TRANSACTIONS

OF THE

NEW ZEALAND INSTITUTE

1908

VOL. XLI

(New Issue)

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

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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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The Hon. the Colonial Secretary.

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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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1871.

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1872.

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1877.

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1880.

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1883.

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1885.

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1888.

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1890.

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1891.

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1894.

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1895.

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1896.

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1900.

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1901.

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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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1908.

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1903–4.

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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.

1909.

Hamilton, Augustus.

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

OF THE

NEW ZEALAND INSTITUTE,

1908.

Art. I.—*On the Nesting Habits of* Rhipidura flabellifera.

By W. W. Smith.

[*Read before the Manawatu Philosophical Society, 19th March,* 1908.]

The native fantails or fly-catchers are, by their abundance and airy and graceful evolutions on the wing when in pursuit of their tiny prey, perhaps the best-known birds at the present time in the New Zealand avifauna. By reason of there being few ornithological observers in the early days of settlement, and the rapid extinction of species proceeding meanwhile, the latter have nearly all vanished without science knowing anything—or, at least, very little—of their nesting habits, or of the respective periods of time occupied during their incubation. Although the late Sir Walter Buller has given a good general history, with very perfect delineations of each species, only in three cases has he referred to their approximate time-periods of incubation. His great industry during his early life in compiling general and accurate histories of all species coming under his observation occupied his full time, and frequently prevented him from observing and noting their several and perfect habits and full periods of hatching. It may therefore be of interest to members of our Society to have complete and accurate notes on the nesting habits of the fantail, from the hour of lacing the first twig on to the forked site of the nest to that of the four young fledglings reared therein leaving it for the first time.

For many years two pairs of these charming little birds have built their nests in Mr. W. Park's garden at "The Wattles," Palmerston North. On hearing of this a year ago, and being much interested, I requested Mr. Douglas Park to observe and make absolutely accurate notes of the brood or broods of young fantails. With kindly and commendable patience and perseverance Mr. Park, jun., daily closely observed and accurately noted all phases of life of the parent birds when engaged nesting.

On the 9th August, 1907, a pair began to construct a nest in the fork of a climbing rose trained on the outside of a summer-house in the shade of native trees. After working earnestly and many hours per day for four days the birds apparently became displeased with their work and discontinued operations. Inside the roof of the summer-house some stems of clematis have grown down through the air-passages and formed a small compact network of growth. On one of these stems the fantails chose a site for a new nest, and immediately began to demolish the unfinished structure, and use the same materials with which to rebuild it. "The work of constructing the second nest," writes Mr. Park, jun., "was started on the 14th August, and was finished on the 31st. They laid four eggs—the first on the day they completed the nest, and one on each morning following until the 4th. At 10 a.m. they commenced sitting—each parent taking turns on the nest until the young birds were hatched on the 21st. The young ones were full-fledged and flew away at about 10 a.m. on the 30th September." The time-period of incubation of the New Zealand fly-catcher therefore occupies a full day less than that of any European species of the genus as recorded in the works of British ornithologists.

Whilst engaged dismantling the partially finished nest, and utilising the materials with which to build the new one in the dome of the summer-house, the birds would alight occasionally on the side of the nest, and, fixing their feet thereon, would use their full strength in drawing asunder with their beaks the tightly and closely woven materials. They displayed great activity at their work, meanwhile uttering notes of apparent instruction and approval to each other. The male performed most of the work of carrying the materials to the new site, while the female did most of the work in building the nest. When the young birds were hatched the parent birds continued to hunt vigorously on the wing for tiny insects with which to feed them. When not hunting on the wing for their own sustenance the parent birds—especially the male—frequently sat close to its mate hatching, and occasionally on the rim of the nest. The habit is practiced by many species of birds, but more especially by those of the group to which the fly-catchers belong. Mr. Park states that the weather, being very wet and boisterous while the nest was in course of building, retarded considerably the progress of their work at it.

On the 16th January last we observed a pair of fantails hunting assiduously and passing frequently into a "lacebark" tree (*Hoheria populnea*) growing on the Victoria Esplanade, Palmerston North. On looking up through the branches I located the nest, which contained three young birds. They remained in the nest until about noon the following day, when they left it and fluttered along towards the extremity of the bough bearing the nest. The weather being hot and calm, they remained sitting near each other for nearly two days, and were well fed meantime by their active parents. On the 21st they separated, and were fed at times for several days after leaving the "lacebark" tree in which they were reared. It was indeed interesting to observe these young fantails flitting gracefully from bough to bough or from tree to tree, as if training and developing their wings, by which they were soon to become self-dependent. These birds are now expert fly-catchers, and belong to a group of about twenty individuals regularly inhabiting the Esplanade and its environs. Nearly all trees of *Hoheria populnea* and its varieties *lanceolata* and *angustifolia*, with *Plagianthus betulinus*, have been extremely floriferous on the Esplanade during the late-early and midsummer months. The great masses of scented white flowers they produce are a great attraction to all classes of insect. On calm days, when insects were plentiful at the flowers, the fantails were generally close to them on the wing, having a royal time subsisting on the numerous small insects, chiefly *Diptera*, passing to and from the flowers. After feeding for several minutes on the wing on the minute flies frequenting the blossoms, the birds would dart through the outer branches, and, resting for a few minutes within them in the shade, would again dart swiftly out in pursuit of their prey as it hove in sight. These graceful little birds possess remarkably quick and clear vision, while their minute and delicate beaks may occasionally be distinctly heard snapping at their prey as they flit near the observer.

When at Tirotiro-moana Valley, in Taranaki, on the 7th August, 1905, I observed a pair of fantails constructing a nest on a limb of tutu-shrub partly overhanging the road formed obliquely along the steep east side of the valley. They were using mosses and lichens chiefly, and, as with the pair studied by Mr. Douglas Park, the male was carrying the materials, while the female wove them expertly and neatly into the nest. For about two minutes during the half-hour I watched them the male assisted in placing and fixing the materials it brought into the structure. They were working with great vivacity and vigour, meanwhile twittering freely to each other. The female seemed to work fretfully, but with perfect precision, and was a little fastidious in the selection of the materials brought by her mate wherewith to build the nest. They were working with great activity when I reluctantly left them.

When engaged preparing these notes I received an interesting letter from Mr. D. Sinclair, C.E., of Terrace End, Palmerston North, narrating a remarkable experience with a fantail's nest, which I have pleasure in reproducing here.

"While I was engineer for the Pohangina County Council," writes Mr. Sinclair, "I was using a slasher cutting a line through the bush. In doing so I cut a small branch of a rather bushy tawhara, which often grows on the side of a tree-fern. The branch fell from the slasher upside down, when I noticed a fantail's nest, and, to my surprise, found that the bird was on the nest, and, although it was upside down, the bird was clinging so tenaciously to the nest that it prevented the little eggs (four in number) from falling out. The little bird sat on the nest with its eyes closed, and seemed oblivious to the rough ordeal it was being subjected to. I lifted it partly off the nest to count the number of eggs, when it hustled itself down again in the nest, saying in effect, if not in words, without sound or motion, 'Do what you will with me, I am going to stick to my nest.' Maternity seemed for the moment to outweigh all sense of danger in the little fantail. I carried it a little distance in the bush from where the line was being cut. and inserted the branch in an upright position in the trunk of another fern-tree, with the hope that the fearless little mother would be rewarded in due time with four little fantails."

To Mr. Park, jun., is due the honour of first observing and ascertaining precisely the respective time-periods of nest-building, egg-laying, and hatching of the native fantail fly-catcher, which constitutes a valuable addition to our knowledge of the habits of the species. Though these birds are still fairly numerous, there is some probability of them becoming rarer as the native bush disappears. In parts of the South Island they adapt themselves to wholly altered conditions to those of the native bush during the winter months. On the approach of cold weather in the bush remaining in some of the valleys of the fore hills of other ranges in Canterbury the fantails migrate across the plains and live in the plantations and shubberies around the settlers' homes, until the nesting instinct returns with the warmth of spring, when they again repair to the bush to nest for the season.

The nest of the native fantail ranks amongst the neatest and best-finished of its class, and is an excellent model of bird-architecture. A closer examination of the methods of lacing together the soft mosses, lichens, tiny leaves, and pappus with threadlike tendrils and roots, all collected in the bush, into a beautiful and compact structure, imparting great warmth, further enhances admiration of its instinctive work. The graceful habits and delightful twitterings when flitting through and on the outskirts of our perennially green forests in pursuit of minute prey are likewise some of the more pleasing scenes of native bird-life to be seen and enjoyed in this beautiful country. No words or language could adequately express the feelings of regret of the true naturalist and nature-lover to know that already, within the period of fifty years of settlement in New Zealand, some of the most remarkable species of birds man has seen or science known have vanished for ever from our green forests, grassy plains, and reedy swamps, which almost everywhere existed in their full native beauty when European settlement began.

It may be of interest to note some of the sites on which nests of the fantail have been observed in the North Island:—

1. On the matipo-tree (*Myrsine Urvillei*) in Mr. Park's garden, Palmerston North; September, 1905.

2. On a mahoe (*Melicytus ramiflorus*) at Hawera; October, 1905.

3. On a tutu-shrub (*Coriaria ruscifolia*) at Tirotiro-moana, Taranaki; 7th August, 1905.

4. On a *Magnolia grandiflora* in Mr. Park's garden, Palmerston North; October, 1906.

5. On a young totara (*Podocarpus totara*) in Mr. Barton's garden, Fareham, Featherston; October, 1907.

6. On clematis inside roof of summer-house in Mr. Park's garden, Palmerston North: August and September, 1907.

7. On *Hoheria populnea*, Victoria Esplanade (an area of native bush); January, 1908.

8. On tawhara (*Freycinetia Banksii*), on trunk of fern-tree, Kimbolton bush; no month or year given. (Mr. D. Sinclair.)

9. On tutu (*Coriaria ruscifolia*), Pakekura Park, New Plymouth; October and November, 1906. (W. Pycroft.)

Having in view the rapid and inevitable passing of the native birds, it invariably seems to me to be the bounden duty of observers of the present time to place on permanent record all facts respecting them, for the information and delight of generations who are to follow us. To me there is no ornithological subject more urgent. The remark would also apply to many remarkable species belonging to other groups of the New Zealand fauna, and to many rare species of plants, now threatened with extinction.

Art. II.—*Notes and Descriptions of New Zealand* Lepidoptera.

By E. Meyrick, B.A., F.R.S., F.Z.S.

Communicated by G. V. Hudson, F.E.S.

[*Read before the Wellington Philosophical Society, 6th May, 1908.*]

I am again indebted for the material of these notes to the energetic assistance of my valued correspondents, Mr. G. V. Hudson, of Wellington, and Mr. A. Philpott, of Invercargill.

Caradrinidæ.

Leucania phaula, Meyr.

L. neuræ, Philp. (Trans. N.Z. Inst., 1904, 330), is a synonym of this species. Mr. Philpott kindly sent me two examples of his species, himself suggesting that it might be identical with my *phaula*, and this is undoubtedly the case.

Plusiadæ.

Plusia transfixa, Walk.

Mr. Hudson sent me several examples of this species from the Thames district. It is common and widely distributed in eastern Australia, where it is undoubtedly native; it has not been hitherto recorded from New Zealand, and may perhaps have only recently succeeded in introducing itself. The species of this genus are strong and bold fliers, and can cross wide seas.

Hydriomenidæ.

Eucymatoge anguligera, Butl.

♂ ♀. 32–37 mm. Head and thorax whitish-ochreous, partially sprinkled with brown-reddish; thorax with an irregular transverse anterior reddish-fuscous or dark-fuscous line. Abdomen whitish-ochreous sprinkled with brown-reddish, with a bar of blackish suffusion on apex of second segment, and sometimes a double dorsal series of blackish dots. Forewings triangular, costa posteriorly moderately arched, apex obtuse, termen bowed, oblique, strongly waved; pale brownish-ochreous, with numerous waved ferruginous-brown striæ, tending to be somewhat marked with black on veins and costa; median band somewhat paler through obsolescence of striæ, limited by groups of striæ more distinctly marked with black, anterior curved, posterior rounded-prominent beneath costa and in middle, latter prominence suffused with blackish; an oblique subapical patch of darker brown suffusion, its upper edge defined and running from above median prominence to apex: cilia pale ochreous mixed with brown-reddish, basal half sprinkled with dark fuscous. Hindwings with termen rounded, irregularly waved-dentate; colour and striæ as in forewings, but prominences of median band nearly obsolete; a blackish discal dot; cilia as in forewings.

Invercargill, common on flowers of *Senecio* in March (Philpott); two specimens. Much like *gobiata*, from which it may be certainly distinguished by the much more strongly waved termen of both wings; *gobiata* is also rather smaller, whiter-irrorated, with straighter striæ, lower half of anterior margin of median band and oblique streak from apex forming distinct black lines. I formerly quoted Butler's name erroneously as a synonym of *gobiata*.

Xanthorhœ adonis, Huds.

Having received two fine specimens from Mr. Philpott, I am satisfied it is a good species, and readily distinguished from *beata* by the colour of the hindwings.

Notoreas fulva, Huds. (*Lythria fulva*, Huds., Trans. N.Z. Inst., 1904, 357.)

According to two ♀ specimens communicated by Mr. Hudson, this species is a true *Notoreas*.

SELIDOSEMIDÆ.

Selidosema leucelæa, n. sp.

♂ 30–32 mm., ♀ 27–30 mm. Head white or ochreous-whitish, somewhat mixed with grey and dark fuscous, anterior half of crown in ♂ suffused with ochreous. Antennal pectinations of ♂ : *a*, 9 ; *b*, 6. Thorax whitish, anteriorly irregularly marked with blackish, and in ♂ partially suffused with brownish-ochreous. Abdomen whitish-ochreous tinged with grey. Forewings triangular, costa somewhat bent beyond middle, termen rounded, somewhat oblique; white, more or less strewn with black or in ♂ brownish specks and strigulæ; in ♂ the whole wing is more or less suffused with grey or olive-brown, except a straight white fascia (usually interrupted in middle) before subterminal line, and more or less of dorsal area towards middle, and there is usually a broad streak of brown suffusion beneath costa and another along termen, in ♀ there is no brown colouring, but sometimes some grey suffusion; basal area more or less marked with blackish; first and second lines more or less indicated by white marks, enclosed between thick blackish more or less interrupted waved lines, first obtusely angulated above middle, second nearly straight, sinuate near dorsum; median cloudy, blackish, sinuate, interrupted; discal spot transverse-linear, black, beyond median line; subterminal line slender, waved, white, partially edged anteriorly with blackish suffusion, and followed by grey or brown suffusion: cilia grey, barred in ♂ with brownish, in ♀ with white. Hindwings pale whitish-ochreous, sometimes tinged with grey, sometimes darker posteriorly; a grey discal dot; two or three waved grey lines sometimes more or less developed posteriorly; a terminal series of blackish-grey crescentic marks: cilia whitish-ochreous, obscurely barred with greyish.

Christchurch, Otira Gorge, Dunedin, Invercargill; from January to March, and in July; seven specimens. I have possessed examples of this species for a long time, but did not feel sure of their status, the species being a very variable one, and allied to other variable species; having now, however, received four very fine specimens from Mr. Philpott, I am satisfied that it is a good species. Mr. Philpott writes that it is usually confused in collections with *productata*; it is, however, nearer *melinata*, from which it differs by the much longer antennal pectinations, less rounded termen of forewings, distinct and unusually straight white posterior fascia, hindwings of ♂ not tinged with fuscous towards base, and other details. *S. productata* is also very variable, but easily distinguished by different form of median band, of which the posterior margin is obtusely angulated rather above middle; in fact, all the allied species could be distinguished by the form of the posterior margin of median band, which is different in each.

Selidosema lupinata, Feld.

S. humillima, Huds., is a synonym of this species, according to specimens sent me by Mr. Philpott, by request of Mr. Hudson.

Pyraustidæ.

Scoparia gyrotoma, n. sp.

♂. 20 mm. Head pale ochreous, sides mixed with whitish. Palpi $2\frac{1}{2}$, grey sprinkled with whitish, white towards base beneath. Antennæ blackish, ciliations $\frac{1}{2}$. Thorax pale brassy-ochreous sprinkled with grey, margins suffused with whitish. (Abdomen broken.) Forewings elongate, narrow, gradually dilated, costa sinuate in middle, apex obtuse, termen slightly rounded, somewhat oblique; light brassy-yellowish-fuscous, suffusedly irrorated with white and sprinkled with dark fuscous; an oblique fascia of blackish suffusion near base; lines thick, suffused, whitish, first rather indented on fold, followed by a fascia of blackish irroration, second slightly angulated above middle, preceded by a fascia of blackish irroration; orbicular and claviform coalescing to form an 8-shaped blotch of blackish suffusion with two whitish centres, confluent with blackish fascia of first line; a smaller 8-shaped discal spot outlined with blackish and filled with whitish, its lower extremity confluent with margin of second line; terminal area irrorated with blackish, subterminal line represented by broad cloudy whitish suffusion not reaching tornus: cilia whitish, with a grey median shade, basal half barred with darker grey. Hindwings $1\frac{1}{2}$, grey-whitish, costa and termen narrowly suffused with light grey; cilia white.

Lake Tekapo; one specimen (Hudson). Allied to *S. asaleuta*, but very distinct.

Scoparia cyptastis, n. sp.

♂ ♀. 17–20 mm. Head grey, more or less mixed or suffused with white. Palpi 3, dark-grey, sprinkled with white above, wholly white towards base beneath. Antennæ dark fuscous, ciliations in ♂ $\frac{1}{3}$. Thorax dark purplish-grey sprinkled with whitish. Abdomen whitish-ochreous, more or less sprinkled with grey. Forewings elongate, narrow at base, oblique; fuscous, variably mixed or suffused with whitish, veins tending to be more or less streaked with dark fuscous or blackish; a black streak on fold from base to first line, interrupted in middle by a white spot; lines thick, white, first curved, little oblique, more or less edged with dark fuscous posteriorly, second slightly curved, indented beneath costa and sinuate above dorsum; orbicular and claviform small, rather elongate, black, orbicular sometimes touching edge of first line; discal X-shaped, black; subterminal line cloudy, whitish, entire, irregular, not touching second line; a terminal series of black marks on veins: cilia whitish, with rather dark fuscous basal and paler median shades. Hindwings $1\frac{1}{3}$, without long hairs in cell; pale whitish-fuscous, with a faint yellowish tinge, termen suffused with fuscous, more strongly in ♀: cilia whitish, with two light-fuscous shades, basal darker in ♀.

Invercargill, common in November (Philpott); three specimens. Belongs to the *cleodoralis* group; not very like any New Zealand species, but probably related to the Tasmanian *plagiotis* and its allies.

Scoparia luminatrix, n. sp.

♂ ♀. 19–22 mm. Head rather dark fuscous, sprinkled with whitish and mixed on crown with yellow-ochreous. Palpi 3, dark fuscous sprinkled with whitish, towards base white beneath. Antennæ dark fuscous, ciliations in ♂ $\frac{1}{3}$. Thorax fuscous mixed with dark fuscous and whitish. Abdomen fuscous, segmental margins ochreous-whitish. Forewings very elongate-triangular, costa slightly arched, somewhat bent posteriorly, apex obtuse, termen rather obliquely rounded; deep ochreous-brown, suffusedly streaked with blackish on veins, especially tending to form a median longitudinal black streak interrupted by lines; first and second lines white, well marked, first curved, waved, little oblique, edged posteriorly with black suffusion, on upper half sometimes broadly, second slightly curved, indented towards costa, and sinuate above dorsum; median band much mixed with white, especially towards second line below middle, where it sometimes forms a conspicuous patch of white suffusion; orbicular and claviform small, round, partially outlined with black, and filled with whitish, sometimes absorbed in black suffusion of first line; discal indistinct, 8-shaped, white, partially edged with black; subterminal line cloudy, whitish, remote from second throughout, indistinctly interrupted above middle: cilia whitish, with two grey shades interrupted by white bars. Hindwings $1\frac{1}{4}$, with long hairs in cell; whitish-fuscous tinged with brassy-yellowish; discal spot, postmedian line, and a terminal fascia indistinctly fuscous: cilia fuscous-whitish, with two fuscous shades.

Invercargill, in October and November; five specimens (Philpott). Rather variable in the development of the black and white scales. A distinct species, somewhat intermediate between *legnota* and *epicremna*.

Crambidæ.

Crambus saristes, n. sp.

♂. 17–18 mm. Head and thorax ferruginous-brown, face prominent, flattened-conical; edge of collar and a spot on shoulders whitish. Palpi $3\frac{1}{2}$, brown mixed with dark fuscous, whitish towards base beneath. Antennæ dark fuscous, pubescent-ciliated ($\frac{1}{2}$). Abdomen dark grey. Forewings elongate, gradually dilated, costa slightly arched, apex obtuse, termen little rounded, rather oblique; bright ferruginous-brown; a slender median longitudinal rather irregular ochreous-whitish streak from base to termen, terminal fifth attenuated and tending to be obsolescent: cilia slaty-grey. Hindwings dark-grey; cilia pale-grey, basal third slaty-grey. Undersurface dark-grey, hindwings sometimes with very slender indistinct median streak of whitish suffusion; costal edge of hindwings whitish-yellowish; all cilia whitish-grey.

Invercargill, in January (Philpott): two specimens. Very close to *heteranthes* from Mount Cook, but that species is darker, median streak of forewings whiter, broader, more regular, forewings on under-surface with dorsum suffused with white, hindwings on under-surface with costa suffused with white towards base, and well-marked white median streak, cilia white towards base. Possibly more extensive material may show this to be a local form of *heteranthes*, but at present it seems better to treat them as distinct.

Crambus aulistes, n. sp.

♂. 16 mm. Head, palpi, and thorax ferruginous-brown, face rounded-prominent: palpi 4, whitish towards base beneath. Antennæ dark fuscous, pubescent-ciliated ($\frac{3}{4}$). Abdomen rather dark fuscous. Forewings elongate, broader than in *saristes*, costa gently arched, apex obtuse, termen straight, rather oblique, rounded beneath; ferruginous-brown; a moderate regular white median longitudinal streak from base to termen, somewhat edged with fuscous suffusion towards middle: cilia pale grey, with darker basal shade, on costa whitish except near apex, with a white bar on terminal extremity of median streak. Hindwings dark fuscous; cilia whitish, basal third fuscous. Under-surface dark grey, forewings much suffused with yellowish towards costa and termen, on dorsum broadly whitish-yellowish, hindwings with costa rather broadly pale ochreous-yellowish, with veins suffusedly streaked with pale yellowish, especially on a median streak, all cilia whitish.

Invercargill (Hudson); one specimen. Distinguished from the preceding by the broader forewings, rather longer palpi and antennal ciliations, white costal cilia, extensive yellowish suffusion of under-surface, and other details.

Crambus melitastes, n. sp.

♂ ♀. 17–20 mm. Head, palpi, and thorax ochreous-brown, in ♀ with a broad dorsal white stripe extending through crown and thorax, face somewhat rounded-prominent; palpi 4, whitish beneath and more or less above, especially in ♀. Antennæ dark fuscous, in ♂ simply ciliated ($\frac{1}{3}$). Abdomen rather dark fuscous, more or less whitish on segmental margins posteriorly. Forewings elongate, gradually dilated, costa hardly arched, apex obtuse, termen straight, rather oblique, rounded beneath; ochreous-brown; a moderate white median longitudinal streak from base to termen, slightly broadest in middle, in ♂ more or less edged beneath with dark-fuscous suffusion, in ♀ broadly edged with dark-fuscous suffusion on both margins except towards base above; in ♀ a narrow irregular white suffused subcostal streak, and broad dorsal or subdorsal white streak narrowed towards base; in ♂ a slender white streak along upper part of termen above median streak, in ♀ a broader undefined patch of white suffusion: cilia in ♂ pale grey, with a white basal streak on upper half of termen, in ♀ almost wholly white. Hindwings rather dark fuscous, with a broad costal streak of whitish-ochreous suffusion from base to $\frac{3}{4}$; cilia whitish-ochreous, in ♂ more or less greyish-tinged, and with a grey basal line. Under-surface wholly light ochreous-yellowish, forewings somewhat infuscated; cilia ochreous-whitish.

