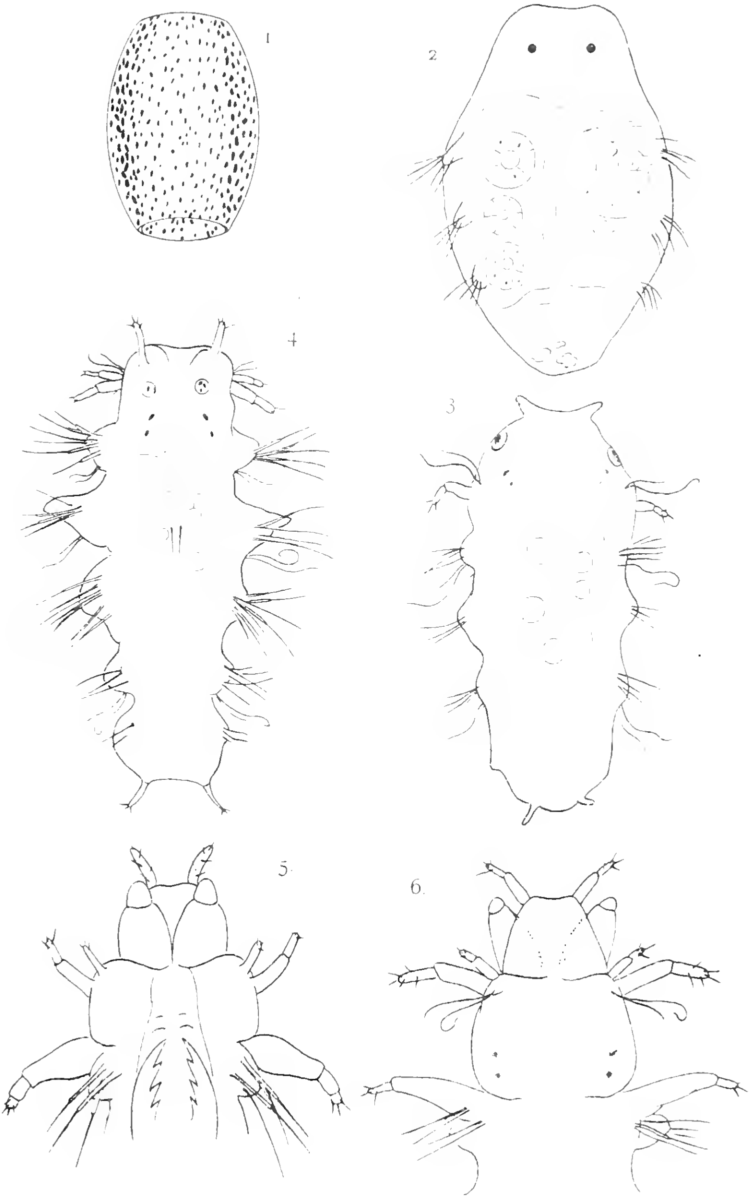

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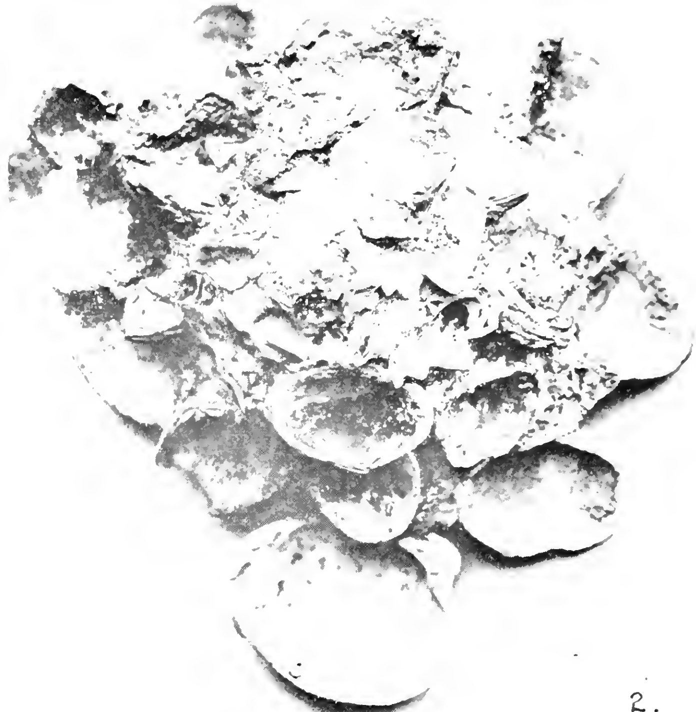