Invercargill, in December; three specimens taken by myself, and three others received from Mr. Philpott. I have hitherto confused this species with *æthonellus*, and recorded it under that name, but now see it to be distinct. *Æthonellus*, which is known from Mount Hutt only, has the costal edge of forewings ochreous-whitish, no white streak on upper part of termen or in cilia, hindwings without the pale-yellowish costal patch, but with cilia clear pale-yellowish except basal line, under-surface of forewings suffused with grey except towards costa and on a median streak, of hindwings partly greyish between veins. In five of the seven species of this group—viz., *æthonellus*, *aulistes*, *saristes*, *heteranthes*, and *antimorus*—the antennæ of ♂ are pubescent-ciliated—that is, clothed with short pubescence over their whole surface, but with a row of somewhat longer cilia on one side; in the other two—*melitastes* and *heliotes*—they are glabrous (devoid of pubescence), but simply ciliated on one side.

PTEROPHORIDÆ.

Platyptilia æolodes, Meyr.

Described (Trans. Ent. Soc. Lond., 1902, 278) from the Chatham Islands; but Mr. Philpott has now sent me two specimens from Invercargill—a very interesting record. It is allied to *falcatalis*, but smaller and darker, and distinguished by the prominent angulation of termen of second segment of forewings (in *falcatalis* the margin is somewhat bent but not angulated), and the principal dorsal scale-tuft of hindwings being hardly beyond the middle, whereas in *falcatalis* it is much broader and is considerably beyond the middle.

Platyptilia isoterma, n. sp.

♂. 18 mm. Head white mixed with dark reddish-fuscous, frontal tuft moderately long. Palpi brownish irrorated with dark fuscous. Antennæ grey, above with a blackish line. Thorax whitish irrorated with dark reddish-fuscous, metathorax suffused with black and edged with white. Abdomen dark reddish-fuscous sprinkled with whitish, and mixed with blackish on sides towards middle. Legs reddish-fuscous sprinkled with white, tibiæ and tarsi banded with white and dark fuscous. Forewings cleft from beyond $\frac{3}{4}$, segments broad, termen of first sinuate, of second bowed in middle; reddish-fuscous closely irrorated with whitish and sprinkled with dark fuscous, anterior $\frac{3}{4}$ transversely strigulated with white, especially towards dorsum; costal edge suffused with dark fuscous and strigulated with white; a triangular black blotch on costa at $\frac{2}{3}$, its apex produced and extending to before lower angle of cleft, edged posteriorly by a fascia of brownish-ochreous suffusion crossing base of both segments, followed by a broader fascia of dark-fuscous suffusion, edged posteriorly by an even whitish line parallel to termen: cilia grey, on costa dark fuscous with a white spot before apex, on termen whitish towards base with a sharply marked even black basal line throughout, on dorsum mixed with black scales, forming a tolerably even line posteriorly, at $\frac{2}{3}$ with a flat black scale-tooth preceded and followed by whitish patches. Hindwings cleft firstly from middle, secondly from $\frac{1}{4}$, segments moderately broad, termen of second subsinuate; grey; cilia light grey, on dorsum mixed with black scales throughout, with a moderate elongate-triangular black scale-projection beginning at $\frac{3}{5}$.

Wellington; one specimen (Hudson). Allied to *falcatalis* and *æolodes*, but differs from both in the strong black entire line at base of terminal cilia of forewings. The species of this genus require careful discrimination, and probably more remain to be found in the mountains; their larvæ are usually attached to *Compositæ* (feeding variously on the flowers or leaves, or in the stems), and should be looked for.

EPIBLEMIDÆ.

Strepsicrates chaophila, n. sp.

♀. 14 mm. Head, palpi, and thorax ochreous. Abdomen grey. Forewings elongate, gradually dilated, costa moderately arched, apex obtuse, termen somewhat sinuate, rather oblique; ferruginous-ochreous, irregularly mixed with white; costa and dorsum shortly strigulated with blackish; a large trapezoidal blotch of partial blackish suffusion extending over costal half of wing from base to near middle, posteriorly formed by upper part of central fascia; a rounded-triangular blackish spot on dorsum before tornus; a curved leaden-metallic stria from $\frac{4}{5}$ of costa to tornus, forming posterior margin of ocellus, anterior margin silvery-whitish, ocellus limited above by a triangular blackish spot, and containing two or three undefined black dashes: cilia ferruginous-ochreous, with a blackish basal line (imperfect). Hindwings with vein 4 absent; rather dark grey; cilia grey, with darker basal shade.

Wellington; one specimen (Hudson).

TORTRICIDÆ.

Cacœcia sphenias, n. sp.

♂. 15 mm. Head and palpi grey; palpi moderate, terminal joint very short. Antennal ciliations 1. Thorax reddish-ochreous, somewhat mixed with grey. Abdomen rather dark grey. Forewings elongate-triangular, costa gently arched, fold occupying basal $\frac{2}{5}$, apex obtuse, termen slightly rounded, rather oblique; reddish-fuscous, suffusedly strigulated with light yellow-ochreous; costal fold strigulated with blackish; several dark ferruginous-brown dots on dorsum; a wedge-shaped ochreous patch mixed with dark reddish-fuscous and towards costa with orange, resting on costa from $\frac{3}{5}$ to $\frac{4}{5}$, its apex touching termen above tornus, preceded and followed by undefined bands of grey-whitish suffusion: cilia reddish-fuscous, tips whitish-yellowish. Hindwings with 6 and 7 stalked; rather dark grey; cilia grey-whitish, with grey basal line.

Invercargill, in January; one specimen (Philpott).

Dipterina crypsidora, n. sp.

♂. 12 mm. Head, palpi, and thorax brown mixed with dark fuscous; palpi under 2, whitish-ochreous towards base; antennal ciliations 2. Abdomen dark fuscous. Forewings elongate-oblong, costa anteriorly moderately arched, apex obtuse, termen slightly rounded, somewhat oblique; dark purplish-fuscous, irregularly strigulated with blackish-fuscous; a narrow blackish-fuscous fascia from middle of costa to $\frac{3}{4}$ of dorsum, slightly curved, somewhat expanded towards costa; the dark strigulation tends to form two or three spots towards apex: cilia dark fuscous, towards tips paler and somewhat mixed with orange-ochreous. Hindwings dark fuscous, more blackish posteriorly; cilia grey mixed with bronzy, with blackish-grey basal shade, tips more whitish. Forewings beneath with a short longitudinal coppery-orange streak beneath upper margin of cell before middle of wing.

Invercargill, in January; one specimen (Philpott).

Eurythecta potamias, n. sp.

♂ ♀. 8–9 mm. Head and thorax brown, sometimes suffused with ferruginous-reddish. Palpi brownish, paler towards base. Abdomen dark grey. Forewings elongate, narrow, costa slightly arched, apex obtuse, termen very obliquely rounded; 3 absent, 7 present; in ♂ with narrow costal fold towards base; varying from ochreous-brown or dark brown tinged with ochreous to bright ferruginous, sometimes sprinkled with black, termen always suffused with ferruginous; in ♂ a more or less indicated streak of ochreous or pale-ochreous suffusion running from base through disc to below middle and thence curved upwards to costa before apex, sometimes distinct and marked at $\frac{2}{3}$ with a whitish spot, sometimes almost obsolete: cilia brown. Hindwings dark grey; cilia grey.

Invercargill, abundant on short vegetation on sandhills in March (Philpott); four specimens. This species differs from all the others of the genus in the possession of a costal fold in ♂, but is otherwise so nearly allied that it is clearly unnecessary to separate it generically. The genus is separated from all others by the neuration.

Eurythecta eremana, Meyr.

This species, previously included by me in *Proselena*, is properly referable to *Eurythecta*, having the same neuration as the preceding. I am much indebted to Mr. Philpott for calling my attention to the actual structure, and thus enabling me to correct my original error of observation. It may, however, be regarded as the most primitive of the five known species of the genus, and the affinity with *Proselena* is real.

Phaloniadæ.

Heterocrossa thalamota, n. sp.

♂ ♀. 17–18 mm. Head, palpi, and thorax fuscous irrorated with whitish, head paler and more ochreous-tinged; palpi irrorated with blackish on inferior half. Abdomen ochreous-grey-whitish. Forewings elongate, narrow, costa moderately arched, apex obtuse, termen nearly straight, rather strongly oblique; fuscous irrorated with ochreous-whitish; a small pale brownish-ochreous basal patch, suffused with fuscous on costa, limited by an inwardly oblique black line resting externally on a ridge of raised scales; beyond this a dark fuscous blotch from costa reaching half across wing, its posterior angle touching a large tuft of blackish scales below fold surrounded with pale brownish-ochreous suffusion; immediately beyond this a small round ochreous spot strongly edged with blackish in disc at $\frac{1}{3}$, a blackish dot above this, and another at $\frac{2}{5}$ above middle of disc; an irregular light ochreous spot in disc at $\frac{2}{3}$, followed by some blackish scales; an angulated series of blackish dots running from a dark spot on costa beyond $\frac{2}{3}$ to dorsum before tornus: cilia grey irrorated with whitish. Hindwings grey-whitish, slightly ochreous-tinged posteriorly; cilia ochreous-grey-whitish.

Invercargill, in January; two specimens (Philpott). Allied to *iophaea*, but readily distinguished by the black line limiting the pale basal patch, the whitish hindwings, and other differences.

Gelechiadæ.

Gelechia cheradias, n. sp.

♂ ♀. 12–13 mm. Head and thorax ochreous-grey-whitish. Palpi whitish, second joint tinged with greyish-ochreous beneath, terminal joint shorter than second, with blackish anterior line. Antennæ whitish, sprinkled with dark grey. Abdomen grey mixed with ochreous-whitish, in ♂ suffused with pale ochreous towards base. Forewings lanceolate, acute; light ochreous-brown, suffusedly irrorated with whitish, tending to leave a more or less clear median longitudinal streak of ground-colour; a blackish mark on fold towards base; discal stigmata rather large, black, approximated, plical represented by a dark fuscous or brown cloud, very obliquely before first discal, sometimes extending upwards towards costa; several cloudy blackish or dark fuscous dots on posterior part of costa and termen: cilia whitish, partially tinged with ochreous or fuscous, with an indistinct blackish median line. Hindwings 1, light grey; cilia ochreous-grey-whitish.

Invercargill, common in December at New River (Philpott); three specimens. Quite distinct from any other.

ŒCOPHORIDÆ.

Borkhausenia brachyacma, n. sp.

♂. 18 mm. Head whitish-ochreous sprinkled with fuscous. Palpi whitish-ochreous, second joint and a median band of terminal joint irrorated with dark fuscous, terminal joint unusually short, about half second. Antennæ pale ochreous suffusedly ringed with dark fuscous, uniformly pubescent-ciliated. Thorax whitish-ochreous suffused with brownish and irrorated with dark fuscous. Abdomen grey, segments dorsally banded with golden-ferruginous. Forewings elongate, costa gently arched, apex round-pointed, termen very obliquely rounded; ochreous-whitish, closely irrorated with brown; a triangular brownish patch above dorsum towards base, limited posteriorly by a fine inwardly oblique blackish line terminating beneath in a conspicuous raised black dot above $\frac{2}{5}$ of dorsum, preceded by some whitish suffusion; discal stigmata large, round, brown, edged with a few black scales; a small blackish spot on dorsum at $\frac{4}{5}$, whence proceeds a sinuate line of scattered blackish scales near termen, angulated in middle and continued to costa at $\frac{4}{5}$, where it is somewhat dilated and preceded by a spot of whitish suffusion; a bar of brown suffusion from second discal stigma to tornus: cilia ochreous-whitish tinged with brown and irrorated with fuscous, at tornus with a grey bar preceded by whitish suffusion. Hindwings light grey; cilia ochreous-whitish suffused with pale greyish.

Invercargill, in October; one specimen (Philpott). Superficially much like *B. griseata*, but really abundantly distinct when examined in detail; the unusually short terminal joint of palpi and pubescent-ciliated antennæ are notable structural characteristics; the large brown discal stigmata are also a salient point.

Borkhausenia cenchrias, n. sp.

♂. 17 mm. Head whitish-ochreous. Palpi whitish-ochreous, second joint suffusedly irrorated with dark fuscous, terminal joint nearly as long as second, with dark fuscous subapical ring. Antennæ whitish-ochreous spotted with dark fuscous, simply ciliated. Thorax whitish-ochreous mixed with light brownish. Abdomen grey, dorsally banded with ferruginous. Forewings elongate, rather narrow, costa gently arched, apex obtuse, termen rounded, rather strongly oblique; whitish-ochreous suffusedly mixed with ochreous-brown; base of costa suffused with dark fuscous; first discal stigma represented by a short oblique linear black mark, followed by whitish suffusion, second round, whitish, partially edged with black, plical black, rather obliquely beyond first discal; a suffused blackish dot on dorsum towards tornus; some fuscous suffusion towards costa at $\frac{2}{3}$, and towards apex and termen; between these are indications of an angulated suffused whitish-ochreous subterminal line, most distinct towards costa: cilia whitish-ochreous, with a light fuscous sub-basal shade. Hindwings light grey; cilia whitish-grey.

Invercargill, in December; one specimen (Philpott). Also belongs to the *griseata* group, but quite distinct by the character of the stigmata and subterminal line.

Atomotricha isogama, n. sp.

♂ ♀. 23 mm. Head and thorax whitish-ochreous, in ♂ more brownish-tinged. Palpi whitish-ochreous, externally with a few scattered dark-fuscous scales. Antennæ whitish-ochreous, obscurely ringed with dark fuscous.

Abdomen whitish-ochreous, in ♂ more brownish, dorsally suffused with brassy-golden except on margins of segments. Forewings elongate, costa moderately arched, apex obtuse, termen very obliquely rounded; whitish-ochreous, with a few scattered dark-fuscous scales, in ♂ mostly suffused with brownish except on dorsal streak; a broad pale dorsal streak from base to tornus, upper edge prominent near base, where there is a tuft of scales, and about middle of dorsum; some dark-fuscous suffusion extending above this streak from base to $\frac{3}{5}$ of disc, and thence upwards to costa; stigmata round, whitish-ochreous, edged with dark fuscous, plical obliquely beyond first discal; an angulated dark-fuscous line or series of dots from $\frac{4}{5}$ of costa to tornus: cilia ochreous-whitish, in ♂ irrorated with grey, basal third barred with fuscous. Hindwings very pale whitish-ochreous; a cloudy round fuscous discal spot; apex and lower half of termen suffused with fuscous irroration; cilia ochreous-whitish, round apex and on lower half of termen with a suffused fuscous shade.

Wellington; two specimens (Hudson). Differs from both the other described species in having the wings of ♀ fully developed, and formed quite as in ♂; the pale dark-edged stigmata are also characteristic.

Izatha percnitis, n. sp.

♂ ♀. 16–17 mm. Head and thorax rather dark fuscous, somewhat sprinkled with whitish, forehead with conical horny projection. Palpi dark fuscous, somewhat whitish-sprinkled, terminal joint with two whitish bands. Antennæ grey-whitish spotted with dark fuscous. Abdomen dark fuscous, two basal segments dorsally amber-coloured. Forewings rather narrowly elongate-oblong, costa rather arched towards base and apex, apex obtuse, termen almost straight, oblique; dark fuscous, partially tinged with ochreous-brown, slightly whitish-sprinkled; some variable irregularly scattered black dashes and dots in disc, plical stigma represented by a blackish tuft of scales, second discal by a transverse black mark; three very ill-defined transverse fasciæ or lines of whitish suffusion, first at $\frac{1}{4}$, straight, moderately broad, second median, straight, very indistinct, third at $\frac{3}{4}$, narrow, curved, representing subterminal line: cilia fuscous mixed with dark fuscous. Hindwings dark fuscous, somewhat lighter anteriorly; cilia grey, with dark fuscous basal shade.

Wellington; two specimens (Hudson). Distinct by its relatively small size and dark colouring.

Plutellidæ.

Gracilaria, Hw.

I have recently (Proc. Linn. Soc. N.S.W., 1907, 54–68) recast the limits of this genus and its near allies, from extended material. The New Zealand species are now classified as follows:—

Conopomorpha, Meyr. Middle tibiæ not thickened, posterior tibiæ with bristly hairs.
cyanospila, Meyr.

Macarostola, Meyr. Middle tibiæ not thickened, scales sometimes expanded at apex only, posterior tibiæ smooth-scaled.
miniella, Feld.
leucocyma, Meyr.
ællomacha, Meyr.
æthalota, Meyr.

Gracilaria, Hw. Middle tibiæ thickened with dense scales, more or less rough beneath, posterior tibiæ smooth-scaled.
- *linearis*, Butl.
- *selenitis*, Meyr.
- *chrysitis*, Feld.
- *chalcodelta*, Meyr.

Gracilaria selenitis, n. sp.

♀. 12 mm. Head yellow-whitish, sides of crown reddish-ochreous. Palpi yellow-whitish, terminal joint ferruginous-tinged near base. Antennæ white ringed with blackish, basal joint whitish-ferruginous. Thorax ferruginous-ochreous, with a yellow-whitish dorsal stripe. Abdomen rather dark grey, beneath yellow-whitish. Legs whitish, anterior and middle femora and tibiæ mixed with ferruginous-ochreous and sprinkled with black, tips of tarsal joints blackish. Forewings elongate-lanceolate, costa moderately arched posteriorly, apex acute; deep ochreous-yellow, more orange towards dorsum, with a strong purple gloss, strewn throughout except beneath fold with very numerous suffused yellow-whitish dots separated by small dots and strigulæ of dark fuscous scales; three moderate brassy-yellow-whitish spots on dorsum: cilia ochreous-whitish. Hindwings rather dark grey; cilia grey.

Mount Holdsworth, 3,000 ft.: one specimen (Hudson). Very distinct.

Glyphipteryx, Hb.

Finding that *Phryganostola*, which only differed from *Glyphipteryx* by the rough projecting scales or tuft of second joint of palpi, appeared to be an artificial division, which separated nearly allied species, I have suppressed it, including all the species in *Glyphipteryx*.

Glyphipteryx codonias, n. sp.

♀. 14 mm. Head, antennæ, thorax, and abdomen dark fuscous, patagia shining bronze. Palpi black, second joint without tuft, with three white rings, terminal joint with two white stripes. Forewings elongate, rather narrow, costa gently arched, apex round-pointed, termen hardly sinuate, rather strongly oblique; bright golden-bronze; five variably oblique narrow violet-silvery-metallic partly black-edged streaks from costa, first short, slightly before middle, second angulated, reaching half across wing, third short, fourth longer, rather dilated apically, fifth running to termen beneath apex: an erect similar streak from tornus, terminating in a black mark just beyond apex of second costal streak, and a short streak from termen below middle; a small blackish apical spot: cilia grey, basal half bronzy, with a silvery dot on subapical streak, on costa with white bars on streaks. Hindwings blackish-grey; cilia dark grey.

Invercargill, in January; one specimen (Philpott). Resembles *transversella*, but without the pale longitudinal streak, the silvery streaks differently formed, the second angulated, third shorter than fourth (in *transversella* longer than fourth), and otherwise distinct.

Tineidæ.

Eschatotypa, Meyr.

Under the names of *derogatella*, Walk., and *melichrysa*, Meyr., treated as synonymous, I have hitherto confused two distinct species, which can now be distinguished under these two names; both are common.

Eschatotypa derogatella, Walk.

Characterized by its dull brownish-ochreous ground-colour, tendency to confusion of the white markings, so that anterior half of wing is sometimes wholly suffused with white, plentiful black strigulation, the ante-median white fascia broadly dilated towards costa, shortly angulated above middle, posterior part of disc confusedly mixed with white and black scales, and presence of distinct black sub-basal line in terminal cilia.

Masterton, Wellington, Christchurch, Invercargill (and, according to Walker, Auckland), from December to March.

Eschatotypa melichrysa, Meyr.

Characterized by clear yellow-ochreous ground-colour, well-defined and separate white black-edged markings, ante-median white fascia very acutely angulated in middle, and absence of black line in terminal cilia.

Whangarei, Auckland, Nelson, Dunedin, Invercargill, in December and January. My original description clearly included both species, but the name (meaning "honey-golden") is a relative definition of this one, and I now limit it in that sense.

Mallobathra scoriota, n. sp.

♂. 13–14 mm. Head, palpi, thorax, and abdomen rather dark fuscous. Antennæ dark fuscous, ciliations 4. Forewings elongate, costa gently arched, apex obtuse, termen very obliquely rounded; 6 present; whitish-fuscous, strewn with cloudy dark-fuscous strigulæ; a moderately broad slightly oblique dark-fuscous median fascia; a cloudy dark-fuscous spot on costa at $\frac{3}{4}$; the confluence of the strigulæ tends to form suffused spots in disc towards apex, and along termen: cilia whitish-fuscous, with dark-fuscous ante-median shade and indistinct bars on basal third. Hindwings with 6 present; grey; cilia grey.

Wellington (Hudson), Invercargill (Philpott); two specimens.

Art. III.—*On a Method of carrying out the Decimal Currency.*

By H. Skey.

[*Read before the Otago Institute, 11th August, 1908.*]

It must be conceded by all that a revision of our tables of money, weights, and measures is absolutely necessary. This is a true social question, to be solved scientifically. Owing to the magnitude of the undertaking, it would be impossible to deal with more than one of those questions at a time, so that the general public might become conversant with it first before undertaking the others. There is little doubt that the commencement should be with the currency, and I think, if it can be shown that the introduction of only one or two coins is all that is necessary to give us the decimal system of counting, the following method is well worthy of consideration.

We have now eleven different coins in our currency; but the decimal currency can be effected by the use of only seven, four of which are already in use. These can be made to give us all the advantages of a binary system as well. To effect this, let these represent—

1 pound, status of the sovereign or pound (not altered).
1 florin (not altered); 10 equal 1 pound.
1 bron (a new bronze coin), the integer; 10 equal 1 florin.
1 tenny (a new copper coin); 10 equal 1 bron.

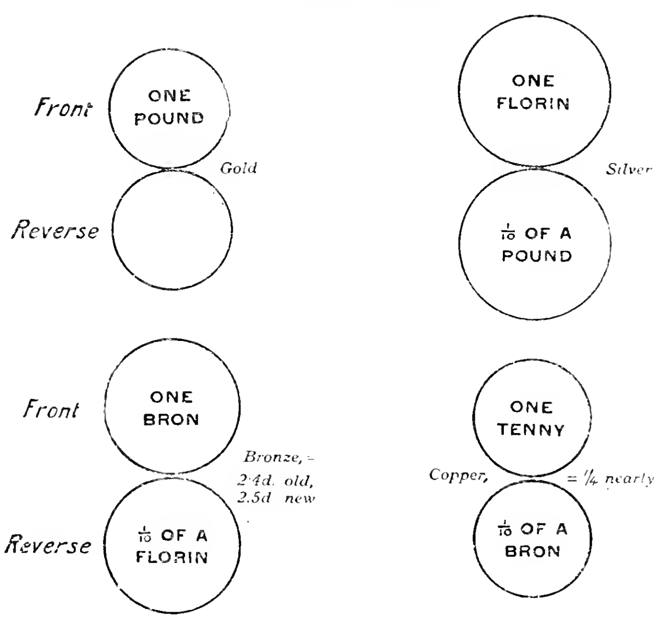
On all these coins the names and relative values of each should be marked, so that if we at first forget their names and values, we would only require to look at what is on them, and commit to memory the following money-table:—

10 tennies equal 1 bron.
10 brons " 1 florin.
10 florins " 1 pound.