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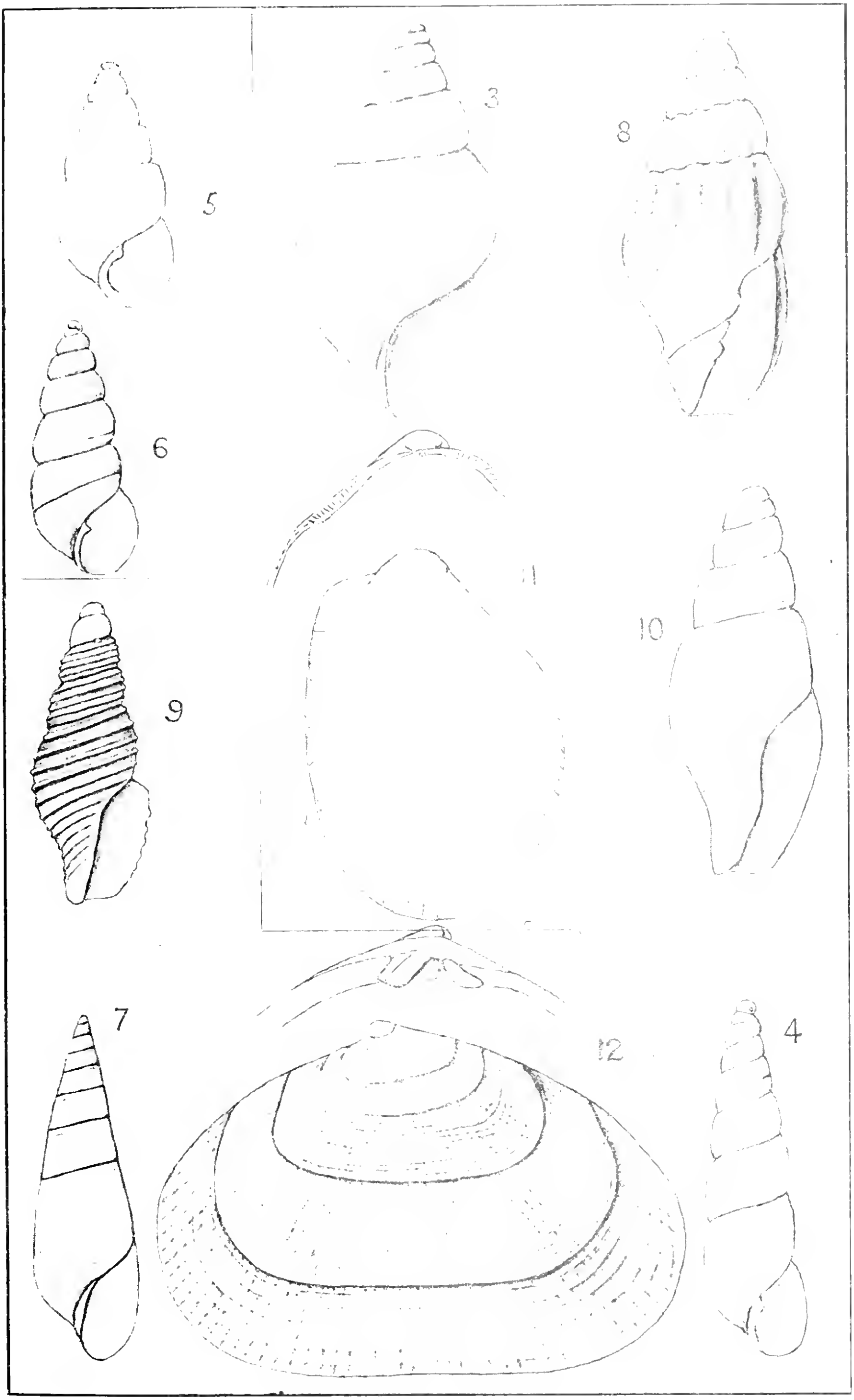

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