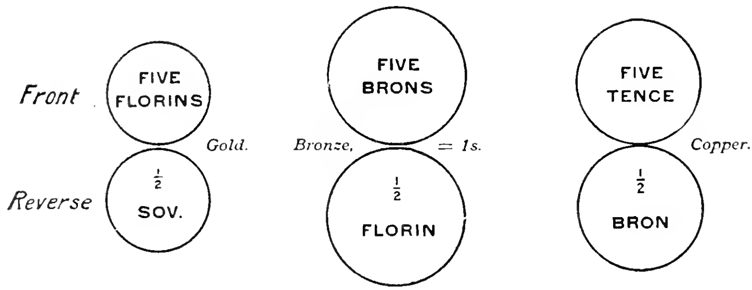
This is the decimal system. Now, as some may object to this because it involves the carrying about of too many pieces for change, I propose to retain the half-sovereign under the name of a 5-florin piece; the shilling, under the name of a 5-bron piece; and have a new piece under the name of a 5-tenny piece. These three half-way pieces lead to all the advantages of a binary system as well; for, taking the seven coins, each is one-half of that which precedes it. All counting and booking, however, has to be done in terms of the foregoing decimal table, the values of all of which are marked thereon. (This is not done in our present currency.) The use of these half-way pieces is only parallel to our present use of the sixpence, as sixpences are not counted and tabulated as sixpences, but are placed in the pence-column. Therefore these half-way pieces are not included in the new money-table.

The diagram on the next page shows these three pieces, two of which we already possess, and which merely require their names being changed.

Four Decimal Coins.



Three Half-way Pieces.



The four highest pieces are not altered in value, and only one of them in name. The four lowest would be made of bronze and copper, and, as they are in the most frequent use, the wear-and-tear thereon would not be so costly as it now is on the shillings and sixpences.

The name "bron" was selected because of the coin being made of bronze, which would soon become shortened to "bron."

The name of the lowest coin, the "tenny," was selected because its first three letters form an abbreviation for the words "tenny," "tennies," "tence," and "tenths," which would be used as occasion requires.

Giving of Change.

A person owes 9 tence and tenders 1 florin: all there is to do is to convert the larger sum to the term of the lower, thus:—

F.	B.	T.
1	0	0
0	0	9
	9	1

reading 9 brons and 1 tenny, which would soon be identified as 9 point 1.

If a person owes 1 bron and tenders 1 pound, then, as there are 100 brons in the pound, it would be done thus:—

£	F.	B.
1	0	0
0	0	1
	9	9

reading 9 florins and 9 brons, which would soon be identified as 9 and 9.

	£	F.	B.
To	2	7	1·3
add	5	9	2·8
	8	6	4·1

	£	F.	B.
From	8	6	4·1
take	2	7	1·3
	5	9	2·8

reading 8 pounds 6 and 4 point 1, and 5 pounds 9 and 2 point 8.

BOOKKEEPING.

Only three columns will be required, as at present, for the last column always requires a decimal point on the line dividing the bron or integer from the tenths (4·3)—

	£	F.	B.
To	9	5	9
add	7	6	5·9
	17	2	4·9

	£	F.	B.
From	17	2	4·9
take	7	6	5·9
	9	5	9·0

reading 17 pounds 2 and 4 point 9, and 9 pounds 5 and 9. This last can be read as 959 brons, or 95 florins and 9 brons, or as 9 pounds 5 and 9, which should satisfy the most exacting in giving change, for the figures all adjust themselves without calculation.

```
1283 at 8F. 7B.
  87
-----
 8981
10264
------
111621
```

reading 1116 pounds 2 and 1.

How many times is 8F. 7B. contained in £1116 2F. 1B.?

```
      £    F.  B.
87)1116   2   1(1283
   87
   ---
   246
   174
   ---
    722
    696
    ---
     261
     261
     ---
```

The character £ requires always placing over the integer of pounds.

The word "pound" would be used after the pounds; the word "and" after the florins; and the word "point" before the tence.

There is nothing to militate against the decimal system if the tenny coins were grouped together thus: the ·2 taking the place of the half-penny (nearly); the ·4 taking the place of the penny (nearly); the ·5 already mentioned as a half-way coin; and ·8. This would provide still more efficiently, if possible, for giving change. Thus could the changes be rung on all the tennies, and provide for use a single coin, if desired, for paying for, say, postage-stamps, tram-fares, &c.

Similarly, there is nothing to prevent the space between the bron and the florin having a 2-bron piece inserted—for instance, one equalling 5 pence of our coinage. This would equal the 10-cent piece of the United States, and a 4-bron piece would very nearly equal the franc of France and her allies in currency. A 2-bron piece would soon be as popular as the sixpence, as being near it in one coin; of course, a 5-tenny piece could be added to make its value sixpence.

So that every coin now in common use is represented in the new system, but would require to be counted and booked in terms of the new coinage.

It follows as a useful corollary that when any one of these intermediate groups is in quantity, then every ten of them pass without calculation into the next value of coin—say, ·4 taken ten times gives the same figure in brons (4), and if taken 100 times gives the same number in florins; thus the figures merely want passing on to left one or more columns in book-keeping; dividing being done with the same celerity.

Advantages.

I need not dilate on the immense advantages which this system would confer on, say, banks, firms, companies, shops, factories, &c.; also on the preparation of statistics, tenders, contracts, taxes, wages, price-lists which are continually changing; and on very small levies, such as ·111, or as far as we like to go, for this system allows of extension at either end.

As money would circulate more freely, it would tend to make business more profitable and many commodities of life cheaper, consequently making us all richer.

Schools.

To the advantages enumerated there is another of still greater moment: I allude to the burden laid upon the children of our schools, for it is little better than child-slavery to compel them to wade through our unsystematic tables, and perform the feats they do, with the antiquated tools at their disposal. It is time we took off some of their useless burdens. This system would result in their having time at their disposal for more delightful studies in the higher branches of wisdom and knowledge.

Tourists.

We shall soon have foreigners on our list of tourists, and is it not better to have a scientific currency ready for them, so that they may feel more like ourselves? The system enumerated might also help to pave the way for an international currency, which would be a boon that could not be overestimated.

It is clear that if the decimal system were adopted the British currency would be the best in the world, and if any foreign nation were revising or decimalising its currency our method would be bound to be adopted, either wholly or in part.

Postage.

It is just possible, if the details of the international penny postage are not yet completed, that the proposed decimalisation of our coinage might be taken into consideration, and the value of the stamp altered to either the 4-tenny or the 5-tenny coin, in which case all calculations therewith would be workable on the decimal system.

Foreign nations do not appear to have as low a coinage as we have, generally stopping, as far as I can ascertain, at or near 2½d. The question is, will they have this coin halved, thus making a coin close to the 5-tenny herein proposed, or will they not more likely divide it into tenths and make a coin equal to four of them?

In any case, the 5-bron piece, equalling 1 shilling, can still purchase twelve stamps, and a lesser number be paid for by the 5-tenny piece for each stamp, the small difference going to the revenue; thus the truly great scheme of international postage will not be interfered with. It is very desirable to have the value in one coin, and that a decimal.

Very few foreign nations appear to possess even an approximation to either a pure decimal or a binary currency. This suggests the fact that they, like ourselves, are in a transition state, and that further changes will be made as occasion requires.

INTERNATIONAL.

It is interesting to note the number of nations which possess coins of the same value, or very nearly the same, as those made use of in this proposed system. Out of fifteen countries, twelve have a coin close to the 2·4d., or the bron; seven to the 2s., or florin; five near the double florin; seven near the pound; and the Japanese have a coin at £1 0s. 6d., one at 2s. 0½d., and another at 2½d.

If ever an international coinage conference were convened England could not keep out of it. Is it not better to put our own currency in order before that takes place? There would then be little danger of our currency being interfered with.

Moreover, if we wilfully handicap ourselves by the use of antiquated tables, surely we ought not to be jealous of other nations if they outstrip us in commercial success.

WITHDRAWAL OF OBSOLETE COINS.

These could be allowed to circulate as tokens for a certain fixed time —say, three years—during which time the banks would have absorbed the bulk of them when empowered to change them into their equivalent new coins. After this any coins left might still be allowed to circulate, but at a depreciated value, for a further time—say, three years more— the 1d. being reduced to the value of ·4, the ½d. to ·2, and the ¼d. to ·1. After this any coins left might be kept as curiosities.

It is only the three copper coins that are affected by the change of currency, and the depreciation in their values would hasten their withdrawal before the end of the three years. The depreciation is so slight that the question suggests itself, Is there no means whereby they could be retained in the currency till worn out? They are reduced in value by this proposed method $\frac{1}{24}$. Now, if the banks were empowered to stamp on both sides their new values (·4), and for every ninety-six pennies thus stamped add four more new (the Government providing these and the labour), we should then have 100 of the ·4 pieces; and the same with all the coppers as they accumulated in any quantity in the banks.

These old copper coins are not really quite worth their weight in copper, and might be considered as tokens, so that the change suggested would bring them nearer to their intrinsic value; and it would be only right for the Government to provide the four new pieces to make the ninety-six pennies into 100 of the 4-tenny pieces.

The threepenny bits could be called in, and with them any worn sixpences, to purchase their equivalents in brons, and issued contemporaneously with the new coppers.

Thus would a cheap, gradual, and effective change be provided, without inconveniencing the general public. It would not take long to get thoroughly initiated in the new method of counting, by which time we could begin to apply a decimal system to our weights and to our measures.

My object is to show that there are no insuperable or even formidable difficulties to contend with. Australia would doubtless join us, and thus give the question an Australasian weight.

I know this is an Imperial question, and that it would be almost as easy for the Home Government to make a new coin as to reproduce an old one, which they are continually compelled to do; but if the change is not carried out at Home, that fact should surely not prevent us from adopting it here if found desirable.

Art. IV.—*A List of the* Hemiptera *(excluding* Sternorrhyncha) *of the Maorian Subregion, with Notes on a Few of the Species.*

By G. W. Kirkaldy.

[*Read before the Philosophical Institute of Canterbury, 5th August, 1908.*]

The list of *Hemiptera* given in the "Index Faunæ Zealandiæ" (1904 is so inadequate as regards the correctness of the nomenclature, and as indicating the probable endemicity or otherwise of the species included, that I have been tempted to prepare a new list, and to add a few notes on one or two of the forms. The total number now enumerated of the *Heteroptera* and auchenorrhynchous *Homoptera*—that is to say, the bugs and leaf-hoppers—is seventy-seven species (this excludes eight recorded in almost positive error). Of these, thirteen may be positively assumed to be non-endemic; of the remaining sixty-four, only about forty may be reasonably assumed to be endemic, but a considerable proportion of these belong to groups scarcely known yet outside the palearctic region.

The forms which may be considered at once pretty safely as endemic are the species of *Rhopalimorpha*, *Oncacontias*, *Acanthia*, *Anisops*, most of *Cicadetta*, and probably some at least of *Oliarus*, *Cixius*, and *Nysius*. The rest are entirely conjectural.

The valuable contributions by Hutton, Hudson, Fereday, and others, in the "Transactions of the New Zealand Institute," dealing with the fauna of the country, lay stress on the almost entire absence of *Hemiptera*, and especially of *Homoptera;* but I am sure that this is entirely a mistake.

The only other Pacific fauna of which the *Hemiptera* are at all well known is that of the Hawaiian Islands. Although endemic *Coccidæ* and *Aphidæ* are absent, I estimate the total number of endemic *Hemiptera* at little less than 360; of these, 138 have already been described, over a hundred more are in manuscript awaiting early publication, and I have at least a hundred more before me. These figures do not include thirty-six introduced *Heteroptera* and *Auchenorrhyncha*, as well as over a hundred coccids, aphids, and aleyrodids, all introduced.

In the Hawaiian fauna the following families are represented endemically: *Lygæidæ*, *Myodochidæ*, *Nabidæ*, *Reduviidæ*, *Anthocoridæ*, *Miridæ*, *Acanthidæ*, *Tettigoniidæ*, *Fulgoridæ*, *Asiracidæ*, and *Chermidæ*, and possibly *Cimicidæ*—that is, eleven or twelve out of forty recognised families. In New Zealand all these are present, and we have to add *Thyreocoridæ*, *Aradidæ*, *Enicocephalidæ*, *Gerridæ*, *Notonectidæ*, *Corixidæ*, *Cicadidæ*, *Cercopidæ*, *Aleyrodidæ*, and *Coccidæ*, all of which may be (and five certainly are) endemic.

The principal Hawaiian plants, from a hemipterological point of view, are *Nani* (= *Metrosideros*) *polymorpha*, *Pipturus*, *Myrsine*, *Ipomœa*, *Sida*, various tree-ferns, *Myoporum*, and, to a less degree, *Acacia koa*, *Cyathodes*, *Elæocarpus*, *Eugenia*, *Freycinetia*, *Dodonæa*, and *Bobea*. Of these, I find, on reference to Kirk's great work on New Zealand forest-trees (the only such work I have for reference), that *Cyathodes*, *Elæocarpus*, *Eugenia*, *Dodonæa*, *Nani*, *Myoporum*, and *Myrsine*—and, I suppose, *Freycinetia*, *Ipomœa*, and *Sida* also—are well represented in New Zealand. It is almost impossible to believe that they too are not the shelters or food plants of a large hemipterous fauna there.

I have estimated the total endemic Hawaiian fauna at little less than 360. Taking into consideration the hemipterous faunas of the Hawaiian Islands and the British Islands, and the coleopterous and lepidopterous faunas of New Zealand, the British Islands, and the Hawaiian Islands, I have no hesitation in estimating at least 750 species of endemic *Hemiptera* for New Zealand, and I think that this is really much too little.

As it is just possible that some of the members of our Society may feel moved to remedy our deplorable state of knowledge—or, rather, want of knowledge—of the New Zealand *Hemiptera*, I venture to give a few hints as to what may prove to be the best method of securing specimens.

To a considerable extent collecting in New Zealand will be not unlike collecting in the Hawaiian Islands. In the latter, almost all the endemic species are arboreal. They are to be obtained, therefore, by careful beating of the leaves, twigs, and branches, especially the last, but, better still, by searching. The wonderful native grasses, however, must not be neglected, as they are certain to have a large fauna. When collecting leaf-hoppers, searching is often best, but if not, then the branches should be beaten into a large, rather deep net, as the very agile hoppers will jump at once right out of an ordinary umbrella. It is very important to identify the food-plants, and also the nymphal stages, of the various *Hemiptera*, especially of the plant-eating kinds, which are often much restricted in that way. In Hawaii, however, such carnivorous kinds as *Reduviolus* (*Nabidæ*) are also considerably thus restricted. In the forests themselves "sweeping" will be of little avail, this method of capture being reserved principally for grasses. One fruitful method of capturing certain *Miridæ*, *Anthocoridæ*, *Ploiariinæ*, &c., is to beat dead trees which still retain their leaves, though these are withered; such trees will be found near recent forest-clearings.

Of course, these remarks are based on methods of collecting which have been found effective in the Hawaiian Islands, but I believe they will also be found effective in New Zealand. I have only to add that I will be very pleased to help any one who contemplates collecting *Hemiptera* in New Zealand if he will write to me at Honolulu.

Suborder HETEROPTERA.

Fam. CIMICIDÆ (= *Scutelleridæ*, *Asopidæ*, *Sciocoridæ*, *Pentatomidæ*, *Halydidæ*, and *Acanthosomatidæ* of Hutton's list).

Œchalia, Stål.

1. *consocialis* (Boisduval) = *O. schellembergii*, Hutton.

This has been figured by Schouteden, 1907, Gen. Ins., fasc. 52, pl. v, f. 12. It is scarcely endemic in New Zealand, being common almost all over Australia and Tasmania. The record from the Philippines is almost certainly a mistake. In Australia, *Œchalia* is (at least partly) carnivorous, preying on the larvæ of *Phalænides glycine* (the vine-moth), and of *Galeruca semipullata* (the figleaf-beetle).

Cermatulus, Stal.

2. *nasalis* (Westwood).

This also is scarcely endemic, as it is also found in Australia and Tasmania. Schouteden figures it: pl. v, f. 6. Hudson, who figures the nymph (Man. N.Z. Ent., pl. xx, f. 6A), notes it from "white rata" (*Metrosideros scandens*). I seem to have another species in my collection, but none of the material is in good enough condition for description. I have recorded *C. nasalis* from French Pass and Stephen Island.

Glaucias, Kirkaldy.

3. *amyoti* (White) = *Nezara amoyti* (!), Hutton.

This also is an Australian species, and not endemic. I have recorded it from French Pass.

Nezara, Am. and Serv.

4. *viridula* (Linn.) = *prasina*, Hutton.

Not endemic, but a practically cosmopolitan species, figured in Wolff's Icon. Cim. 56, f. 53 (as *smaragdula*).

Diemenia, Spinola (= *Platycoris*, Hutton).

5. *immarginata* (Dallas).

Another Australian form.

[**Sciocoris**, Fallén.

helferi, Fieber. A southern European species, recorded almost certainly in error from New Zealand.]

Dictyotus, Dallas.

6. *cœnosus* (Westwood) = *polysticticus*, Hutton.

Distributed over Australia and Tasmania. I have recorded it from French Pass.

Rhopalimorpha, Mayr.

7. *obscura*, Dallas.

This species seems to be autochthonous. I have recorded it from French Pass and Chatham Island.

8. *ignota*, Hutton, 1898.

From the Chatham Islands.

Oncacontias, Breddin (= *Anubis*, Hutton).

9. *vittatus* (Fabricius).

Apparently also autochthonous.

[**Calliphara**, Germar.

imperialis (Fabricius). An Australian species, whose presence in New Zealand requires confirmation; certainly not endemic. It is figured in Donovan's Ins. New Holland, pl. iii, f. 2.]

[**Scutiphora,** Guérin.

pedicellata, W. Kirby. The presence of this species in New Zealand also requires confirmation. It occurs in Papua, Australia, and Tasmania, and is somewhat of a pest at times on fruits in Australia.]

Fam. THYREOCORIDÆ (= *Cydnidæ*, Hutton).

Hahnia, Ellenrieder (= *Geotomus*, Hutton).

10. *australis*, Erichson = *leptospermi*, Hutton.

Distributed over Australia, Tasmania, New Caledonia, and Ceylon. F. B. White states that this was once found "in numbers on the sea-beach at Sumner, either floating in salt-water pools or crawling on the sand" (Ent. Mo. Mag. xiv, 275).

Chœrocydnus, A. White (= *Chæno*, Hutton).

11. *nigrisignata*, F. B. White.

Not known elsewhere.

Pangæus, Stål.

12. *scotti*, Signoret. Figured 1882, A. S. E. France (6), ii, pl. ix, f. 117.

Not known elsewhere.

Fam. ARADIDÆ.

Aradus, Fabricius.

13. *australis*, Erichson.

Also from Australia, Tasmania, and New Caledonia. I have recorded it from Chatham Islands.

Ctenoneurus, Bergroth.

14. *hochstetteri* (*Mayr*) = *Crimia attenuata* and *Mezira maorica*, Hutton, syn. *Aneurus*, Curtis.

15. *brouni*, F. B. White.

Fam. MYODOCHIDÆ (= *Lygæidæ*, Hutton).

Arocatus, Spinola.

16. *rusticus*, Stål. = *ruficollis*, Hutton.

A common Australian species. I have recorded it from French Pass.

Stalagmostethus, Stål. (= *Lygæus*, Hutton, syn.).

pacificus (Boisduval). Distributed over Australia, Tasmania, and New Caledonia. The record from New Zealand is doubtful.]

Nysius, Dallas.

17. *huttoni*, F. B. White.

I have recorded it also from Chatham Islands.

18. *claviconis* (Fabricius) = *zealandicus*, Hutton.

19. ? *anceps*, F. B. White.

Metagerra, F. B. White (= *Paresuris*, Reuter).

20. *helmsi* (Reuter).

21. *obscura*, F. B. White.

Orthœa, Dallas (= *Plociomerus*, Hutton).

22. *nigriceps*, Mayr = *inornatus*, Hutton.

Also recorded from the Hawaiian Islands, Tahiti, and the Philippines. The synonymy of this species is perhaps a little doubtful. I have recorded the var. *inornata* (Walker) from Chatham Islands.

Targarema, F. B. White.

23. *electa*, F. B. White.
24. *stali*, F. B. White.

Margareta, F. B. White.

25. *dominica*, F. B. White.

Scolopostethus, Fieber.

26. *putoni*, F. B. White.

Fam. Nabidæ.

Reduviolus, W. Kirby (= *Nabis*, Hutton).

27. *saundersi* (F. B. White).
28. *maoricus* (Walker).

[*lineatus*, Dahlbom (not Dahlberg !), is a European species, and was almost certainly recorded in error.]

Fam. Gerridæ.

Microvelia, Westwood (= *Hydroessa*, Hutton).

29. *macgregori*, Kirkaldy.

Fam. Reduviidæ (incl. *Emegidæ*).

Peirates, Am. and Serv. (= *Pirates*, Hutton).

30. *ephippiger* (A. White).

An Australian species.

Ploiaria, Scopoli (= *Emesodema*, Hutton).

31. *huttoni* (Scott).

Fam. Enicocephalidæ.

Enicocephalus, Westwood (= *Henicocephalus*, Hutton).

32. *maclachlani* (Kirkaldy).

Probably not endemic, but Australian, though not known elsewhere than in New Zealand.

[Fam. Macrocephalidæ (= *Phymatidæ*, Hutton).

Phymata inconspicua and *feredayi* were recorded in error, or else were introduced from America.]

Fam. Anthocoridæ.

Cardiastethus. Fieber.

33. *brounianus*, F. B. White.
34. *consors*, F. B. White.
35. *poweri*, F. B. White.

Fam. Clinocoridæ.

Clinocoris, Fallén (= *Cimex*, Hutton).

36. *lectularius* (Linneus).
Cosmopolitan.

Fam. Miridæ (= *Capsidæ*, Hutton).

Megalocerœa, Fieber.

37. *reuteriana*, F. B. White.

Romna, Kirkaldy (= *Morna*, F. B. White).

38. *capsoides* (F. B. White).
39. *scotti* (F. B. White).

Reuda, F. B. White.

40. *mayri*, F. B. White.

The next three species are of uncertain generic position.

41. *Leptomerocoris maoricus*, Walker.
42. *Capsus laticinctus*.
42a. *C. ustulatus*, Walker.
This appears from the description to be the same as No. 42.

Fam. Acanthiidæ (= *Saldidæ*, Hutton).

Acanthia, Fabricius (= *Salda*, Hutton).

43. *australis* (F. B. White).
44. *butleri* (F. B. White) = *bulteri!* Hutton.
45. *lælaps* (F. B. White).

Fam. Corixidæ.

Arctocorisa, Wallengren (= *Corixa*, Hutton).

46. *arguta* (F. B. White).

[*Diaprepocoris barycephala*, Kirkaldy, is an Australian form, and has not been taken in New Zealand.]

Fam. Notonectidæ.

Anisops, Spinola.

47. *wakefieldi*, F. B. White.
I have recorded this from Chatham Islands also.
48. *assimilis*, F. B. White.

Fam. Cicadidæ.

Cicadetta, Kolenati (= *Melampsalta*, Hutton).

49. *cassiope* (Hudson) = ? *nervosa* (Walker).
50. *mangu* (F. B. White).
51. *iolanthe* (Hudson).
52. *scutellaris* (Walker).
53. ? *arche* (Walker).

A doubtful species, placed by Stal as a synonym of *telxiope*, but probably in error.

54. *muta* (Fabricius) (var. *subalpina*, Hudson).
Also on Chatham Islands.

55. *aprilina* (Hudson).
C. cutora (Walker) and *ochrina* (Walker) may belong to this, but were placed by Stål as synonyms of *muta*.

56. *cruentata* (Fabricius).
C. rosea (Walker), *bilinea* (Walker), *sericea* (Walker), and *muta* vars. *rufescens* and *flavescens*, probably belong to this. Hutton and I have recorded it from Chatham Islands.

57. *cincta* (Walker).
This is probably *muta* var. *minor*, Hudson.

58 *cingulata* (Fabricius).
This is probably *zealandica* (Boisduval) and *indivulsa* (Walker).

59. *strepitans*, nom. nov.!
This is *Cicada cingulata* var. *obscura*, Hudson, which is a good species. I have renamed it, as I have not been able to identify it with any of Walker's species.

60. *angusta* (Walker).
This is probably *muta* var. *cinerascens*, Hudson.

The New Zealand species of *Cicadetta* much need revision, but it will be necessary for Walker's types to be examined. Stål made a hurried revision of them in 1862, and later notes were made by Kirby and Distant, but their conclusions are not to be relied on, as they did not study the ♂ genitalia, the most important specific characteristic in this genus. There are doubtless still many more species to be obtained in New Zealand.

My remarks cited by Alfken (1904 Zool. Jahrb. Syst., xix, 582) were written in 1899, and are to be disregarded entirely, as I had not then studied the genitalia.

Fam. CERCOPIDÆ.

Cercopis, Fabricius (= *Aphrophora*, Hutton).

61. *jactator* (F. B. White).

Philænus, Stål (= *Philænus*, Hutton).

62. *fingens* (Walker).
63. *subvirescens* (Butler).
64. *trimaculatus* (Walker).
The type-form with two vars. (*tristis*, Alfken, and *læta*, Alfken) have been recorded from Chatham Islands.

Fam. TETIGONIIDÆ (= *Jassidæ*, Hutton).

Paradorydium, Kirkaldy (= *Dorydium*, Hutton).

65. *westwoodi* (F. B. White).
The genus of the following specimens is doubtful. I have not seen a specimen.

66. *negatus*; F. B. White.

Fam. FULGORIDÆ.

Cixius, Latreille.

67. *interior*, Walker.
68. *punctimargo*, Walker.
69. ? *aspilus*, Walker.
70. *rufifrons*, Walker.

Oliarus, Stål.

71. *oppositus* (Walker).

72. *marginalis* (Walker).

Fam. PŒKILLOPTERIDÆ.

Scolypopa, Stål (= *Ricania*, Hutton).

73. *australis* (Walker).

An Australian species, feeding on passion-vines, &c. The nymph is green, with white filaments.

Aka, F. B. White.

74. *finitima* (Walker).

Semo, F. B. White.

75. *clypeatus*, F. B. White.

Agandecca, F. B. White.

76. *annectens*, F. B. White.

Fam. ASIRACIDÆ (= *Delphacinæ*, Hutton).

Micromasoria, Kirkaldy (= *Cona*, Hutton).

77. *cælata* (F. B. White).

P.S.—Recently I have received from Mr. A. Hamilton, Director of the Dominion Museum, Wellington, a small box of *Hemiptera*, containing, with other species, a specimen of *Dindymus versicolor*, an addition to the Maorian fauna. It is distributed over Australia and Tasmania, and is therefore not likely to be endemic, but has probably been introduced with fruit or fruit-trees. It belongs to the family *Pyrrhocoridæ* (not previously known from New Zealand), which may be recognised by the antennæ being inserted low down on the head, by the absence of ocelli, by the numerous veins on the membrane, &c.

In *Dindymus versicolor*, H.-S., the head, antennæ (mostly), legs, anterior area of pronotum, scutellum, apical margin of tegmina broadly, pygophor beneath, black; rest of pronotum and of tegmina brownish-red; sterna and pleura mostly red; abdomen beneath pale-yellow. Length, about 12 mm.

In the collection was also a specimen of *Nysius anceps*, White, which belong to the subgenus *Nithecus*, Horváth, if this is indeed a natural one. The species may, as White suggests, have a macropterous form.

Art. V.—*Birds on Kapiti Island.*

By James Drummond, F.L.S., F.Z.S.

[*Read before the Philosophical Institute of Canterbury, 2nd September, 1908.*]

Early this year, when my annual holiday arrived, I gladly took advantage of an opportunity to visit Kapiti Island, which was declared a native bird and plant sanctuary a few years ago. It is one of three sanctuaries in New Zealand. There is the Little Barrier Island in the north, Resolution Island in the south, and Kapiti Island halfway between. It lies about three miles off the western coast of Wellington Province, and at the western mouth of Cook Strait. It is about 5,000 acres in area, six miles long, and a mile and a quarter broad along its whole length. It is a rugged, precipitous island, and is much cut up into gorges, gullies, and creeks. Unlike the Little Barrier, however, it has a good deal of flat land. All along the western side of the island there are high cliffs, some of which rise to a height of 1,700 ft., near Mount Titeremoana, the highest peak.

I spent a week on the island, from the 21st February to the 27th February, making my headquarters at the Government cottage, on the terrace above the Rangatira Flat, halfway down the eastern coast. This site is very suitable for the purpose, as forest-clad hills rise up immediately behind the terrace, and I had to go only a few paces to be amongst the birds. I noted twenty-three species, and I have included in the list seven others which were seen by previous observers.

The whitehead (*Certhiparus albicapillus*) is very plentiful. It was the first native bird I saw on the sanctuary. I had hardly entered the bush on the slopes of the hills behind Rangatira when I heard the whitehead's noisy twittering. I heard it every day that I spent on the island. The silence of the forests was broken more frequently by whiteheads than by any other birds. It is satisfactory to know that this bird is represented on Kapiti as well as on the Little Barrier, as it had been reported to be on the verge of extinction. When I returned to Wellington after my visit to Kapiti, Mr. A. Hamilton told me that he had seen it in large numbers at Silverstream, near Wellington City, and in Christchurch. Mr. Edgar Stead reported its presence in Hawke's Bay, while Dr. L. Cockayne states that he saw large numbers in the central part of the Tongariro National Park, when he made a botanical survey there this year.

Bell-birds (*Anthornis melanura*) are also plentiful. I do not think that there is any place in the Dominion where they are more plentiful. The graceful flight of the tui (*Prosthemadera novæ-zealandiæ*) is a common sight on the sanctuary. These handsome birds are seen in large numbers on the karaka-trees. The berries were ripe at the time of my visit, and they seemed to afford the "parson-bird" ample supplies of food. I saw only a few fantails, but I noted that both the pied (*Rhipidura flabellifera*) and the black species (*R. fuliginosa*) are present. I was rather surprised to find the black one as plentiful as the pied. The pied fantail is found all over New Zealand, but the black one is common only in the south.

Except for the presence of this bird, the avifauna of the island has all the characteristics of the north: that is to say, several small birds are distinguished by white in their plumage, as against the yellow of the south. The robin (*Miro australis*) and the tomtit (*Petrœca toi-toi*), for instance, have the northern white breasts, and the presence of the whitehead instead of the yellowhead (*Mohua ochrocephala*) adds another northern characteristic. I should say that the position of the North Island robin on the sanctuary is an exceptionally satisfactory one. I seldom went into the bush without seeing this bird, which displayed all the traits that make it the most charming companion of those who visit New Zealand forests. On some days I spent hours without seeing a whitehead, a fantail, a bell-bird, a tui, a pigeon, or a tomtit, but I seldom went more than a few paces without the pleasure of the company of robins. Although the North Island tomtit is not represented as well as the robin and whitehead, it seems to be present in large numbers.

There is one peculiarity of bird-life that is noticeable on both the Little Barrier and Kapiti sanctuaries: the English birds and the native birds seem to keep apart. Apparently, there is no attempt on either side to establish relationships of any kind. I do not think that the English birds are in any way to blame for the decrease in the numbers of the native birds. The English birds, as far as I have been able to ascertain, do not interfere with the natives, and the natives take no notice of the intruders. Both have their own domains. I did not see any English bird inside the fringe of the bush, and I saw hardly any native birds in the open, outside of the trees, unless they were hurrying from one part to another.

One of the most striking phases of animal life on the island at present is the presence of hundreds of goats. The ancestors of these herds escaped from the whalers in the days of the whaling industry. In some parts of the island the goats are very plentiful. Their tracks are seen all over the hills and up and down the gullies, and there is no doubt that, although they have not interfered in any way with the bird-life, they have had a marked effect upon the vegetation. Sheep have also helped to bring about changes in this direction, and a few cattle have played their part. At the time of my visit there were a few deer on the island. Cats have been reported there, and I saw one opossum in the forests. I do not think that the cats are sufficiently numerous to do any serious injury to the birds. Apart from the cats, the birds have no natural enemies.

Between 1,200 and 1,300 acres of the island, or more than one-fifth, are held by Maori owners, who use their land as a small sheep-station. Their presence endangers the forests, and also, of course, the birds. They are careless, and through their carelessness a bush-fire may spread from their land on to the Government reserve, and sweep the island from end to end. During my visit, which was in the heat of summer, a fire broke out on the Maoris' end of the island, but it fortunately stopped just as it reached the Government's boundary. It has been suggested that the Maoris should be offered some inducement to relinquish their rights on the sanctuary, and that the whole island should be reserved.

I append a list of the native birds I noted. It contains the names of the Auckland Island flightless duck, and parrakeets from the Auckland and Antipodes Islands, liberated by Dr. L. Cockayne at the end of 1907. It also contains the names of a few birds which I did not see, but which were noted by Mr. H. G. Drew, of Wanganui, a few years previously: these are marked with an asterisk.

Popular Name.	Maori Name.	Scientific Name.
Grey warbler ...	Riroriro ...	*Pseudogerygone igata.*
North Island tit ...	Miromiro ...	*Petrœca toi-toi.*
North Island robin ...	Toutouwai ...	*Miro australis.*
Pied fantail ...	Tiwakawaka	*Rhipidura flabellifera.*
Black fantail ...	Tiwakawaka	*Rhipidura fuliginosa.*
Whitehead ...	Popokatea ...	*Certhiparus albicapillus.*
Ground-lark ...	Pihoihoi ...	*Anthus novæ-zealandiæ.*
White-eye ...	Tauhou ...	*Zosterops cærulescens.*
Tui or parson-bird ...	Tui ...	*Prosthemadera novæ-zealandiæ.*
Bell-bird or mocking-bird	Makomako ...	*Anthornis melanura.*
Kingfisher... ...	Kotare ...	*Halcyon vagans.*
Shining cuckoo* ...	Pipiwharauroa	*Chalcococcyx lucidus.*
Long-tailed cuckoo*	Koekoea ...	*Urodynamis taitensis.*
Kaka	Kaka ...	*Nestor australis.*
Antipodes Island parrakeet	...	*Cyanorhamphus unicolor.*
Red-fronted parrakeet	Kakarika ...	*Cyanorhamphus erythrotis.*
Bush-hawk ...	Karewarewa	*Nesierax australis.*
Quail-hawk ...	Karewarewa	*Nesierax novæ-zealandiæ.*
Pigeon	Kuku ...	*Hemiphaga novæ-zealandiæ.*
Woodhen* ...	Weka ...	*Ocydromus australis.*
Blue heron* ...	Matuku ...	*Demiegretta sacra.*
Pied stilt*... ...	Poaka ...	*Himantopus picatus.*
White-fronted tern ...	Tara ...	*Sterna frontalis.*
Black-backed gull ...	Karoro ...	*Larus dominicanus.*
Mutton-bird ...	Oi ...	*Puffinus griseus.*
Blue penguin* ...	Korora ...	*Eudyptula minor.*
Gannet	Takapu ...	*Sula serrator.*
Black shag* ...	Kawau ...	*Phalacrocorax carbo.*
Grey duck* ...	Parera ...	*Anas superciliosa.*
Flightless duck (Auckland Islands) ...	...	*Nesonetta aucklandica.*

STRIATED STONES.—Gudex.

ART. VI.—*Some Striated Stones from the St. Bernard Saddle, Upper Waimakariri Valley.*

By M. C. GUDEX.

Communicated by R. Speight.

[*Read before the Philosophical Institute of Canterbury, 2nd September, 1908.*]

ALTHOUGH almost all proofs of glaciation are frequently met with in New Zealand, it is remarkable that the discovery of ice-striated stones has been seldom recorded. In 1904 Mr. E. G. Hogg* recorded his discovery of striated stones at Lake Wakatipu.

The St. Bernard Saddle is really the terminal moraine of an old glacier which came down the valley of the Bealey over the Goldney Saddle and rounded the hill west of the Cass River. All the surrounding country bears unmistakable evidence of having been subjected to glaciation, for small lakes, *roches moutonnées*, moraines, and glacier-terraces are to be seen on every hand. Probably the most remarkable feature to be seen from the Saddle is a series of glacier-terraces high up on the slope of the hill to the right; all are parallel and dip slightly to the south, thus showing the direction of the glacier's motion. The St. Bernard Saddle, which is the most characteristic moraine, is well exposed in section in a great many railway-cuttings, shingle-pits, and road-cuttings. A typical section† shows that this morainic *débris* has been assorted by the action of streams flowing from the glacier, for the current-bedding is well defined. The angular nature of the boulders, however, shows that they cannot have been carried far by streams. A careful search among the stones thrown to the sides of the cuttings reveals many good specimens of striated stones of all sizes. They are usually composed of greywacke, but sometimes they are composed of blue slate. They possess a characteristic oval or round shape with parallel striæ, and this is decisive proof of the nature of their origin. The late Captain Hutton once expressed the opinion that few striated stones would be found in Canterbury; but the opening-up of the shingle-pits and cuttings at the St. Bernard Saddle has exposed many good specimens. These stones are an additional proof of the former glaciation of the Upper Waimakariri Valley.

* Trans. N.Z. Inst., xxxvii, 1904, p. 426.
† See Plate I.

Art. VII.—*On the Harmonic Conic of Two Given Conics.*

By Evelyn G. Hogg, M.A., Christ's College, Christchurch.

[*Read before the Philosophical Institute of Canterbury, 4th July, 1908.*]

1. Let two conics be taken—say,

$$S_1 \equiv 2l_1yz + 2m_1zx + 2n_1xy = o$$
$$S_2 \equiv 2l_2yz + 2m_2zx + 2n_2xy = o.$$

These conics are respectively the isogonal transformations of the lines

$$L_1 \equiv l_1x + m_1y + n_1z = o$$
$$L_2 \equiv l_2x + m_2y + n_2z = o.$$

The tangent to S_1 at any point P will transform isogonally into a conic touching L_1 at the point which is the isogonal conjugate of P.

Let a common tangent to S_1 and S_2 touch these conics in P_1 and P_2 respectively, and let its equation be

$$\lambda x + \mu y + \nu z = o.$$

This transforms isogonally into the conic

$$\lambda yz + \mu zx + \nu xy = o,$$

which touches L_1 and L_2 in the points which are the isogonal conjugates of P_1 and P_2 respectively. Hence, since this conic has double contact with L_1 and L_2, its equation is of the form

$$L_1L_2 - (px + qy + rz)^2 = o.$$

Comparing this with the form

$$\lambda yz + \mu zx + \nu xy = o$$

we have $p^2 = l_1l_2$, $q^2 = m_1m_2$, $r^2 = n_1n_2$, and this shows that the four conics which are the isogonal transformations of the common tangents of S_1 and S_2 touch L_1 and L_2 along the four lines

$$\sqrt{l_1l_2}\,x \pm \sqrt{m_1m_2}\,y \pm \sqrt{n_1n_2}\,z = o.$$

These four lines determine on L_1 and L_2 eight points which are the isogonal conjugates of the points of contact of the four common tangents of S_1 and S_2. The four points lying on L_1 and the four on L_2 may be regarded as the intersections of L_1 and L_2 with a quartic curve.

The equation of this quartic will be of the form

$$L_1L_2\,(ax^2 + by^2 + cz^2 + 2fyz + 2gzx + 2hxy) + c_1c_2c_3c_4 = o,$$

where

$$c_1 \equiv \quad \sqrt{l_1l_2}\,x + \sqrt{m_1m_2}\,y + \sqrt{n_1n_2}\,z$$
$$c_2 \equiv \quad \sqrt{l_1l_2}\,x - \sqrt{m_1m_2}\,y - \sqrt{n_1n_2}\,z$$
$$c_3 \equiv -\sqrt{l_1l_2}\,x + \sqrt{m_1m_2}\,y - \sqrt{n_1n_2}\,z$$
$$c_4 \equiv -\sqrt{l_1l_2}\,x - \sqrt{m_1m_2}\,y + \sqrt{n_1n_2}\,z.$$

If we now let $a = l_1l_2$, $b = m_1m_2$, $c = n_1n_2$

$$2f = -(m_1n_2 + m_2n_1),\ 2g = -(n_1l_2 + n_2l_1),\ 2h = -(l_1m_2 + l_2m_1)$$

the quartic reduces to

$$(m_1n_2 - m_2n_1)^2\,y^2z^2 + (n_1l_2 - n_2l_1)^2\,z^2x^2 + (l_1m_2 - l_2m_1)\,x^2y^2$$
$$+ 2\,[(n_1l_2 + n_2l_1)\,(l_1m_2 + l_2m_1)\,x^2yz + (l_1m_2 + l_2m_1)\,(m_1n_2 + m_2n_1)\,y^2zx$$
$$+ (m_1n_2 + m_2n_1)\,(n_1l_2 + n_2l_1)\,z^2xy] = o.$$

The isogonal transformation of this—on which lie the eight points of contact of the common tangents of S_1 and S_2—is the conic

$$(m_1n_2 - m_2n_1)^2 x^2 + (n_1l_2 - n_2l_1)^2 y^2 + (l_1m_2 - l_2m_1) z^2$$
$$+ 2 [(n_1l_2 + n_2l_1)(l_1m_2 + l_2m_1) yz + (l_1m_2 + l_2m_1)(m_1n_2 + m_2n_1) zx$$
$$+ (m_1n_2 + m_2n_1)(n_1l_2 + n_2l_1) xy] = o,$$

which is the F conic of the two circumconics S_1 and S_2.

The form of the above quartic also shows that on the conic F lie eight points which are the isogonal conjugates of the points in which the four lines

$$\sqrt{l_1l_2}\, x \pm \sqrt{m_1m_2}\, y \pm \sqrt{n_1n_2}\, z = o$$

intersect the conic

$$F^1 \equiv l_1l_2x^2 + m_1m_2y^2 + n_1n_2z^2 - (m_1n_2 + m_2n_1) yz$$
$$- (n_1l_2 + n_2l_1) zx - (l_1m_2 + l_2m_1) xy = o.$$

If $\left(\frac{1}{l_1}, \frac{1}{m_1}, \frac{1}{n_1}\right)$ and $\left(\frac{1}{l_2}, \frac{1}{m_2}, \frac{1}{n_2}\right)$ be respectively the co-ordinates of two points o_1 and o_2, then the conic F^1 passes through the six points in which the lines joining the vertices of the triangle of reference to o_1 and o_2 meet the opposite sides of that triangle; but these six points are the points in which the conics

$$S_3 = \sqrt{l_1x} + \sqrt{m_1y} + \sqrt{n_1z} = o$$
$$S_4 = \sqrt{l_2x} + \sqrt{m_2y} + \sqrt{n_2z} = o$$

touch the sides of the triangle of reference.

Hence the conic F^1 is the F conic of S_3 and S_4.

To obtain the equations of the four common tangents of S_1 and S_2 let us form the four conics

$$T_1 \equiv L_1L_2 - c_1^2 = o$$
$$T_2 \equiv L_1L_2 - c_2^2 = o$$
$$T_3 \equiv L_1L_2 - c_3^2 = o$$
$$T_4 \equiv L_1L_2 - c_4^2 = o,$$

and write down their isogonal transformations, which will be the equations of the common tangents.

Let
$$X_0 = (\sqrt{m_1n_2} - \sqrt{m_2n_1})^2,\ X_1 = (\sqrt{m_1n_2} + \sqrt{m_2n_1})^2$$
$$Y_0 = (\sqrt{n_1l_2} - \sqrt{n_2l_1})^2,\ \ Y_1 = (\sqrt{n_1l_2} + \sqrt{n_2l_1})^2$$
$$Z_0 = (\sqrt{l_1m_2} - \sqrt{l_2m_1})^2,\ Z_1 = (\sqrt{l_1m_2} + \sqrt{l_2m_1})^2,$$

then the equations of the common tangents of the two conics S_1 and S_2 are

$$t_1 \equiv X_0x + Y_0y + Z_0z = o$$
$$t_2 \equiv X_1x + Y_1y + Z_1z = o$$
$$t_3 \equiv X_1x + Y_0y + Z_1z = o$$
$$t_4 \equiv X_1x + Y_1y + Z_1z = o.$$

These tangents constitute four of the group of eight lines represented by the equation

$$(\sqrt{m_1n_2} \pm \sqrt{m_2n_1})^2 x + (\sqrt{n_1l_2} \pm \sqrt{n_2l_1})^2 y + (\sqrt{l_1m_2} \pm \sqrt{l_2m_1})^2 z = o.$$

The remaining set of four lines may be written

$$p_1 \equiv X_1x + Y_1y + Z_1z = o$$
$$p_2 \equiv X_1x + Y_0y + Z_0z = o$$
$$p_3 \equiv X_0x + Y_1y + Z_0z = o$$
$$p_4 \equiv X_0x + Y_0y + Z_1z = o.$$

Let now the equations of the following conics

$$F^1 - c_1^2 = o,\ F_0^1 - c_2^2 = o,\ F^1 - c_3^2 = o,\ F^1 - c_4^2 = o$$

be formed. They are found to be respectively—

$$P_1 \equiv X_1yz + Y_1zx + Z_1xy = o$$
$$P_2 \equiv X_1yz + Y_0zx + Z_0xy = o$$
$$P_3 \equiv X_0yz + Y_1zx + Z_0xy = o$$
$$P_4 \equiv X_0yz + Y_0zx + Z_1xy = o$$

—that is to say, these conics are the isogonal transformations of the four lines p_1, p_2, p_3, p_4.

Hence the sixteen points found on F may be regarded as the isogonal conjugates of the sixteen points in which each of the lines c_1, c_2, c_3, c_4 is met respectively by the isogonal transformations of the pairs t_1, p_1; t_2, p_2; t_3, p_3; t_4, p_4.

The isogonal conjugates of the four points in which c_1 is met by the conics T_1 and P_1 will lie on the conic which is the isogonal transformation of c_1, hence the sixteen points on F lie four by four on the four conics

$$\sqrt{l_1l_2}\,yz \pm \sqrt{m_1m_2}\,zx \pm \sqrt{n_1n_2}\,xy = o.$$

It may be easily shown that

$$\begin{aligned} F &\equiv t_1p_1 + 4\sqrt{\Delta_1\Delta_2}\,(\sqrt{l_1l_2}\,yz + \sqrt{m_1m_2}\,zx + \sqrt{n_1n_2}\,xy) \\ &\equiv t_2p_2 + 4\sqrt{\Delta_1\Delta_2}\,(\sqrt{l_1l_2}\,yz - \sqrt{m_1m_2}\,zx - \sqrt{n_1n_2}\,xy) \\ &\equiv t_3p_3 + 4\sqrt{\Delta_1\Delta_2}\,(-\sqrt{l_1l_2}\,yz + \sqrt{m_1m_2}\,zx - \sqrt{n_1n_2}\,xy) \\ &\equiv t_4p_4 + 4\sqrt{\Delta_1\Delta_2}\,(-\sqrt{l_1l_2}\,yz - \sqrt{m_1m_2}\,zx + \sqrt{n_1n_2}\,xy) \end{aligned}$$

where Δ_1 and Δ_2 are the discriminants of S_1 and S_2.