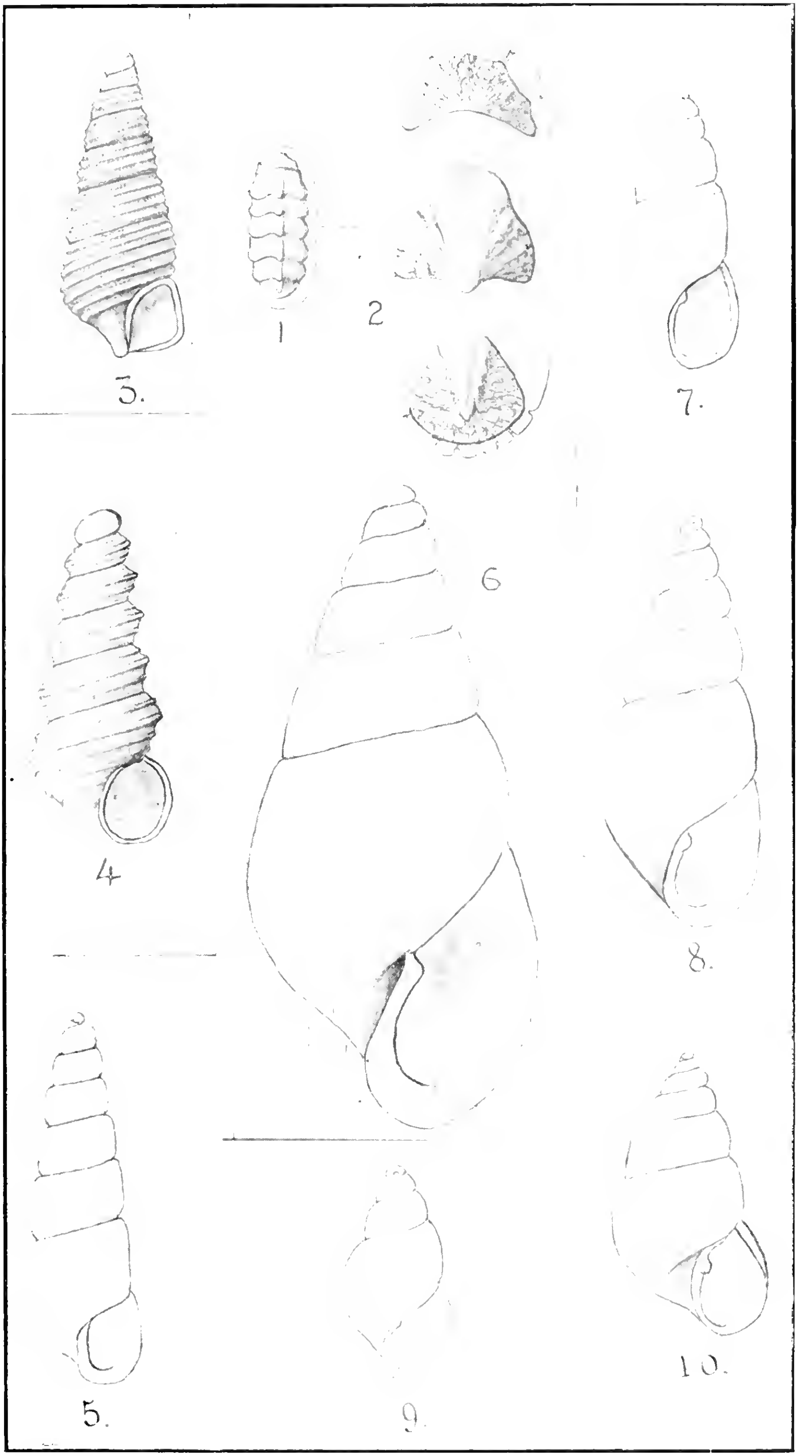

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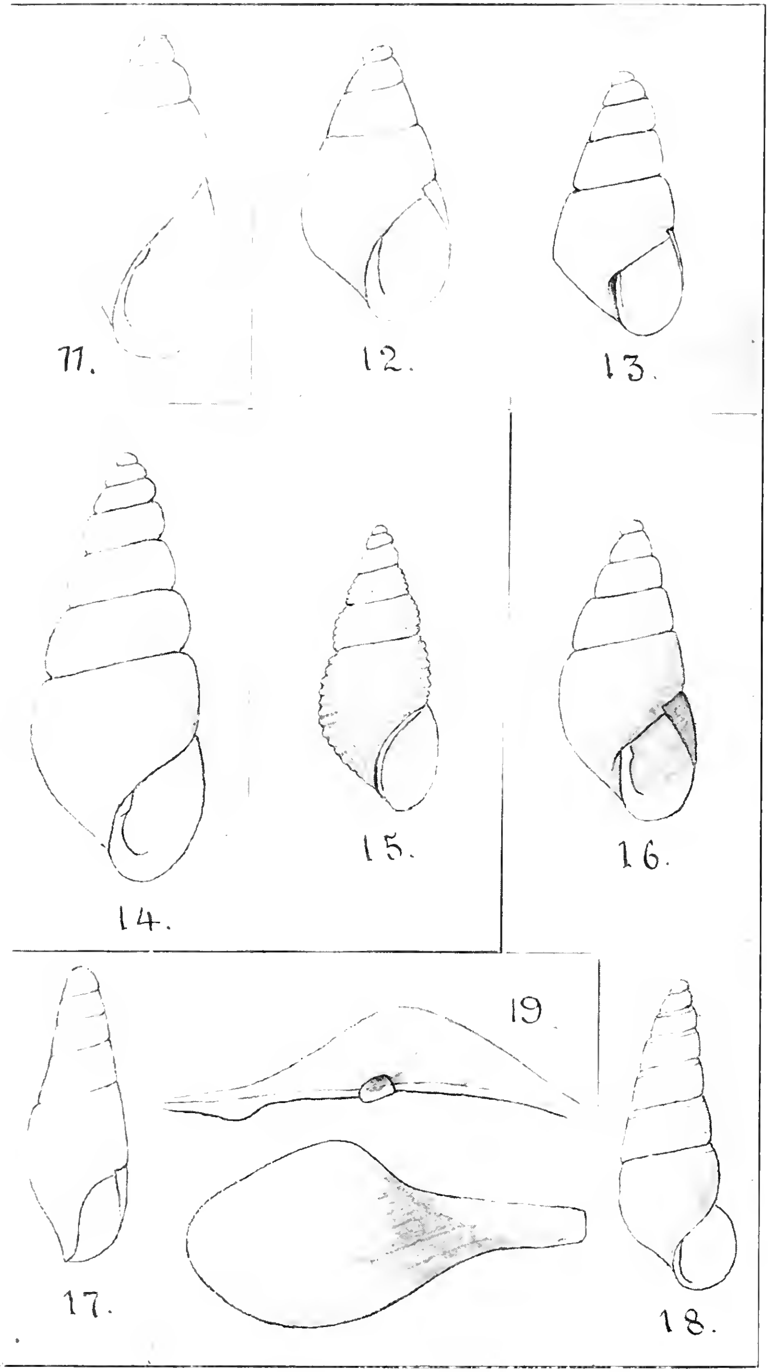

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