It also follows that

$$F \equiv \tfrac{1}{4}(t_1p_1 + t_2p_2 + t_3p_3 + t_4p_4) = \tfrac{1}{4}\Sigma\,(tp).$$

The conic F^1 passes through the intersection of the conics

$$l_1l_2x^2 + m_1m_2y^2 + n_1n_2z^2 = o$$
$$(m_1n_2 + m_2n_1)\,yz + (n_1l_2 + n_2l_1)\,zx + (l_1m_2 + l_2m_1)\,xy = o.$$

The former of these is the fourteen-point conic of the system of lines

$$\sqrt{l_1l_2}\,x \pm \sqrt{m_1m_2}\,y \pm \sqrt{n_1n_2}\,z = o,$$

while the latter is the isogonal transformation of the line

$$L \equiv (m_1n_2 + m_2n_1)\,x + (n_1l_2 + n_2l_1)\,y + (l_1m_2 + l_2m_1)\,z = o.$$

It may be at once shown that

$$F \equiv L^2 - \Delta_1\Delta_2S_0$$

where S_0 is the conic $\quad \dfrac{x^2}{l_1l_2} + \dfrac{y^2}{m_1m_2} + \dfrac{z^2}{n_1n_2} = o.$

It is seen on inspection that

$$t_1 + p_1 = t_2 + p_2 = t_3 + p_3 = t_4 + p_4 = 2L,$$
$$\Sigma(t) = \Sigma(p) = 4L,$$

and it is easily proved that

$$\Sigma(t^2) = \Sigma(p^2) = 4\,[F + 2\Delta_1\Delta_2 S_0]$$
$$t_1 t_2 t_3 t_4 = F^2 - 4\Delta_1\Delta_2 S_1 S_2$$
$$= p_1 p_2 p_3 p_4 - 128xyzL.$$

It may also be noticed that the lines L_1 and L_2 are conjugate with respect to all conics inscribed in the standard quadrilateral

$$\sqrt{l_1 l_2}\,x \pm \sqrt{m_1 m_2}\,y \pm \sqrt{n_1 n_2}\,z = o.$$

Since t_1 touches each of the conics S_1 and S_2 we have

$$\sqrt{l_1 X_0} + \sqrt{m_1 Y_0} + \sqrt{n_1 Z_0} = o$$
$$\sqrt{l_2 X_0} + \sqrt{m_2 Y_0} + \sqrt{n_2 Z_0} = o$$

with similar equations of condition for t_2, t_3, and t_4: hence the co-ordinates of the four intersections of the conics S_3 and S_4 are

$$(X_0Y_0Z_0),\ (X_0Y_1Z_1),\ (X_1Y_0Z_1),\ (X_1Y_1Z_0).$$

The common tangents t_1, t_2, t_3, t_4, are the axes of homology of the isogonal conjugates of the intersections of S_3 and S_4.

Let the equations of two rectangular hyperbolas S' S'' referred to their common self-conjugate triangle be

$$S' \equiv l'x^2 + m'y^2 + n'z^2 = o$$
$$S'' = l''x^2 + m''y^2 + n''z^2 = o.$$

The equations of their common tangents are

$$x\sqrt{l'l''(m'n''-m''n')} \pm y\sqrt{m'm''(n'l''-n''l')} \pm z\sqrt{n'n''(l'm''-l''m')} = o.$$

Let one of these tangents touch S' and S'' at $P'(x'y'z')$ and $P''(x''y''z'')$ respectively, then

$$l'x' = \kappa'\sqrt{l'l''\,(m'n'' - m''n')}$$
$$l''x'' = \kappa''\sqrt{l'l''\,(m'n'' - m''n')},$$

and therefore $\quad x'x'' = \kappa'\kappa''\,(m'n'' - m''n')\,;$

similarly, $\quad y'y'' = \kappa'\kappa''\,(n'l'' - n''l')$

$$z'z'' = \kappa'\kappa''\,(l'm'' - l''m').$$

Also, since $\quad l' + m' + n' = o,\ l'' + m'' + n'' = o,$

we have $\quad m'n'' - m''n' = n'l'' - n''l' = l'm'' - l''m',$

and therefore $\quad x'x'' = y'y'' = z'z''$

—that is to say, P' and P'' are isogonal conjugates.

Hence the points in which the harmonic conic of S' and S'' cuts those conics are isogonal conjugates in pairs with respect to the self-conjugate triangle of the hyperbolas.

Art. VIII.—*On certain Conic-loci of Isogonal Conjugates.*

By Evelyn G. Hogg, M.A., Christ's College, Christchurch.

[*Read before the Philosophical Institute of Canterbury, 1st July, 1908.*]

1. The locus of a point P $(\alpha\beta\gamma)$ which moves so that the line joining it to its isogonal conjugate P' $\left(\frac{1}{\alpha}\frac{1}{\beta}\frac{1}{\gamma}\right)$ passes through a fixed point $(\alpha_0\beta_0\gamma_0)$ is the cubic

$$\frac{\alpha}{\alpha_0}(\beta^2-\gamma^2)+\frac{\beta}{\beta_0}(\gamma^2-\alpha^2)+\frac{\gamma}{\gamma_0}(\alpha^2-\beta^2)=o.$$

If, however, the point $(\alpha_0\beta_0\gamma_0)$ lie on either the internal or external bisector of an angle of the triangle of reference, the cubic becomes a conic and a straight line; and the object of the present paper is to investigate certain properties which this family of conics possesses. For the sake of brevity the fixed point $(\alpha_0\beta_0\gamma_0)$ through which the line joining any point to its isogonal conjugate passes will be called the *centrum* of the conic.

The co-ordinates of the *centrum* are comprised in the system $(\alpha_0 \pm 1 \pm 1)$ if we limit ourselves merely to the internal and external bisectors of the angle A of the triangle of reference ABC. The following four types of conic exist :—

Centrum $(\alpha_0\,11)$	$\alpha^2+\beta\gamma-\alpha_0\alpha(\beta+\gamma)=o$	... I
Centrum $(\alpha_0\,-11)$	$\alpha^2-\beta\gamma+\alpha_0\alpha(\beta-\gamma)=o$	... II
Centrum $(\alpha_0\,1-1)$	$\alpha^2-\beta\gamma-\alpha_0\alpha(\beta-\gamma)=o$	... III
Centrum $(\alpha_0\,-1-1)$	$\alpha^2+\beta\gamma+\alpha_0\alpha(\beta+\gamma)=o$	... IV

2. These conics possess the following properties: they all pass through the vertices B and C of the triangle of reference; those of classes I and IV pass through the ex-centres I_2 and I_3; those of classes II and III pass through the in-centre I and the ex-centre I_1. The tangents to the conics at I and I_1 or at I_2 and I_3 pass through the *centrum*; the tangents to the conics at B and C meet at the isogonal conjugate of the *centrum*. Hence, when the position of the *centrum* has been assigned, the centre of the conic can be constructed geometrically.

Furthermore, the chord of intersection of any conic of this family with the circumcircle of the triangle of reference is parallel to either the internal or external bisector of the angle A of that triangle. Suppose any conic to cut the circle ABC in the points P and Q: then, since the isogonal conjugate of any point on that circle lies at infinity in a direction perpendicular to the Simson line of the point, the isogonal conjugates of P and Q will be at infinity in directions perpendicular to the Simson lines of those points—that is to say, the asymptotic angle of the conic is equal to the angle between the perpendiculars from the *centrum* on the Simson lines of P and Q.

If the position of the chord of intersection of the conic and circle ABC is determined, the position of the asymptotes, and therefore of the axes, may be found, since the centre is known, while the eccentricity of the conic may be deduced from the relation

$$e^2 = \frac{2R}{p + R}$$

where R is the radius of the circumcircle, and p is the length of the perpendicular from the circumcentre on the chord of intersection.

3. We now proceed to deal with certain particular conics of this family. The line $\beta - \gamma = o$ will meet the line at infinity in the point $(b + c, -a, -a)$; with this point as *centrum* we have the conic

$$a(\alpha^2 + \beta\gamma) + (b + c)\alpha(\beta + \gamma) = o \quad \ldots \quad \ldots \quad \ldots \quad A$$

which may be written

$$a\beta\gamma + \beta\gamma\alpha + c\alpha\beta + \alpha(a\alpha + b\beta + c\gamma) = o.$$

It is the circle on I_2I_3 as diameter. Hence the theorem—

"Any line parallel to the internal bisector of the angle A of the triangle ABC meets the circle described on I_2I_3 as diameter in two points which are isogonal conjugates with respect to that triangle."

The external bisector $\beta + \gamma = o$ meets the line at infinity in the point $(b - c, -a, a)$. This point being taken as *centrum*, we have the conic

$$a(\alpha^2 - \beta\gamma) + (b - c)\alpha(\beta - \gamma) = o \quad \ldots \quad \ldots \quad \ldots \quad B$$

which is the circle on the line II_1 as diameter. Hence the theorem—

"Any line parallel to the external bisector of the angle A of the triangle ABC meets the circle described on II_1 as diameter in points which are isogonal conjugates with respect to that triangle."

4. The line $\beta - \gamma = o$ meets the circle ABC in the point $(-a, b + c, b + c)$: with this *centrum* we have the conic

$$(b + c)(\alpha^2 + \beta\gamma) + a\alpha(\beta + \gamma) = o \quad \ldots \quad \ldots \quad \ldots \quad C.$$

It meets the circle ABC along the line

$$(b + c)(a\alpha - c\beta + b\gamma) + a^2(\beta + \gamma) = o,$$

which may be written

$$(b + c)(a\alpha + b\beta + c\gamma) - [(b + c)^2 - a^2](\beta + \gamma) = o.$$

This is satisfied by the co-ordinates of the centre of the circle ABC. Hence the chord of intersection is the diameter parallel to the external bisector of the angle A. Therefore, since the Simson lines of the extremities of a diameter of a circle are at right angles to each other, we see that the conic is a rectangular hyperbola. The tangents to the conic at B and C are parallel to the internal bisector of A, hence the centre of the conic is the middle point of BC.

The line $\beta + \gamma = o$ will meet the circle ABC in the point

$$(a, -b + c, b - c);$$

with this *centrum* we have conic

$$(b - c)(\alpha^2 - \beta\gamma) + a\alpha(\beta - \gamma) = o \quad \ldots \quad \ldots \quad \ldots \quad D.$$

Its chord of intersection with the circle ABC is the diameter parallel to the internal bisector of the angle A, and its centre is at the middle point of BC.

5. Let D, E, F be respectively the middle points of BC, CA, and AB: then the equations of EF, FD, and DE are

$$-a\alpha + b\beta + c\gamma = o \quad \dots \quad \dots \quad \dots \quad \dots \quad \text{(i)}$$
$$a\alpha - b\beta + c\gamma = o \quad \dots \quad \dots \quad \dots \quad \dots \quad \text{(ii)}$$
$$a\alpha + b\beta - c\gamma = o \quad \dots \quad \dots \quad \dots \quad .. \quad \text{(iii)}$$

The line $\beta - \gamma = o$ will meet the first of these lines in the point $(b + c, a, a)$: using this point as *centrum* we have the conic

$$a(\alpha^2 + \beta\gamma) - (b + c)\,\alpha\,(\beta + \gamma) = o \quad \dots \quad \dots \quad \dots \quad \text{E}$$

which meets the circle ABC along the line

$$a\alpha - (b + 2c)\,\beta - (c + 2b)\,\gamma = o,$$

or

$$a\alpha + b\beta + c\gamma - 2\,(b + c)\,(\beta + \gamma) = o.$$

This line meets the internal bisector of angle A at the point $[3(b+c), a, a]$, which is the middle point of the line joining A to the point in which the internal bisector of A meets EF. Hence the conic is a hyperbola, whose centre and asymptotes are found in the manner previously employed.

The line $\beta - \gamma = o$ meets the lines (ii) and (iii) respectively in the points $[(b-c), a, a]$ and $[-(b-c), a, a]$. With these points as *centra* we obtain the conics

$$a(\alpha^2 + \beta\gamma) - (b - c)\,\alpha\,(\beta + \gamma) = o \quad \dots \quad \dots \quad \dots \quad \text{F}$$
$$a(\alpha^2 + \beta\gamma) + (b - c)\,\alpha\,(\beta + \gamma) = o \quad \dots \quad \dots \quad \dots \quad \text{G}.$$

The former of these conics meets the circle along the line

$$a\alpha - b\beta - (2b - c)\,\gamma = o,$$

which is parallel to $\beta + \gamma = o$ and passes through the middle point of AB. The latter conic meets the circle ABC along the line

$$a\alpha + (b - 2c)\,\beta - c\gamma = o,$$

a line parallel to $\beta + \gamma = o$ and passing through the middle point of AC. Hence each of the conics F and G is a hyperbola.

6. The line $\beta + \gamma = o$ will meet the lines (i), (ii), and (iii) of the preceding section respectively in the points

$$[(b - c), a, -a],\ [(b + c), a, -a],\ [(b + c), -a, a].$$

Using these points as *centra* we have the conics

$$a(\alpha^2 - \beta\gamma) - (b - c)\,\alpha\,(\beta - \gamma) = o \quad \dots \quad \dots \quad \dots \quad \text{H}$$
$$a(\alpha^2 - \beta\gamma) - (b + c)\,\alpha\,(\beta - \gamma) = o \quad \dots \quad \dots \quad \dots \quad \text{J}$$
$$a(\alpha^2 - \beta\gamma) + (b + c)\,\alpha\,(\beta - \gamma) = o \quad \dots \quad \dots \quad \dots \quad \text{K}.$$

Their chords of intersection with the circle ABC are respectively

$$a\alpha + (2c - b)\,\beta + (2b - c)\,\gamma = o$$
$$a\alpha - b\beta + (2b + c)\,\gamma = o$$
$$a\alpha + (b + 2c)\,\beta - c\gamma = o.$$

These lines are all parallel to the internal bisector of the angle A: the first of them passes through the point $[3\,(b - c), a, -a]$, which is the middle point of the line joining A to the point in which the external bisector of A meets EF. The second and third lines pass respectively through the middle points of AB and AC.

7. If the *centrum* be taken at the point (011) in which the internal bisector of the angle A meets BC we have the conic

$$\alpha^2 + \beta\gamma = o \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad L$$

touching AB, AC, at B and C respectively, and passing through I_2 and I_3.

This conic meets the circle ABC in the line

$$a\alpha - c\beta - b\gamma = o,$$

showing that it passes through the point in which the tangent to the circle ABC at A meets BC. This chord may also be written in the form

$$a\alpha + b\beta + c\gamma - (b + c)(\beta + \gamma) = o,$$

showing that it is parallel to the external bisector of the angle A. It has real intersections with the circle ABC, hence the conic is a hyperbola.

The tangents at I_2 and I_3 meet at the *centrum:* hence the centre is the point in which the median drawn from A meets the line joining the *centrum* to the middle point of I_2I_3. The position of the axes of the conic is therefore given.

8. If the *centrum* be taken at the point (0–11) in which the external bisector of the angle A meets BC we obtain the conic

$$\alpha^2 - \beta\gamma = o \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad M$$

which intersects the circle ABC along

$$a\alpha + b\beta + c\gamma - (b - c)(\beta - \gamma) = o,$$

a line which passes through the intersection of BC and the tangent to the circle ABC at A. The intersections of this line with the circle ABC are real if $a^2 > 4bc$, in which case the conic is a hyperbola. If $a^2 = 4bc$, the conic is a parabola whose axis is perpendicular to the Simson line of the point in which the above line touches the circle ABC. If $a^2 < 4bc$, the conic is an ellipse: to determine the direction of its axes, draw through the pole of this line with respect to the circle a line parallel to it, then the equi-conjugate axes of the ellipse are perpendicular to the Simson lines of the two points in which this line cuts the circle ABC, and the directions of the axes are therefore obtained.

9. The conics of this family possess the property that the isogonal transformation of the tangent to a conic at any point P is a conic circumscribing the triangle of reference and touching the given conic at the point P′, which is the isogonal conjugate of P.

Hence one of the common tangents to the circles described on I_1I_2, I_1I_3 as diameters will be a circumconic which touches each of these circles at the points isogonally conjugate to the points of contact of the common tangent.

10. Let any straight line L meet the circles described on the lines I_2I_3, I_3I_1, I_1I_2 as diameters in the three pairs of points P_1P_2, P_3P_4, P_5P_6 respectively; let chords of the three circles be drawn through P_1P_2 parallel to the internal bisector of A, through P_3P_4 parallel to the internal bisector of B, and through P_5P_6 parallel to the internal bisector of C; and let the extremities of these six chords be respectively $P_1'P_2'$, $P_3'P_4'$, $P_5'P_6'$. Further, let the line L cut the three circles on II_1, II_2, II_3 as diameters in the pairs of points Q_1Q_2, Q_3Q_4, Q_5Q_6, and let chords of these circles drawn parallel to the external bisectors of A, B, and C respectively have their extremities at $Q_1'Q_2'$, $Q_3'Q_4'$, $Q_5'Q_6'$. Then the fifteen points A, B, C, the six points P′, and the six points Q′ all lie on the conic which is the isogonal transformation of the line L.

11. The general form of the conic which is satisfied by the co-ordinates of a point and of its isogonal conjugate is

$$a(la + m\beta + n\gamma) \pm (l\beta\gamma + m\gamma a + na\beta) = o,$$

the *centrum* of the conic being the intersection with $la + m\beta + n\gamma = o$ of either the internal or the external bisector of the angle A of the triangle of reference.

The locus of a point moving so that the line joining it to its isogonal conjugate is parallel to the line $la + m\beta + n\gamma = o$ is the cubic

$$(mc - nb)\, a(\beta^2 - \gamma^2) + (na - lc)\, \beta(\gamma^2 - a^2) + (lb - ma)\, \gamma(a^2 - \beta^2) = o,$$

which, if any two of the three quantities $mc - nb$, $na - lc$, $lb - ma$ be equal or have their sum zero, reduces to a conic and either the internal or external bisector of an angle of the triangle of reference. If the two latter quantities be equal, the conic is

$$(na - lc)(a^2 + \beta\gamma) - (mc - nb)\, a(\beta + \gamma) = o,$$

which, since $a(m + n) = l(b + c)$, at once reduces to the form I of section 1 of this paper. A similar reduction occurs if the sum of the two quantities in question be zero.

Art. IX.—*The Technical Analysis of Sliped Wool.*

By A. M. Wright, F.C.S.

[*Read before the Philosophical Institute of Canterbury, 4th November, 1908.*]

New Zealand exported in 1906 wool to the total value of £6,765,655, weighing 154,384,568 lb. Of this, 15,049,470 lb., valued at £752,639, was sliped wool.

Sliped wool is the wool obtained from skins which have been washed in water to remove the adhering sand and dirt, together with a certain amount of the fat. After partially drying the skins in centrifugals the wool is removed by depilation and dried.

This is the process of treating the skins of sheep and lambs killed at the freezing-works in the Dominion. The sliped wool exported from New Zealand is almost exclusively a freezing-works product.

Two years ago a Royal Commission was appointed by the New Zealand Government to inquire into the cause of fires on wool-ships. Whilst some of the evidence taken before this Commission showed that fires had occurred in sliped wool, it could not be shown that this wool, either through excessive moisture or fat, had been the cause of fire.

In order to guard as far as possible against fires originating in sliped wool, either through excessive moisture or on account of foreign fatty matter, and, further, to obtain a standard quality for their output of wool, one of the largest meat-freezing and wool-export companies now requires that samples of wools from their various factories be regularly examined in their chemical laboratory—determinations of moisture, natural wool-grease, other fatty matter, sand, dirt, and lime, and wool-fibre being made.

The methods of analysis in a works-laboratory must of necessity be rapid, but at the same time reasonable accuracy must be assured, otherwise the method is valueless.

As far as the author can find, no methods of wool-analysis requiring the above determinations have as yet been published, so the following methods were devised to meet the requirements of a works-laboratory in which the chemical control of wools is carried out.

All that is claimed for the following methods is that they meet the requirements of a works-laboratory, and that, while they give accurate results, they are rapid, and the condition of the wool can be reported before a consignment is baled for shipment.

Moisture is determined in 1 gram by drying in an air-oven at 110° C. for one hour. After removal from the oven the sample must be placed in a desiccator under vacuum, and, after cooling, be weighed rapidly to prevent the absorption of atmospheric moisture, which, on account of the hydroscopic nature of wool, is readily taken up.

Natural wool-fat is determined in 2 grams of the material by extraction with hot alcohol. An aliquot portion of the liquid is evaporated to determine the total fat extracted; in another portion determine the free fatty acidity, using phenolphthalein as the indicator. After deducting the free acidity from the total fats, the balance is considered natural wool-fat.

In another portion of the material extract the total fats with petroleum-ether, and after deducting the natural wool-fat the balance is entered as "other fatty matter." After drying the wool substance used in the previous determination, weigh. The sand, dirt, and lime may be approximately determined by shaking out mechanically the adhering particles after the total-fat extraction, and, after washing in hot alcohol and drying, the loss on again weighing is entered as sand, lime, and dirt. The remaining substance is wool-fibre, and is entered as such.

The following are examples of analysis of sliped wools carried out as described:—

——	Leicester.	Lincoln.	Three-quarter-bred.	Half-bred.	Seconds.	Thirds.
	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.	Per Cent.
Moisture	12·22	13·40	11·08	11·70	12·80	12·74
Natural wool-fat ..	5·42	3·44	7·28	12·06	3·68	11·90
Other fatty matter ..	1·86	1·02	1·62	0·72	1·56	
Sand, dirt, and lime ..	5·74	6·42	10·30	8·14	12·26	19·08
Wool-fibre	74·76	75·72	69·72	67·38	69·70	56·28
	100·00	100·00	100·00	100·00	100·00	100·00

It should be noted that scoured wools, or wools washed with soap, cannot be examined for natural wool-grease by the method stated above, for the reason that all scoured wools retain some of the soap used, which is soluble in alcohol. The analysis of "thirds" shown above is an example of scoured wool.

For permission to publish these results I have to express my thanks to the Christchurch Meat Company (Limited).

Art. X. — *Notes on* Lepidoptera *collected by H. Hamilton in various Localities in the Queenstown District, Otago, between November,* 1907, *and March,* 1908.

By A. Hamilton.

[*Read before the Wellington Philosophical Society, 8th December,* 1908.]

In November, 1907, my son, H. Hamilton, was employed on a survey party of the New Zealand Geological Survey, under Professor Park, and in the course of the survey he came across a considerable number of *Lepidoptera.* The specimens secured were forwarded from time to time to the Museum, Wellington, and were then relaxed and set. I now give a list of about sixty of the species, as a contribution towards the information which will be necessary before the general distribution of the New Zealand *Lepidoptera* is known with any approach to accuracy. It must be remembered that owing to his duties my son could not devote any special time to collecting, and therefore missed many good things.

Nyctemera annulata, Gml.

This very common insect was sent up at my request, in the hope that some good varieties might occur, but beyond considerable variation in size there was nothing remarkable.

Metacrias huttoni.

A fine series of fourteen specimens was taken early in the season in the upper Arrow River bed, also in the Twelve-mile Creek, Macetown.

Orthosia comma, Walk.

Five specimens, from various localities.

Orthosia immunis, Walk.

Eight specimens, in very poor condition.

Physetica cærulea, Gml.

A very battered specimen. I have since obtained a specimen which, when fresh, exhibited a most beautiful bluish-violet tint.

Leucania moderata, Walk.

A good series of this insect, which appears to be a southern species. I have, however, taken specimens in Wellington this season.

Leucania nullifera, Walk.

The specimens taken of this fine insect were not in good condition. They were taken round the tent at night. I took several at a lamp about the same time at Waiouru, on the North Island Main Trunk line.

Leucania purdii.

I was delighted to receive a very typical specimen of this moth. At present it is decidedly scarce. Mr. Hudson took a specimen, at sugar, in the Routeburn.

Leucania atristriga, Walk.

This occurred in several localities, and seems to be common. I took it plentifully near Dunedin, at sugar, in the middle of March.

Leucania alopa, Meyr.

Four specimens of what I take to be this insect were sent from the neighbourhood of Macetown in February.

Leucania unica, Walk.

There is one specimen in poor condition which may be this species.

Leucania semivittata, Walk.

Four specimens were sent from Skipper's in January, flying round the tent in the evening.

Ichneutica ceraunias.

Five specimens of this very striking species were sent in January. One of the specimens is very light in colour, and is probably a female.

Melanchra disjungens, Walk.

This very distinct species was sent from Macetown. I took a very fine series, at light, at Waiouru, on the Main Trunk Railway, and also a few from the tussock-grass in the daytime in the same place.

Melanchra paracausta.

One specimen may probably represent this southern species.

Melanchra insignis.

Only two specimens are included in the collection. Either it was too early for this handsome moth or the altitude was too great. It was very plentiful, at sugar, in the Botanical Gardens in Wellington in February and March.

Melanchra plena.

A few specimens were obtained by my son, and I took a large number, at sugar, near Dunedin in the middle of March.

Melanchra mutans.

Only five *mutans* were sent.

Melanchra pictula.

My son was greatly interested in the capture of a specimen of this moth, in splendid condition, about the 30th March. He struck with the net at a *Vanessa gonerilla* at rest on a tree-trunk. He missed the butterfly, but heard a rustling in the net and found the *pictula*. It was probably at rest on the trunk of the tree.

Melanchra composita.

This species was, of course, well represented.

Melanchra rubescens.

This insect appeared to be one of the early forms, and was fairly numerous.

Melanchra umbra.

I was glad to receive in one parcel three good specimens of thi species.

Melanchra cucullina.

Four good specimens.

Melanchra dotata.

I think that one specimen received in January is *M. dotata.*

Agrotis admirationis.

There is a fine specimen of what I take to be this species in the collection, and an inferior specimen, much rubbed.

Many other species were also collected, mostly from alpine localities. Along the shores of Lake Wakatipu (1,000 ft.), in the month of March, the following species were gaily sporting in the sunshine :—

Notoreas brephos.
Notoreas perornata.
Lythria euclidiata.

Together with these were *Chrysophanus boldenarum* and an occasional *Vanessa gonerilla.*

From other localities in the same district I received at various times,—

Phrissogonus denotatus, Walk.
Hydriomena deltoidata, Walk.
,, *rixata,* Feld.
,, *purpurifera,* Fered.
Xanthorhoe orophylla, Meyr.
,, *semifissata,* Walk.
,, *chlamydota,* Walk.
,, *beata,* Butl.
,, *adonis,* Huds.
,, *prasinias,* Meyr.
,, *cineraria,* Dld.
,, *recta.*
,, *oraria.*
,, *cataphracta,* Meyr.
Lythria euclidiata, Gml.
Dasyuris anceps, Butl.
,, *hectori.*
Notoreas insignis, Butl.
,, *paradelpha,* Meyr.
,, *perornata,* Walk.
,, *brephos,* Walk.
Selidosema suavis, Butl.
,, *aristarcha,* Meyr.
,, *dejectaria,* Walk.
Azelina fortinata, Gml.

Of the *Rhopalocera,* the beautiful *Vanessa gonerilla* was everywhere present—first the hybernated specimens, and, later on, the new brood. These were in splendid condition when I visited Queenstown in the middle of March.

Argyrophenga antipodum, Doubld.

I particularly asked for specimens of this species from as many localities as possible, and I received altogether about forty specimens in good condition from Macetown, Skipper's, Bullendale, and Moke Lake.

Erebia pluto, var. *micans.*

My son writes with great enthusiasm of his first sight of this alpine species and wired to me that he had taken some. This was early in December, and I could hardly believe that he had correctly identified them; but when they came to hand I was glad to find that not only were they *Erebia*, but they were in some respects different from the specimens which I had seen from Mount Arthur and Mount Peel.

The specimens were in the best possible condition, and are evidently much earlier in appearing than has been supposed, as Mr. Hudson* gives January, February, and March. It is recorded in the same work as being taken by him at Wakatipu, but there is no mention of any considerable variation. The first box of specimens was accompanied by a note, in which my son drew my attention to the spangling of golden scales on the underside hindwings, and to the intense velvet-black of the specimens, as contrasted with the cabinet specimens from Mount Arthur. Some of their rich black has disappeared now that the specimens have been set, but the golden scales are still apparent in the majority of cases, though less bright. They are found on both male and female. By the kindness of Mr. A. McKay, an enlarged photograph was taken of the under-surface, which showed the brilliant reflecting scales, implanted at irregular distances, but all in the same direction as the others, so that there is no possibility of their having been derived by accident in the killing-bottle or in the packing from some other species. Their appearance is very beautiful under the microscope. I have examined the specimens in Mr. Hudson's collection and in two other collections without finding any bright scales of this kind on the under-surface of the hindwings. The average size of the Otago specimens is smaller than that of the Mount Arthur ones.

From the notes that accompanied the specimens it appears that the *Erebia* is found in small colonies.

From the early date at which the majority of the specimens were obtained it is possible that the spangled form may be either an early brood or a very local form. The usual variations are to be found in the number and arrangement of the white centres to the ocelli, but they are uniformly smaller than in the northern specimens which are available for comparison, being in some cases barely visible. The pale spots visible on the under-surface of the hindwings of *E. pluto* are in the majority of cases not to be distinguished in this variety.

I have not examined the venation.

Of thirteen specimens from Mount Arthur and Mount Peel in the Museum collection, I find that the maximum expanse of the forewing is 51 mm. and the minimum 45 mm. Of the thirty-five Otago specimens in the collection, the maximum is 46 mm. and the minimum 40 mm.

Altogether this form is so different from the specimens available from other localities that I suggest for it as a varietal name *E. pluto*, var. *micans*.

The first *Erebias* were caught on the upper Arrow River and on Mount Hyde, at about 6,000 ft., about the 20th November;† one colony was found near the Premier Mine on the 19th December; and on the 30th January they had all disappeared.

The genus is a very variable one, and in all alpine regions local forms are very numerous.

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* Hudson, "New Zealand Moths and Butterflies," p. 114.

† They were then copulating.

Porina.

Specimens of *P. despecta* and *umbraculata* were sent from time to time, and four specimens of a very small form, which may only be small males, or may be the males of other species.

Porina annulata, n. sp.

This most interesting form was received by me one day with the following particulars: "Just returned to Skipper's after a rough trip, which, however, I forgot all about after I caught the moth that I am now sending. When we were up Mount Aurum I thought I saw a large moth with a ringed body flying quickly about, just off the ground, but I could not lay hands on one. When we had finished chaining up Stony Creek one of these flew up and got tangled in a tussock right at my feet. I promptly dropped the net over him. . . . I do not know if it is rare, but it was only seen above 4,000 ft., on tussocky beds among the gentians."

This moth is at once distinguished from the other *Porinas* by the distinct annulate markings on the body, the only other at all partaking of this character being *P. characterifera*, a very much larger moth, probably belonging to a different section of the group. Both the upper and lower wings are semi-transparent. Expansion of forewing, 50 mm.; lower wing, 44 mm. The forewings are sparsely covered with scales, so as to be nearly as translucent as the hindwings of *P. despecta*. Antennæ strongly pectinate in the male. Head and thorax yellowish-brown. Abdomen pale yellowish-grey, with seven or eight black rings, very distinct when fresh, but not so apparent when dry. The forewings are brownish-grey, irregularly covered with markings, the majority of which are spots of an ochre-yellow, interspersed with smaller white marks. The hindwings are brown-grey, showing a few yellowish spots on the termen. Both wings are bordered with dark reddish-brown cilia, longer in proportion than those in *P. cervinata*.

The yellow spots on the wings and the annulated body afford the best distinctive points for the recognition of the species.

In the specimens described the fore and hind wings are more nearly alike in size than in most of the members of the genus, being as 50 and 44. In my specimen of *P. cervinata* they are as 82 to 65. In *P. dinodes* the relation is, however, about 70 to 62. In *Porina* the variation in size, markings, &c., are so great that a long series will be required before any weight can be attached to the proportionate expansion of the wings.

Type in the Dominion Museum: coll., H. Hamilton.

Art. XI.—*A Rapid and Accurate Method of estimating Iron in Iron-ores.*

By J. S. Maclaurin, D.Sc., F.C.S., and W. Donovan, M.Sc.

[*Read before the Wellington Philosophical Society, 2nd September, 1908.*]

Any one who has had experience in the estimation of iron in magnetites and hæmatites must have frequently found difficulty in getting the iron into solution within a reasonable time. Such difficulties led one of us to subject the ore to a preliminary heating in hydrogen or coal-gas. The iron could then be readily dissolved in hydrochloric acid, reduced by stannous chloride, and estimated volumetrically. In these estimations, however, potassium permanganate could not be used if really accurate results were required, owing to the disturbing effect of hydrochloric acid, and consequently one was driven to employ the bichromate method, which has the serious defect of requiring an external indicator. These defects have been entirely removed by modifying the process, which is now carried out in the following manner:—

A weighed quantity of finely ground ore is introduced into a hard glass bulb tube by means of a small copper scoop (made of thick copper foil bent into the desired shape and soldered to a stout piece of copper wire). Into the ends of the tube, corks carrying narrow glass tubes are then fitted. Should the ore contain organic matter, air is drawn through the tube by means of a filter pump or aspirator, and the bulb heated to redness for a few minutes, being gently rotated backwards and forwards during the heating. It is then allowed to cool, the air-current stopped, and a stream of hydrogen or coal-gas substituted. This is lighted at the exit end of the small glass tube. Should hydrogen be used, the tube may be prevented from closing up by the use of a platinum tip, made by rolling a small strip of platinum foil round the end of the tube. After heating for from ten to thirty minutes, according to the nature of the ore, the tube is allowed to cool, the stream of hydrogen or coal-gas is shut off, and the reduced ore shaken into a flask containing 1 or 2 grams of sodium bicarbonate and a little water. Any ore remaining in the tube is washed into the flask with dilute sulphuric acid. By this means sufficient carbon dioxide is evolved to fill the flask, and so prevent oxidation of the iron. In order to still further guard against oxidation, the flask is closed by a rubber cork carrying a short exit-tube, and an inlet-tube which dips beneath the surface of the solution in the flask, through which a steady stream of carbon dioxide is allowed to flow from a Kipp's apparatus. The flask is then heated, and the solution boiled for from five to twenty minutes, according to the ease with which the iron dissolves. This operation requires little or no attention, and can be carried out while another sample is being heated in the bulb tube.

When it is seen that all the iron is dissolved, the solution is allowed to cool in the air, or more rapidly by closing the exit-tube with the finger, and allowing water to flow over the outside of the flask, the carbon dioxide apparatus being still, of course, attached. It only remains to shut off the carbon dioxide, remove the cork from the flask, wash the tubes with a little water, and titrate the solution with potassium permanganate.

This process gives very constant results, duplicate determinations agreeing excellently. Thus, in estimating the iron in fifty-five samples of limonite, the greatest difference in the duplicate determinations, which were made quite independently of one another, was 0·22 per cent. of iron, and the average difference only 0·09 per cent. In many of these determinations, after titrating with permanganate, the solution was reduced with sulphuretted hydrogen, the excess of this gas being removed by passing carbon dioxide through the boiling solution (Hillebrand's method). The iron so reduced was then estimated by titration with permanganate, and in every case the result so found agreed closely with that previously found by our method. This agreement shows that the whole of the iron dissolved out of the reduced ore goes into solution as a ferrous salt, and is therefore estimated in the subsequent titration. Moreover, the residues contained no iron. This was proved by fusing with carbonates of soda and potash and testing for iron.

We had thus conclusive proof of the accuracy of our results, but for the sake of comparison with other methods the following determinations on five limonites were made. The results given under A are by our method; those under B were determined by dissolving in hydrochloric acid and stannous chloride, adding mercuric chloride to remove the excess of stannous chloride, phosphoric acid and manganese sulphate to improve the conditions for titration, and finally titrating with permanganate. In column C of the table the results were obtained by dissolving in hydrochloric acid, reducing with lead and copper sulphate, and titrating with potassium bichromate. The results are percentages of iron.

A.	B.	Difference from A.	C.	Difference from A.
44·03	43·13	— 0·90	43·42	— 0·61
49·21	49·06	— 0·15	49·29	+ 0·08
36·57	36·99	+ 0·42	36·66	+ 0·09
26·73	26·46	— 0·27	26·78	+ 0·05
35·52	35·97	+ 0·45	36·02	+ 0·50
	Mean difference	— 0·09	Mean difference	+ 0·02

The titration in the case of B is not nearly so satisfactory as in A, owing to the presence of a large amount of precipitate, which somewhat masks the ending. Duplicates by this method differ to a much greater extent than do those by the A method.

In making determinations by method C the solution of the ore is very slow, sometimes taking hours to accomplish, and, owing to the necessity for an external indicator, the titration is not nearly so simple and satisfactory as in the A method.

Our method is thus shown to be well adapted for the estimation of iron in limonites. It may also be used with advantage for the much less soluble magnetites, ilmenites, hæmatites, &c. In this case the ore requires fine grinding, and half an hour's reduction in hydrogen—coal-gas cannot be used, as it does not give complete reduction. If the hydrogen be made from commercial zinc, it should be purified from antimony and arsenic, which interfere with the subsequent titration. The purification is most simply effected by passing through a hard glass tube wrapped in thin sheet asbestos, and heated to redness by a long flat burner. The tube should be from 15 in. to 18 in. long. and about ½ in. in diameter, reduced to ⅛ in. or less for 4 in. or 5 in., to allow of the ready deposition of antimony and arsenic. It is interposed between the source of hydrogen and the hard glass bulb tube in which reduction of the ore takes place. This treatment removes all but minute traces of arsenic and antimony, and these may be got rid of by passing the hydrogen through one or two wash-bottles containing glass wool saturated with chromic acid.

Using this method we got the results given in column A of the following table. Those shown under B were obtained from the same solution in the following manner. After titrating with permanganate (for A determinations) the solutions were reduced by hydrogen sulphide (Hillebrand's method), the excess of H_2S removed by CO_2, and again titrated with permanganate. The results so obtained are shown in column B. As a further check on these figures, the ore was fused with sodium and potassium carbonates, dissolved in sulphuric acid, reduced by means of sulphuretted hydrogen, &c., as before, and titrated with potassium permanganate, the percentages of iron so found being shown in column C. Or it was fused as before, dissolved in hydrochloric acid, reduced by stannous chloride, and titrated with bichromate, the results being shown in column D.

—	A.	B.	C.	D.
Magnetite, Taranaki, N.Z. ..	59·62	59·90	60·02	59·75
,, ,, ,, ..	57·75	..	57·72	..
,, Quebec, Canada ..	64·34	..	..	64·12
,, France	67·17	67·24	..	67·34
Ilmenite, Norway	43·48	..	43·53	..
Micaceous iron-ore	57·39	..	..	57·50
Hæmatite, Ohio, U.S.A.	61·18	61·24	..	..

These figures are sufficient to show that our method gives very satisfactory results for such refractory ores as magnetites and ilmenites. For these ores it has the further merit of making the estimation of titanium quite a simple matter. This is done by adding hydrogen peroxide to the solution after the permanganate titration, and estimating the percentage of titanium by comparison with a standard solution of that substance. By this means 9·12 per cent. of titanium dioxide was found in the Taranaki magnetite, as against 9·27 per cent. obtained by fusion. Moreover, it was found that none of the insoluble residues contained more than minute traces of titanium.

To recapitulate very briefly, the process consists of the following steps:—

1. Roasting the finely ground ore.
2. Reduction of the roasted ore by heating in coal-gas or hydrogen.
3. Dissolution of the reduced ore in dilute sulphuric acid in an atmosphere of carbon dioxide.
4. Titration of the resulting solution by potassium permanganate.

The advantages of the process over those commonly employed are the removal of any organic matter which might interfere with the subsequent titration, the ease and completeness with which the ores are dissolved, the accuracy of the titrations, and the possibility of estimating titanium in the same solution.

Art. XII.—*On a Hornblende-andesite from the Solander Islands.*

By R. Speight, M.A., B.Sc., F.G.S.

[*Read before the Philosophical Institute of Canterbury, 4th November*, 1908.]

The Solanders consist of a very small group of rocky islets, the largest about a mile long and 1,100 ft. high, lying to the south-west of New Zealand. Their exact position is twenty nautical miles south of the south coast of western Otago and thirty-five miles W. 15° N. of the north-west point of Stewart Island. They are thus to the south of the western entrance of Foveaux Strait. Between them and the mainland the sea reaches a depth of nearly 100 fathoms, as appears from soundings on the Admiralty charts. There are a number of "rises" in the western floor of the strait, but these do not reach so near the surface as to be any danger to navigation; however, a wide fringe of submerged and partially submerged reefs extends along the northern shore of the strait. The depth of the sea between the Solanders and Stewart Island is over 70 fathoms. The islands, therefore, lie in somewhat deep water. From their isolated position, and on account of the danger of landing except in the very calmest weather, they are rarely visited now, although sealers frequently landed on them in the early days. They have usually been supposed to be a remnant formed of rocks similar to those on the neighbouring coasts, but this turns out not to be the case.

When the G.S.S. "Hinemoa" was searching for traces of the lost ship "Loch Lomond," Captain Bollons landed and brought back two small specimens of the rock of the islands, and transmitted them to me through Dr. Cockayne.

Instead of being a granite or gneissic rock, they are a hornblende-andesite, quite different from any hornblende-andesite that I have met with in New Zealand. Macroscopically they show fairly large crystals of feldspar up to 1 cm. in length, and smaller hornblendes 0·75 cm. in length, in a dark groundmass. The rock is somewhat vesicular, and has a low specific gravity—viz., 2·42. When examined under the microscope the phenocrysts are feldspar (labradorite), with the usual characters. There is also an occasional mica flake and much brown hornblende in large crystals, with marked pleochroism. These crystals show idiomorphic outlines at times, but they grade down through all sizes till they form irregular fragments and flakes. Some take lath- and needle-shaped forms, with parting across. The groundmass is of the hyalopilitic type, with much brownish glass and extremely small microlites of feldspar (oligoclase-andesine), and of hornblende similar to the phenocrysts, the whole showing at times rough flow-structure. The rock shows little sign of alteration, and is as fresh in appearance as many of the Ruapehu andesites. It is therefore likely to be of fairly recent date, most probably late Tertiary.

This occurrence of volcanic rocks is also interesting because no similar type has been recorded from Otago. Dr. Marshall tells me that he saw loose blocks of hornblende-andesite at Cuttle Cove, Preservation Inlet, but was unable to trace them to their source. Dr. Cockayne also says that fragments of scoriaceous and pumiceous rocks are frequently picked up on the shore of Mason Bay, on the west of Stewart Island. This last occurrence has been difficult to account for, owing to the absence of volcanic rocks on the island, but if there is any extent of submerged volcanic land to the westward the powerful currents and heavy seas could easily explain the presence of scoriaceous material on the west coast of Stewart Island.

The Solanders are undoubtedly the remnant of a volcanic cone of probable recent date, a large part having been removed by powerful marine erosion, or been buried under the sea on the land in the locality sinking. There is evidence both from the Sounds of Otago on the one hand, and from the drowned valleys of Stewart Island on the other, that the land was formerly higher, and is now depressed much below its former level. There is also evidence of a very recent elevation. It is possible that the submergence of a large block of land to the south and south-west of New Zealand was connected not only with the formation of the valleys and fiords of western Otago, but also with the volcanic outbursts at the Solanders. Foundered areas, as it has been pointed out, are associated with fractures in the neighbouring crust, which may determine the direction of valleys to a certain extent, and thus affect the initial stages in the formation of fiords; and fractures are no doubt also intimately connected with volcanic action. Their occurrence together in this case may be only a coincidence, and not a different surface manifestation of the same deep-seated cause.

ART. XIII.—*The Fresh-water* Amphipoda *of New Zealand.*

By CHARLES CHILTON, M.A., D.Sc., F.L.S., Professor of Biology, Canterbury College, N.Z.

[*Read before the Philosophical Institute of Canterbury, 4th November, 1908.*]

THE immediate cause of this paper was the discovery in February, 1908, of a fresh-water gammarid at Rona Bay, Wellington Harbour, which, on examination, proved to be the same as *Phreatogammarus propinquus*, a species described in 1907 from a single specimen collected by Mr. Crosby Smith on Mount Anglem, Stewart Island. This species was of special interest as the first species of *Phreatogammarus* to be recorded from the surface waters of New Zealand, and owing to its near relationship to *P. fragilis*, a species inhabiting the underground waters of the Canterbury Plains. During the last few years, too, several facts referring to the other fresh-water *Amphipoda* have been collected, and it seems desirable to gather them together here. This group of the *Crustacea* possesses considerable interest from the point of view of geographical distribution, and for this reason a paper on the subject was commenced and partly written out about fifteen years ago, but was then left unfinished owing to want of knowledge of the fresh-water *Amphipoda* of Australia and elsewhere. Since then many of the gaps have been filled up, and, though our knowledge is still far from complete, some comparison of the fresh-water *Amphipoda* of New Zealand with those of other countries is now possible.

In this paper, however, I shall give only a list of the various species, with references and notes as to their distribution, reserving more general remarks for a future paper. The three subterranean species have been included because it is around them that the chief interest centres, and because two of them are now known to have near representatives in the surface streams. The terrestrial amphipod *Parorchestia sylvicola* (Dana) has not been included, because it is truly terrestrial, living far from streams, although it is found only under decaying leaves and in other moist situations, and its method of respiration is doubtless practically the same as that of the fresh-water species. It is a species very widely distributed in New Zealand and perhaps elsewhere, and there are various uncertainties and difficulties connected with it that require for their solution more time than can be devoted to the question at present. I have, however, included *Parorchestia subtenuis* (Dana), as it seems to be usually found in fresh-water streams, though able to live in brackish water, and perhaps also on land. There are other brackish-water species, such as *Melita inæquistylis* (= *M. tenuicornis*) (Dana), that I have not included, because, although they may be found in water that at the time is almost or quite fresh, they do not appear to have established themselves in the fresh-water streams.

I have arranged the species according to the classification in Stebbing's "Das Tierreich Amphipoda," and have given only such references as appeared necessary; others will be found in that elaborate and exhaustive work.

Fam. Calliopiidæ.

Paraleptamphopus subterraneus (Chilton).

Calliope subterranea, Chilton, in N.Z. Journ. Sci., vol. i, p. 44, and Trans. N.Z. Inst., vol. xiv, p. 177, pl. ix, figs. 1–10 (1882). *Calliopius subterraneus*, Chilton in Trans. Linn. Soc. London, ser. 2, vol. vi, p. 234, pl. xxiii, figs. 10–18 (1894). *Paraleptamphopus subterraneus*, Hutton in Index Faunæ N.Z., p. 259 (1904). *Paraleptamphopus subterraneus*, Chilton in P.Z.S. London, 1906, p. 704 (1906). *Paraleptamphopus subterraneus*, Stebbing in "Das Tierreich Amphipoda," p. 294 (1906).

This species was first described in 1882 from the underground waters at Eyreton, in North Canterbury, and was afterwards obtained from similar situations in Lincoln and Ashburton, and at Winchester, in South Canterbury. I have also two specimens from an artesian at St. Albans, Christchurch, depth probably not more than 70 ft.; collected by Mr. J. B. Mayne. In November, 1903, Dr. Cockayne brought me a few specimens, obtained in a surface stream near the River Porter, at Castle Hill, Canterbury; and a month or two later I myself obtained numerous specimens from the same locality. These specimens were quite colourless, showed no trace of eyes, and in these and in all other respects closely resembled the subterranean forms. They were found in a small stream issuing from a spring in the side of one of the river-terraces of the River Porter, and I afterwards also found them in other streams about two miles distant on the other side of the river. Later on the species was taken by Messrs. Lucas and Hodgkin in their investigation of the fresh-water lakes of New Zealand. Among their collections which were submitted to me for examination there was one specimen obtained from Lake Wakatipu (no depth mentioned) in Otago, and one from Lake Taupo, at a depth of 700 ft., in the North Island. These specimens seem to be practically identical with the subterranean forms first described. About the same time Mr. Laing also found the species in surface streams at Otautau, in Southland, in company with the next species, *P. cæruleus*. The two species were found together in two different streams in that locality, and though very different in appearance, one being colourless—almost white—and the other dark blue, they appeared to be living together under precisely the same conditions. Mr. Laing thinks that probably the *P. subterraneus* may have got into the surface streams from springs feeding the streams, much in the same way as appears to have occurred at Castle Hill.