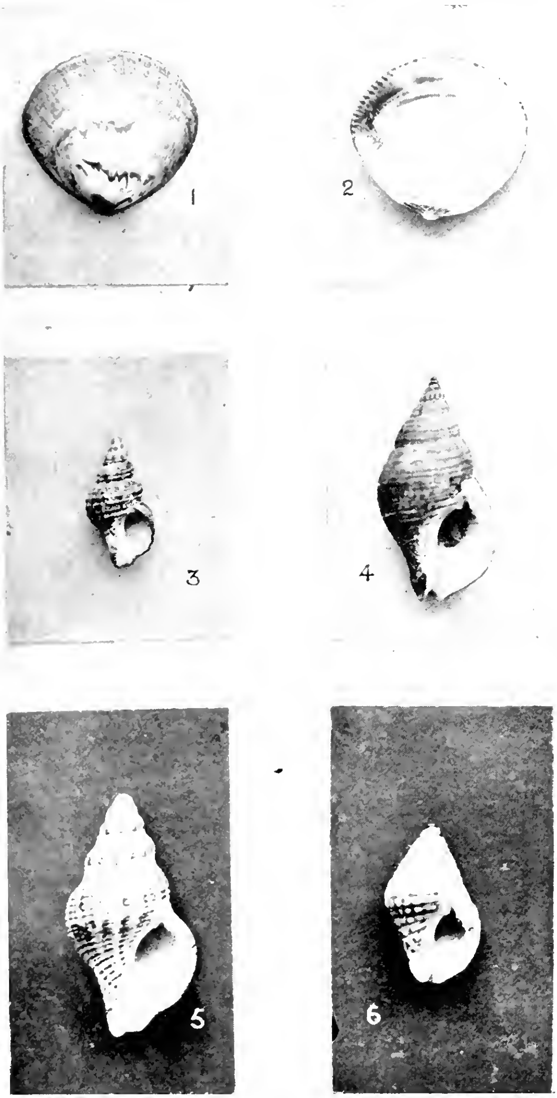

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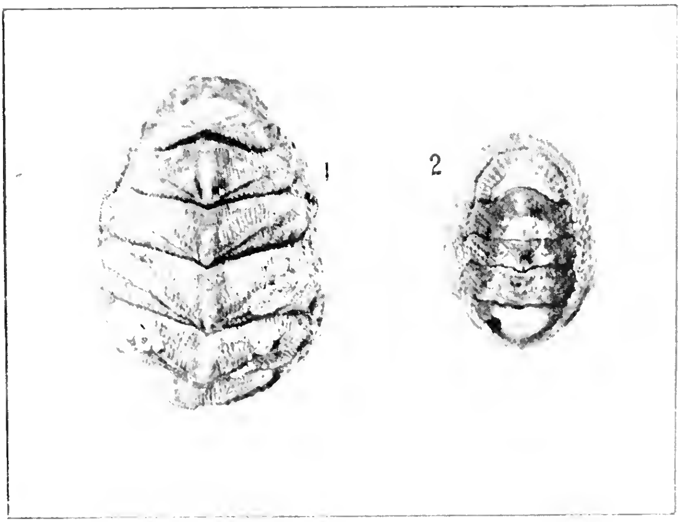