Mr. O. A. Sayce* has called attention to the occurrence of three blind fresh-water *Crustacea* in the surface waters of Victoria, and has given many interesting facts with regard to them and their surface allies. Other examples of the same thing have been recorded from North America also. In the present case we have *P. subterraneus* living side by side at Otautau with *P. cæruleus*, to which it is so closely allied that we may consider it as a subterranean modification of that species.

Paraleptamphopus cæruleus (G. M. Thomson).

Pherusa cærulea, G. M. Thomson in N.Z. Journ. Sci., vol. ii, p. 576 (1885). *Paraleptamphopus cæruleus*. Hutton in Index Faunæ N.Z., p. 259 (1904). *Paraleptamphopus cæruleus*. Stebbing in "Das Tierreich Amphipoda," p. 295 (1906).

This species was originally described by Mr. Thomson from specimens taken in a small stream at the top of the Old Man Range, in Otago, at a height of about 3,000 ft., and for many years afterwards no further specimens were discovered. In 1904 Mr. Crosby Smith sent me one or two specimens of Amphipoda from the bog-water at the top of Swampy Hill, near Dunedin. These were not in a fit state for an exact determination, but appeared to belong to this species. In the next year Mr. R. M. Laing brought me undoubted specimens from a stream at Otautau, in Otago, where it had been found in surface streams along with *P. subterraneus*. Subsequently I found a single specimen among *Crustacea* sent to me from Ruapuke Island by Mr. T. Horan, and in 1907 I collected numerous specimens in pools and streams near Drummond, in Southland, and afterwards in streams near Invercargill. All of these specimens show the dark-blue colour described by Mr. Thomson, and this colour does not fade even after the specimen has been kept for a long time in spirit.

As already stated, this species may be looked upon as the surface form from which *P. subterraneus* has arisen.

Paracalliope fluviatilis (G. M. Thomson).

Calliope fluviatilis. G. M. Thomson in Trans. N.Z. Inst., vol. xi, p. 240, pl. x *c*, figs. 4 *a–c* (1879). *Paracalliope fluviatilis*, Hutton in Index Faunæ N.Z., p. 259 (1904). *Paracalliope fluviatilis*, Chilton in P.Z.S. London, 1906, p. 704 (1906). *Paracalliope fluviatilis*, Stebbing in "Das Tierreich Amphipoda," p. 297.

This species is extremely abundant in all the fresh-water streams of New Zealand, and also in many of the ponds formed by them. I have seldom failed to find it in such positions in the South Island, and, though I have fewer specimens from the North Island, it doubtless occurs there

* "On Three Blind Victorian Fresh-water Crustacea found in Surface Water," Ann. Nat. Hist., ser. 7, vol. viii, pp. 558–64.

almost as abundantly—I have it from Rona Bay, Wellington Harbour, and also from Island Bay; and Messrs. Lucas and Hodgkin obtained specimens from Lake Waikare. Besides being found in fresh water, however, this species is also able to live in salt water. I have on different occasions taken it in great abundance in Otago Harbour in the ordinary sea-water, associated with the usual marine forms. I have also taken it at Island Bay, Wellington, in a pool near high-water mark, which would doubtless be filled with sea-water at particularly high tides, though the water was only slightly brackish at the time I collected the specimens.

Mr. Stebbing considers *Pherusa australis*, Haswell, to be a synonym of this species, and thinks that *Œdicerus novi-zealandiæ*, Dana, may perhaps also belong to it. I have, however, specimens that I think undoubtedly are to be referred to the latter species, and they belong to the *Œdicerotidæ*, and are apparently the same as *Carolobatea schneideri* (Stebbing). I am dealing with them in my report on the *Crustacea* collected by the recent expedition to the subantarctic islands of New Zealand.

Fam. Gammaridæ.

Paracrangonyx compactus (Chilton).

Crangonyx compactus, Chilton in N.Z. Journ. Sci., vol. i, p. 44, and Trans. N.Z. Inst., vol. xiv, p. 177, pl. x, figs. 13–19 (1882). *Crangonyx compactus*, Chilton in Trans. Linn. Soc. London, ser. 2, vol. vi, p. 220, pl. xx (1894). *Paracrangonyx compactus*, Stebbing in "Das Tierreich Amphipoda," p. 369 (1906).

This is a subterranean species found in the underground waters of Canterbury Plains, and has been fully described in my paper in the Trans. Linn. Soc. London referred to above. In that paper I stated that the subterranean crustaceans, though common in the shallow wells on the Plains, had not hitherto been found in the artesian wells of Christchurch. Since then, however, Mr. J. B. Mayne has brought me one or two specimens of this species from an artesian at St. Albans, Christchurch. This artesian is sunk only to the first water-bearing stratum, and probably is not more than 70 ft. deep.

It was from the same artesian that the specimens of *Paraleptamphopus subterraneus* already referred to were obtained, so that the two species are associated in the underground waters at St. Albans, as they are in other parts of the Canterbury Plains.

Phreatogammarus fragilis (Chilton).

Gammarus fragilis, Chilton in N.Z. Journ. Sci., vol. i, p. 44 (1882), and Trans. N.Z. Inst., vol. xiv, p. 179, pl. ix, figs. 11–18. *Gammarus fragilis*, Chilton in Trans. Linn. Soc. London, ser. 2, vol. vi, p. 227, pl. xxi, figs. 1–25 (1894). *Phreatogammarus fragilis*, Stebbing in "Das Tierreich Amphipoda," p. 454 (1906).

This species is found in the underground waters of Canterbury Plains, and has been already fully described in my paper in the Trans. Linn. Soc. London quoted above. Its special characteristic is the possession of very long antennæ, peræopods, &c., and in this respect it resembles several other subterranean species from other parts of the world.

It is closely related to the next species, *P. propinquus*, but differs in the gnathopods, having the 2 pairs similar in size and shape and with the propod oval and the palm very oblique, while the carpus in each is very short and triangular.

Phreatogammarus propinquus, Chilton.

Phreatogammarus propinquus, Chilton in Ann. Nat. Hist., ser. 7, vol. xix, pp. 388–90, pl. xi (1907).

This species was described in 1907 from a single imperfect specimen collected by Mr. Crosby Smith in a small pool near the top of Mount Anglem, in Stewart Island, at a height of about 2,800 ft. above sea-level. In February, 1908, I obtained a few specimens from a small stream at Rona Bay, in Wellington Harbour. The place at which they were obtained is only a short distance above high-water mark, but the water was quite fresh, and the species was found in association with *Parorchestia tenuis* (Dana) and other fresh-water animals. I also have had for many years a mounted specimen sent me from Greymouth by Mr. R. Helms, which I had not previously been able to recognise with certainty, but which I can now tell from comparison with Rona Bay specimens is undoubtedly a female specimen of this species.

The species is of special interest owing to its relationship to the subterranean species *Phreatogammarus fragilis* (Chilton) from the underground waters of the Canterbury Plains. In describing *P. propinquus* I pointed out that the generic characters given by Mr. Stebbing required slight modification in order to admit the species. In the specimen then described it was impossible to say whether eyes were present or not, owing to its imperfect condition; in the Rona Bay and Greymouth specimens, however, the eyes are present and well marked, so that the character " without eyes " included in Mr. Stebbing's generic diagnosis will also have to be struck out, and the genus *Phreatogammarus* is thus shown to be still nearer to *Gammarus*.

The Rona Bay specimens appear to be closely similar to the Mount Anglem specimens originally described, except as regards the 2nd gnathopods. In a female specimen, bearing eggs, from Rona Bay, the 2nd gnathopod is somewhat more similar in general appearance to the 1st, having the carpus moderately long (about two-thirds as long as the propod) and subtriangular in shape. The posterior margin of the carpus bears 3 or 4 short transverse rows of long setæ, and there are 2 tufts of setæ on the anterior margin, one tuft being at the distal end of the joint; and there is a row of about 7 or 8 setæ on the side of the carpus along its distal border. The propod is suboblong in shape; its anterior margin bears 5 short transverse rows of long setæ, the last one, at the joint of the finger, being the longest, and containing the most setæ; the palm is slightly oblique, and is bordered by a double row of stout setæ, which diminish in size towards the base of the finger, those at the place where the point of the finger impinges being the largest, and fairly well defining the palm; the posterior border bears a number of long setæ, and other tufts of setæ are situated on the sides of the joint, some of the longest being arranged close to and parallel to the palm; the finger has the inner margin minutely serrate, the serrations being closely approximated. The whole gnathopod is somewhat larger than the 1st gnathopod, in which the carpus is considerably longer, being longer than the propod, and bears a more well-marked row of setæ along its distal border; the propod is somewhat narrow at the base, and has the palm more transverse, but in other respects the 1st gnathopod is closely similar to the 2nd gnathopod. Some or all of the setæ in the transverse rows on the posterior margin of the carpus in both gnathopods are finely serrate.

The differences in the 2nd gnathopod between the Rona Bay specimens and the Mount Anglem one are perhaps sexual. The Rona Bay specimen described is a female, bearing eggs in the brood-pouches, while the Mount Anglem specimen, with the larger and more oval propod in the 2nd gnathopod, is probably a male; but, as the few Rona Bay specimens that I have appear to be all females, this point cannot at present be definitely settled.

Fam. TALITRIDÆ.

Chiltonia mihiwaka (Chilton).

Hyalella mihiwaka, Chilton in Ann. Nat. Hist., ser. 7, vol. i, p. 423, pl. xviii (1899). *Chiltonia mihiwaka*, Stebbing in "Das Tierreich Amphipoda," p. 555 (1906).

This species was described from specimens found in mountain-streams near Dunedin. During the recent subantarctic expedition specimens were collected both at the Auckland Islands and at Campbell Island. Mr. O. A. Sayce has described 2 species from the fresh waters of Victoria—one, *C. australis*, has the 3rd uropod less reduced, and consequently approaches more nearly to the genus *Hyalella*; the other species, *C. subtenuis*, is more typical of the genus as regards the 3rd uropod, and is apparently closely related to *C. mihiwaka*, but differs in having shorter antennæ and a more slender body.

The genus *Hyalella*, to which *Chiltonia* is closely related, is well represented in the fresh waters of America, particularly in South America. Many species have been described from Lake Titicaca by Faxon,* and more recently by Monsieur Edouard Chevreux.† The various species, although all closely related, show a great variety in the form of the body, the projection of the different segments into spinal processes, and so on.

Parorchestia tenuis (Dana).

Orchestia tenuis, Dana in P. Amer. Ac., vol. ii, p. 202 (1852). *Orchestia tenuis*, Dana in U.S. Expl. Exp., vol. xiii, ii, p. 872, pl. lix, fig. 1 (1853 and 1855). *Parorchestia tenuis*, Stebbing in "Das Tierreich Amphipoda," p. 557 (1906).

This species has been frequently mentioned by previous authors, but, as with many species of the *Orchestidæ*, it is very difficult to identify with certainty, and considerable confusion has arisen with regard to it. It has been recently redescribed by Mr. Stebbing, and I refer to the species (as defined by him) specimens obtained in a fresh-water stream at Rona Bay, Wellington Harbour, and others obtained in similar situations at Akaroa and elsewhere. I also found it on the seashore at Campbell Island, at the mouth of a small stream, and it seems probable that it is a species which can live either in brackish or in fresh water, and perhaps, like many other *Orchestidæ*, it may be also more or less terrestrial in habit.

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* Bull. Mus. Comp. Zool. Harvard College, vol. iii, No. 16 (Cambridge, Mass., 1876).

† "Les Amphipodes des Lacs des Hauts Plateaux de l'Amerique du Sud" (extract from Mission scientifique, G. de Créqui Montfort et E. Sénéchal de la Grange).

Fam. COROPHIIDÆ.

Paracorophium excavatum (G. M. Thomson).

Corophium excavatum, G. M. Thomson in Trans. N.Z. Inst., vol. xvi, p. 236, pl. xii, figs. 1–8 (1884). *Paracorophium excavatum*, Hutton in Index Faunæ N.Z., p. 261 (1904). *Paracorophium excavatum*, Chilton in P.Z.S. London, 1906, p. 704 (1906). *Paracorophium excavatum*, Stebbing in "Das Tierreich Amphipoda," p. 664 (1906).

This species was originally described by Mr. Thomson from the Brighton Creek (salt water), near Dunedin. Subsequently I took it from the same creek at a time when the water was almost fresh, and specimens lived in some of the same water for several months. I have also specimens taken from brackish water at Napier. Messrs. Lucas and Hodgkin afterwards took it near Lake Rotoiti (5 fathoms), and in Lake Waikare, where, of course, the water is perfectly fresh. It therefore appears to be one of several species of our New Zealand *Amphipoda* that are able to live either in salt or in fresh water.

So far as I am aware, it is the only known fresh-water species of the family *Corophiidæ*.

ART. XIV.—*Note on the Amphipodan Genera* Bircenna, Kuria, *and* Wandelia.

By CHARLES CHILTON, M.A., D.Sc., F.L.S., Professor of Biology, Canterbury College, New Zealand.

[*Read before the Philosophical Institute of Canterbury, 2nd December*, 1908.]

IN 1884 I established a new genus *Bircenna* for a peculiar small amphipod found at Lyttelton. The genus was characterized as follows: Body broad, coxæ very shallow. Antennæ subequal, upper without a secondary appendage. Mandibles without an appendage. Maxillepedes with well-developed plates on both basos and ischios. Gnathopoda equal, not subchelate. Last segment of pleon and its appendages rudimentary. Telson simple, not divided.

One of the most characteristic points was the greatly shortened pleon, the 6th segment being indistinct, and the telson (as I then thought) single and undivided.

I left the position of the genus undecided, merely pointing out that in several respects it seemed to resemble *Phlias*, Guérin. The genus remained isolated and unclassified until 1899, when Mr. Stebbing placed it in the family *Phliadidæ*—the position which it occupies in his report on the *Amphipoda* for Das Tierreich, though the name of the family is there written *Phliantidæ*. In 1902, when examining the *Crustacea* collected by Mr. H. O. Forbes at Abd-el-Kuri, Messrs. A. O. Walker and A. Scott found a small amphipod which resembled *Bircenna* in many respects, but differed in having the "telson divided to the base, consisting of two subtriangular plates set on edge." This they described as a new genus *Kuria*, having *Bircenna* as its nearest ally, and, as they were not satisfied with the position of the latter under the *Phliadidæ*, they simply marked the genus "*incertæ sedis*."

Mr. Walker wrote to me at the time he was examining his *Kuria*, giving the points in which it differed from *Bircenna*, and asking for further information as to the uropoda and telson, but as my original dissection of the terminal segments of the pleon has not been preserved, and I had at the time no other specimens available, I could only refer to my figure, which showed an undivided triangular telson.

In 1906 Monsieur Edouard Chevreux established a new genus *Wandelia* for a small amphipod found by the French Antarctic Expedition (1903–5) at Port Charcot and Wandel Island, which he said came very close to *Bircenna*, but differed from it in the uropoda, and in having the telson divided to the base. He placed the genus in the *Phliantidæ*, which, however, he wrote *Phliasidæ*, but pointed out that the completely divided telson separated it from all the other genera of the family. M. Chevreux apparently had not seen Mr. Walker's paper, for he makes no reference to *Kuria*.

As *Wandelia* evidently resembled *Bircenna* even more closely than *Kuria* did, though like the latter it possessed a completely divided telson, I was very anxious to get further specimens to see if my original description was really correct. I did not succeed in doing this till November, 1908, when I secured another small specimen from Lyttelton Harbour, and was able to examine the point carefully. The last segments of the pleon are greatly shortened, and it is difficult to make out the exact condition of the last segment and of its appendage, but I find that the telson is distinctly formed of two parts, and is consequently in harmony with that of *Kuria* and *Wandelia*, and I therefore hasten to make the correction. So far as I can make out, each half is as deep as broad, and is triangular in vertical section as well as horizontally, and consequently the one half, which alone is shown in my figure, is nearly symmetrical when seen from above, and therefore aroused no suspicion that it was only half the telson; and Mr. Stebbing, who dissected a specimen when preparing his generic diagnosis, published in the Trans. Linn. Soc., Zool. vii, p. 421, in 1899, seems to have been equally unaware that the telson had been incorrectly described.

There can be no doubt that *Wandelia* is identical with *Bircenna*, and, indeed, *Wandelia crassipes* is specifically not very different from *Bircenna fulva*. The genus *Kuria* differs in a few points—*e.g.*, in having the body laterally compressed and the 3rd uropoda less modified—and should perhaps be regarded as a separate genus, though evidently very closely allied to *Bircenna*.

After mentioning that Stebbing had placed *Bircenna* in the family *Phliantidæ*, Walker says that "it seems somewhat out of place with such genera as *Pereionotus*, *Iphinotus*, &c." In general appearance it certainly looks very unlike these dorso-ventrally flattened genera, and *Kuria*, which is somewhat laterally compressed, is still more unlike them, and both genera differ from the rest of the family in having the telson double or deeply cleft. In other respects, however, they agree closely with Stebbing's diagnosis of the family. The genus *Phlias*, from which the family takes its name, also differs greatly in general appearance from the genera named above, and resembles *Kuria* in having the body somewhat laterally compressed; but, as a small amount of lateral compression in the one case and of dorso-ventral compression in the other make the general aspect of the two forms very different, it is probable that comparatively little importance should be attached to this point.

The possession of a double telson is more important, and distinctly marks these two genera off from the rest of the family; but this seems to me to point rather to the necessity for slightly enlarging the characters of the family than for the establishment of another family, and I therefore leave the two genera under the *Phliantidæ*, where Chevreux placed his *Wandelia*. In both species of *Bircenna—i.e., B. fulva* and *B. crassipes*—the pleopoda have the peduncle broad and laterally produced, as in other members of the family.

I give below the arrangement I suggest for these forms, with the characters that appear to me most important for differentiating them. I have shortened the diagnosis of *Bircenna*, as that given by Stebbing in "Das Tierreich Amphipoda" appears to me to include some details that are hardly likely to prove of generic value; indeed, some of them have to be omitted to include the second species (*B. crassipes*). The characters given are, of course, additional to those of the family, and these have not been repeated in the generic diagnoses.

Fam. PHLIANTIDÆ.

Phliadidæ. Stebbing in Trans. Linn. Soc., London, ser. 2, vol. vii, p. 414 (1899). *Phliantidæ*, Stebbing in "Das Tierreich Amphipoda," p. 200 (1906).

Genus BIRCENNA, Chilton.

Bircenna, Chilton in Trans. N.Z. Inst., vol. xvi, p. 264 (1884). *Bircenna*, Stebbing in "Das Tierreich Amphipoda," p. 205 (1906). *Wandelia*, Chevreux in Exped. Antarctique Française, 1903–5, "Crustacés Amphipodes," p. 44 (1906).

Body broad, almost cylindrical, pleon segment 5 very short, 6th indistinct. Side-plates all very shallow. Maxillipedes with inner and outer lobes long, both reaching apex of 2nd joint of palp, which, though short, contains 4 joints. Gnathopoda 1 and 2 slender and almost simple, similar. Peræopods short, the 3rd to 5th with the 2nd joint much expanded, and the 4th joint rather expanded and decurrent. Uropoda short, 3rd uniramous, lamelliform, peduncle and branch not clearly distinguishable. Telson split to the base, each half subtriangular.

1. **Bircenna fulva**, Chilton.

B. fulva, Chilton in Trans. N.Z. Inst., vol. xvi, p. 264, pl. xxi, figs. 1, 1 *a–e* (1884). *B. fulva*, Stebbing in "Das Tierreich Amphipoda," p. 205 (1906).

Gnathopods similar, not longer and only slightly more slender than the 1st and 2nd peræopods; 3rd joint longer than broad, as long as 4th; 5th a little shorter than the 6th, which is not expanded, but a little produced at apex, yet not enough to make a chela with the short apically toothed finger. Uropod 1 with peduncle much shorter than the acute curved rami, outer ramus much shorter than inner; uropod 2 similar, but stouter and shorter; uropod 3 apparently consisting of a single joint, bifid at end, outer apex rounded and bearing a few setæ, inner pointed and with only one or two setæ. Telson, each half subtriangular, but with apex broadly rounded, with a small seta on each half. Length, 3 mm.

Lyttelton and Otago Harbours, New Zealand.

2. Bircenna crassipes (Chevreux).

Wandelia crassipes, Chevreux in Exped. Antarctique Française, "Crustacés Amphipodes," p. 45, figs. 24–26 (1906).

Similar to *B. fulva* except in the following points: Gnathopods longer and much more slender than 1st peræopod. Uropods 1 and 2 with rami subequal and only slightly longer than peduncle. Telson completely divided into two triangular lobes, each armed with a small seta. Length, 3 mm.

Port Charcot (dredged at depth of 40 metres). Wandel Island (dredged with sponges in 40 metres).

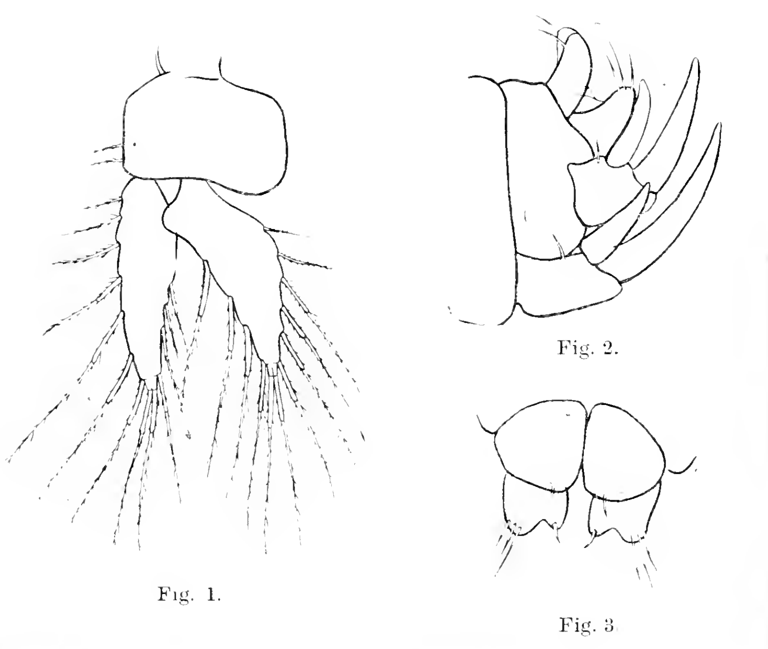


Fig. 1. Fig. 2. Fig. 3.

Bircenna fulva.

FIG. 1.—Third pleopod; highly magnified.
FIG. 2.—Uropoda and telson (side view); highly magnified.
FIG. 3.—Telson and 3rd uropoda (from above); highly magnified.

Genus KURIA, Walker and Scott.

Kuria, Walker and Scott in Nat. Hist. Sokotra, p. 228 (1903).

Body laterally compressed. Side-plates not very shallow, the first 4 as deep as their segments. Maxillipedes with inner and outer lobes very small, especially the latter: neither reaching further than base of 2nd joint of the 4-jointed palp. Gnathopods 1 and 2 subequal, long and slender, with a small subchelate palm. Peræopods short, last three with 2nd and 4th joints expanded. Uropod 3 with single ramus. Telson divided to the base, consisting of 2 subtriangular plates set on edge.

1. **Kuria longimana**, Walker and Scott.

Kuria longimanus, Walker and Scott in Nat. Hist. Sokotra, p. 228, pl. xiv *b*, figs. 5–5*n* (1903). *K. longimana*, Stebbing in "Das Tierreich Amphipoda," p. 726 (1906).