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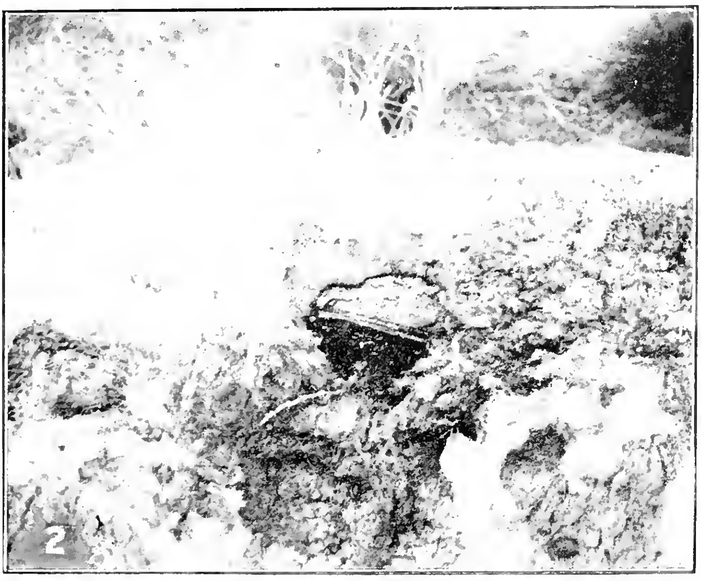

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