Body rather plump, first 4 side-plates deeper than their segments; last 3 segments of pleon coalesced. Gnathopods very slender, 2nd joint as long as the next 3, 5th as wide and almost as long as the 6th, which is about 5 times as long as broad; palm very small, oblique, defined by a spine, finger projecting beyond palm by about one-fourth of its length. Uropods 1 and 2 with peduncles rather shorter than the rami, which are equal and similar, and bear a few spines; 3rd uropod with peduncle short and broad, the single ramus about as long as peduncle, but more slender, and with one or two spines at apex. Telson divided to base, the two subtriangular divisions turned up on edge, the lower margin being convex and the upper straight, with 2 or 3 setæ near the distal end. Length, 2 mm.

Abd-el-Kuri.

Remarks.

In addition to the points that have been mentioned in the descriptions given above, there are several others that I have not included, because I have not yet been able to make a satisfactory comparison of them in the different forms. For example, Messrs. Walker and Scott describe the last 3 segments of the pleon as being fused together in *Kuria longimana*; and Chevreux says that the last 2 segments are fused together in *Bircenna crassipes*. They appear to be fused also in *B. fulva*, but owing to the imperfect development of the 6th segment it is difficult to be quite clear as to the actual state of affairs.

In *Bircenna crassipes*, as figured and described by Chevreux, there is no molar process on the mandible, while in *Kuria longimana* Messrs. Walker and Scott describe the molar process as "rather large." In *Bircenna fulva* the mouth parts, so far as I have been able to examine them in the single very small specimen at my disposal, appear to closely resemble those of *B. crassipes*. The mandible shows no molar process or palp, the cutting-end is formed of some 4 or 5 indistinctly marked teeth, and the accessory process is either absent altogether or very imperfectly developed. The 2 pairs of maxillæ have practically the same form as in *B. crassipes*, and the maxillipede also closely resembles that of the same species. The upper lip is small, and regularly rounded at the end, which bears a few very short setæ; in the lower lip the lateral lobes are rounded and finely ciliated on the distal border.

The 3rd pleopods are shown in fig. 1. They have the inner margin of the peduncle much produced, and bear 2 very short coupling-spines at its distal end; the inner branch has a projection of its outer margin near the base, as shown in the figure. The other pleopods closely resemble the 3rd pair.

Art. XV.—*The Geology of the Quartz Veins of the Otago Goldfields.*

By A. M. Finlayson, M.Sc., A.O.S.M.

Communicated by Dr. Marshall.

[*Read before the Otago Institute, 14th July*, 1908.]

Introduction.

The accompanying paper contains the results of investigations into the geology of the veins of the Otago Goldfield. The area is a large one, and the paper is not exhaustive, but the different types of veins have been examined, and the features of every group described and discussed. As most of the mines are now closed down, the district is not an ideal one for studying vein-phenomena, and it is to be regretted that the work was not undertaken many years ago, when Bullendale, Bendigo, and the O.P.Q. workings were accessible.

I wish to acknowledge my great indebtedness to Professor Park, Dr. Marshall, and Mr. D. B. Waters, of the Otago School of Mines, for much help and advice, both in the field and in the laboratory; and to Mr. A. O. Bishop, of Skipper's, and Mr. R. Mollineaux, of Barewood, who gave me great facilities in examining their mines.

General Description of the District.

The Otago Goldfield, as far as veins are concerned, embraces an area of nearly 10,000 square miles, stretching from Lake Wakatipu on the west to the sea-coast on the east, and from Cardrona in the north to Lawrence in the south. This district is drained chiefly by the Clutha and Taieri Rivers, and also by the smaller Shag River.

The country is mountainous, the various ranges running for the most part approximately north-east and south-west, or at right angles to the course of the Kawarau River, while the tributary streams flow between and parallel to the ranges. This disposition is described and discussed by Dr. Marshall in his "Geography of New Zealand."* Professor Park claims that the ranges of Central Otago are block mountains.†

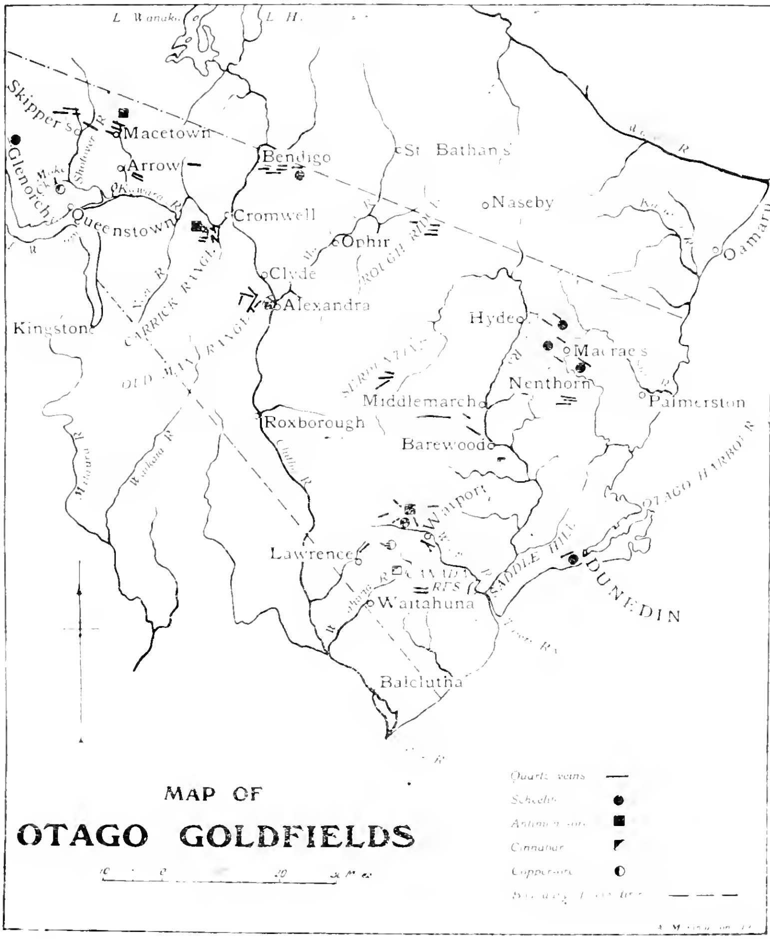
The climate of the inland districts is much hotter in summer and colder in winter than on the east coast, but the rainfall is generally low. For this reason the hills and valleys are practically barren of vegetation, being clothed only in tussock. Dearth of water and absence of timber are serious hindrances to mining in some parts of the field.

The goldfield has no centre of population, but comprises a number of towns which grew up in the roaring days of alluvial mining, for which the district is chiefly noted. The principal towns are situated on the Clutha River, or in its drainage-basin, and stand as fingerposts indicating the

* Marshall, "Geography of New Zealand" (Whitcombe and Tombs, 1905), p. 102.

† Park, Bull. No. 2, N.Z.G.S., 1906, p. 7; Bull. No. 5, N.Z.G.S., 1908, p. 9.

march of the pioneer diggers from the coast inland. Communication, which in the early days was difficult, is now good, the most remote mining districts being connected by coach and rail with Dunedin.



Previous Geological Work.

The geology of the district has been the subject of a good deal of notice, and a complete bibliography is given in Bulletins Nos. 2 and 5, N.Z. Geological Survey (New Series). The quartz veins have, however, not been much studied, the chief works being by Ulrich, Rickard, and Park. The following list includes all work written on the Otago veins:—

McKay, Alexander—
"Carrick Antimony Lodes." Geol. Explorations, 1882, p. 80.
"Antimony on Barewood Run." Geol. Explorations, 1890, p. 54.
"Quartz Reefs at Nenthorn." Geol. Explorations, 1890, p. 50.

Park, James—
"Green's Reef, Ophir." Geol. Explorations, 1888, p. 17.
"White's Reef, Old Man Range." Geol. Explorations, 1888, p. 32.
"Alexandra Antimony Lode." Geol. Explorations, 1888, p. 33.
"Economic Geology of the Alexandra Sheet," Bull. No. 2, N.Z.G.S., 1906, p. 21.
Rickard, T. A.—
"Goldfields of Otago," Trans. Am. Inst. Min. Eng., vol. xxi, p. 411.
Rowe, W. E.—
"Antimony Lode at Hindon," Geol. Explorations, 1879–80, p. 153.
"Antimony Lode, Waipori," Geol. Explorations, 1879–80, p. 155.
"Waitahuna Copper Lode," Geol. Explorations, 1879–80, p. 156.
Ulrich, G. H. F.—
"Goldfields of Otago": Dunedin, 1875.
"Handbook of New Zealand Mines," 1887, 1906.

Geology of the Goldfield.

(*a.*) *Geological Formations.*

The main formation of the goldfields and the country rock of the veins is a foliated schist of considerable thickness. It varies locally, but for the most part it is a mica-schist, more or less quartzose, and only submetamorphic in its upper portions.

The schists have been described by Hutton as forming an anticline whose axis runs south-east from Lake Wakatipu to Dunedin, with a syncline on either side of it.* Along the axis of the anticline, where denudation has been most active, are exposed the lowest and most metamorphic beds, while younger and semialtered slates and phyllites are preserved in the adjacent synclines. As we pass north-east or south-west we come on younger rocks (conglomerates and greywackes), and finally reach fossiliferous beds at Kurow in the north-east, and in the Hokonui Hills in the south-west. The former have been classed as Permo-carboniferous,† and the latter as Triassic and Jurassic.‡ The age of the schists has as yet been little more than guessed at, and no systematic attempt has been made to ascertain their relation to the above fossiliferous beds. The quartz veins are confined to the schistose rocks, but this is evidently an effect of the distribution of the fissuring-force, and not due to a different age of rocks. It will be sufficient at present to regard the gold-bearing series as of middle and upper Palæozoic age.

The schists are traversed by a number of structural faults, running for the most at right angles to the axes of the folds described by Hutton, or north-east and south-west. The faults have been mapped by McKay,§ and described later by Park.‖ It is open to question, however, if they are so dominant and easily traced as these writers claim. This much seems evident—namely, that the schists are much faulted, and that the faults have roughly the direction stated.

* Hutton, "Geology of Otago," 1875, p. 30.
† Park, "Permo-carboniferous Rocks at Mount Mary," Trans. N.Z. Inst., vol. xxxvi, p. 447.
‡ Hector, "Outline of New Zealand Geology" (Wellington, 1886), p. 83.
§ McKay, "Older Auriferous Drifts of Central Otago" (Wellington, 1897), p. 107.
‖ Park, Bulls. 2 and 5, N.Z.G.S., 1906, 1908.

For a goldfield, the district is poor in igneous intrusions. An outcrop of actinolite-schist near Ophir is probably a metamorphosed dyke.* There are, at Gibbston and Moke Creek, outcrops of serpentine-talc rock, representing magnesian intrusives of doubtful age.† Finally, there is the important middle Tertiary series of volcanic rocks developed especially round Dunedin, and along the east coast as far north as Oamaru and inland to Macrae's.‡ The rugged and little-known district between the lakes and sounds doubtless contains extensive igneous intrusions, as judged from pebbles picked up in the Clutha and Kawarau Rivers.

The next formation, chiefly developed along the coast, is the Tertiary limestone series of New Zealand, seen as a small patch at Bob's Cone, near Queenstown, where it has been preserved from denudation by being involved in a fault-line in the schists.

Then follow the Pliocene auriferous gravels and cements, shales, and sands, which fill the valleys of the goldfield (formerly old lake-basins), and finally the Pleistocene river and lake terraces, for the most part auriferous.

(b.) *Geological History.*

As far as we know at present, sedimentation was continuous, with minor breaks, from the middle Palæozoic, and perhaps earlier, till near the end of the Jurassic period. During this extended time a vast thickness of sediments was deposited. Then followed, throughout the South Island, the main upheaval of all these older beds, accompanied by the intrusion of an important belt of granitic rocks, which can be traced from Nelson, through Westland, and probably through western Otago, down to Preservation Inlet and Stewart Island. At the same time the metamorphism and alpine folding of the older rocks was mainly effected.

With elevation, denudation became active, and the younger Mesozoic beds were removed from the central portions of Otago, where the uplift was greatest.

Subsidence followed in the early Tertiary, and a series of coals and limestones was deposited, the sea extending far into the interior. Then followed elevation, accompanied by faulting and volcanic activity. Denudation at the same time almost entirely removed the Tertiary deposits, and the present drainage-system of Otago was inaugurated. Subsequent movements are not quite clear, but there probably occurred a Pliocene depression, during which the deposits of the Central Otago lake-basins were laid down, followed by a late Pliocene and early Pleistocene elevation, accompanied by glacial extension, and then a subsidence, with retreat of the glaciers.

THE VEINS.

With some exceptions, the veins are small, rarely exceeding 2 ft. or 3 ft. in width. The filling is largely crushed and altered rock, accompanied in the smaller ones by veins and stringers of quartz, and in the larger by lenses or blocks of quartz, varying in size.

The predominant ore is gold, with very little silver (fineness, 960), accompanied by auriferous pyrite. Other minerals are scheelite and stibnite, which are common, and sometimes constitute the dominant ore; also galena, bournonite, and zincblende, which are rare.

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* Park, Bull. No. 2, N.Z.G.S., 1906, p. 41.
† Finlayson, "Notes on the Otago Schists," Trans. N.Z. Inst., 1907, p. 76.
‡ Marshall, "Geology of Dunedin," Quart. Journ. Geol. Soc., vol. lxii, p. 422.

There are, in addition, two small copper-veins and one cinnabar-vein.

The veins may be divided into groups according to their locality and characteristics, as follows: (1) Glenorchy, (2) Skipper's and Macetown, (3) Carrick Range, (4) Bendigo, (5) Macrae's, (6) Waipori, (7) Barewood, (8) copper-veins, (9) cinnabar-vein, (10) barren reefs and fault-fractures.

(1.) *Glenorchy Veins.*

The chief vein in this district is a scheelite-bearing vein, which I have described in a previous paper.*

(2.) *Skipper's and Macetown Veins.*

The veins of this district are mineralised shear-zones rather than fissure-veins. The country rock is a soft, finely laminated mica-schist, traversed by broad belts of fracturing. Along these belts the rock is sheeted or divided by several parallel fissures, the intervening schist being crushed and contorted, and more or less altered. These planes of fracture served as channels for the mineralising solutions, which caused the formation of segregated lenses or blocks of quartz. These blocks are of varying size and value. The gold is mostly fine and free, and the adjacent shattered schist or lode-formation is impregnated with pyrite.

The Shotover, or Nugget and Cornish, Vein.—The country rock strikes north and south, and dips to the west at from 30° to 45°. The vein, striking north-west and dipping south-west at about 60°, crosses the Shotover River about two miles above Skipper's Point. At the river-bank there are two veins, the eastern and the western, about 100 ft. apart. These two merge into one a short distance up the hill, and the single fissure-line has been traced across the ranges for some miles to the north-west. On the south-east side of the river the two outcrops are distinctly seen, but only the eastern has been traced for any distance. This runs over the dividing-range, apparently in line with the Premier reef of Macetown.

The vein is typical of its class, two main fractures constituting respectively the hanging and foot walls, with a parallel sheeting of the intervening belt by subordinate fractures. In the western reef four blocks of quartz have been stoped out. At the junction of the two veins a large block (the No. 1) was stoped for a depth of 250 ft. below the surface. The blocks are generally lens-shaped, and limited on all sides. They are generally bounded by thin clay partings or selvages, but not infrequently these are absent, and there

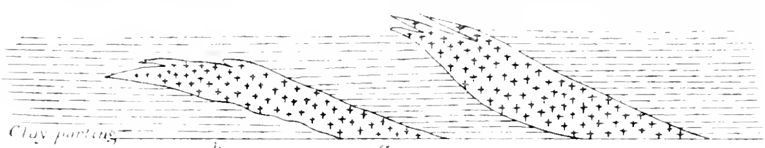


Fig. 1.

a. Quartz shoot. *b.* Vein-formation of crushed schist.

is a gradual transition from quartz to lode formation. In such cases the quartz "makes" gradually out of the lode-formation, and passes over to a parting or wall, where it wedges out (fig. 1).

* Finlayson, "Scheelite-deposits of Otago," Trans. N.Z. Inst., 1907, p. 110.

The lode-formation varies in width from 8 ft. to 20 ft., and has generally defined walls with tough clay casings. The value of quartz varies from 5 dwt. to 20 dwt. per ton. The gold is fine, hackly, and free, the extraction being about 80 per cent. by mill amalgamation. The pyrite is auriferous, but not by any means rich enough to warrant the treatment of the pyritic lode-formation, as some promoters would have us believe.

In places, more especially near the surface, the lode-formation contains bands of a soapy yellowish-grey rock, especially near quartz, and devoid of pyrites.

The following analyses indicate the normal mode of alteration :—

	1.	2.	3.	4.
H_2O	2·06	2·48	2·13	+ 0·07
SiO_2	53·05	54·12	46·30	— 6·75
Al_2O_3	10·31	11·94	10·31	..
Fe_2O_3	9·74	5·63	4·83	— 4·91
FeO	8·60	6·54	5·60	— 3·00
CaO	5·17	3·93	3·37	— 1·80
MgO	0·72	1·65	1·41	+ 0·60
K_2O	4·74	4·73	4·05	— 0·69
Na_2O	2·90	4·31	3·69	+ 0·79
MnO	0·51	0·22	0·18	— 0·33
TiO_2	1·06	0·39	0·32	— 0·74
CO_2	1·15	1·51	1·30	+ 0·15
FeS_2	..	3·43	2·94	+ 2·94
	100·01	100·88	86·43	+ 4·64
				— 18·22
				—13·58

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

These figures show—(1) that a good deal of replacement has occurred in connection with the segregation of quartz; (2) that the type of rock-alteration may be regarded as partial sericitization.

The following analyses indicate the nature of the yellowish altered rock :—

	1.	2.	3.	4.
H_2O	2·06	2·60	1·56	— 0·50
SiO_2	53·05	46·90	28·14	—24·91
Al_2O_3	10·31	16·46	10·31	..
Fe_2O_3	9·74	6·67	4·00	— 5·74
FeO	8·60	7·26	4·35	— 4·25
CaO	5·17	7·45	4·47	— 0·70
MgO	0·72	1·97	1·18	+ 0·46
K_2O	4·74	4·07	2·44	— 2·30
Na_2O	2·90	2·08	1·25	— 1·65
MnO	0·51	0·23	0·14	— 0·37
TiO_2	1·06	0·27	0·16	— 0·90
CO_2	1·15	3·98	2·19	+ 1·04
FeS_2	..	..	..	..
	100·01	99·94	60·19	+ 1·50
				—41·32
				—39·82

1. Country rock.
2. Yellow rock.
3. Yellow rock, recalculated with constant alumina.
4. Gains and losses.

It is evident from these figures that this altered rock is a kaolinized variety of the normal lode-formation. The bleaching and the total removal of pyrite are probably due to the secondary processes of descending surface waters, accompanied by the formation of kaolin.

Present mine-workings have not yet shown what factors regulate the occurrence of the quartz blocks. It is probable, however, that they are connected with some local structural features. The No. 1 block, for instance, occurred where the two reefs junction.

A common occurrence of gold in this and other veins of the district is as fine " paint " coating the clay selvages. This is probably due to processes of secondary enrichment, the clay partings acting as a filter to the gold-bearing solutions. In other words, this seems to be an instance of adsorption—the process recently studied by Kohler.*

Microscopically the quartz occurs in coarse granules, with patches of fine-grained quartz studded with pyrite crystals. Such patches evidently indicate portions where replacement has occurred.

Other Veins.—The Invincible, fifteen miles up the Rees Valley from Glenorchy; the extensive group of veins round Macetown; some veins near Arrowtown; and the Bullendale or Phœnix vein, up Skipper's Creek, as well as other smaller veins in the Shotover Basin, all belong to this type, and have the same characteristics.

(3.) *Veins of the Carrick Range.*

The northern flank of the Carrick Range, overlooking the Bannockburn Flat, is intersected by a complicated system of small veins, striking in various directions. The country rock is a mica-schist of varying type, striking north and south, and dipping to the east. The eastern flank of the range is bounded by a well-marked fault, which passes near the veins and drags down the schist with it, the rock along the fault-line standing almost vertically.

The veins, which are irregular and considerably disturbed, vary in width from 18 in. to 3 ft., and the filling consists of mullock or highly crushed schist, impregnated with pyrite, and traversed by stringers of gold-bearing quartz. Ulrich referred the irregularities of the veins to disturbances caused by the intrusion of supposed dykes of " hornstone-porphyry."† As I have shown elsewhere,‡ these dykes do not exist, and both Hutton and Ulrich made a peculiar mistake in failing to identify the horny silicified gossan of some of the vein-outcrops.

The map of the Carrick Range veins shows the interesting system the individual members of which have been described in detail in Bulletin No. 5, N.Z. Geological Survey. They fall naturally into four groups—the Caledonian, Carricktown, Young Australia, and Antimony groups.

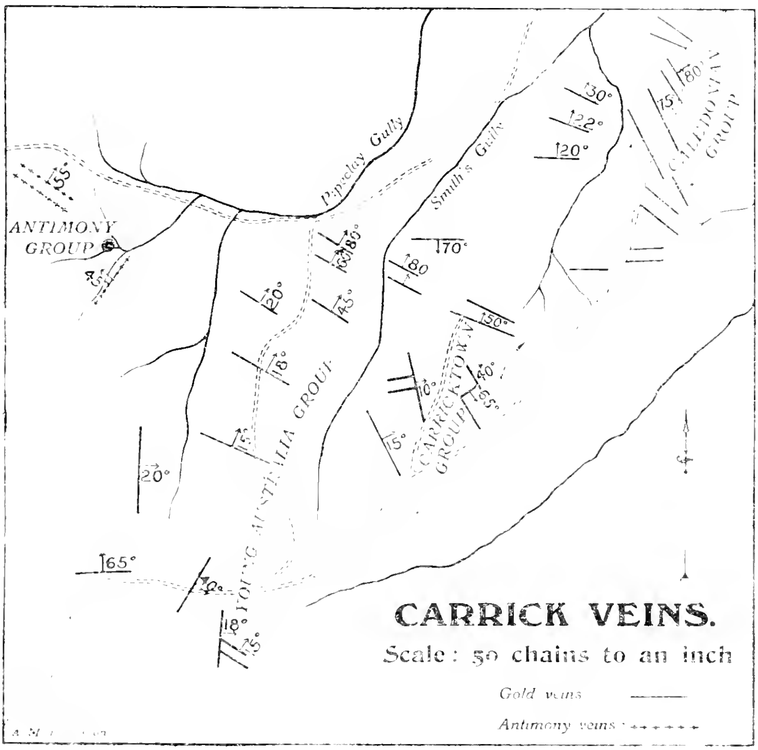
1. *The Caledonian Group.*—The veins of this group, the most northerly of all, occupy a radiating group of fissures, varying in strike from north and south to north-west and south-east. They dip at high angles.

2. *Carricktown Group.*—These veins, which occur near old Carricktown, also form a similar radiating group, opening out, however, towards the north and west, whereas those of the Caledonian group spread out to the south and east.

* E. Kohler, " Zeitschrift fur Praktische Geologie," 1903, p. 49.
† Hutton and Ulrich, " Geology of Otago," 1875, p. 162.
‡ Finlayson, " Notes on the Otago Schists," Trans. N.Z. Inst., 1907, p. 72.

3. *Young Australia Group.*—This comprises a number of flat-dipping veins lying for the most part to the south of the last group, and crossing the country rock both in strike and dip. They occur only on the higher slopes of the range, having evidently been denuded off the lower parts. The Border Chief, Heart of Midlothian, and Vale of Avoca veins, lying on the high spur west of the Caledonian group, are also members of this group, the ridge not having been sufficiently denuded to remove them.

4. *Antimony Group.*—The veins of this group are similar in character to the others, but they carry bunches of stibnite besides being auriferous. They occur in a scattered group on the summit of the range, to the west of and distinct from the other groups.



The Fissure-system.—The somewhat complicated system seems to be best interpreted as follows: There have been two sets of radiating fissures formed—the Caledonian and the Carricktown. Their formation was doubtless due to torsional stress, and the features of these groups are very well reproduced by Daubrée's experiments on the fracturing of glass by torsional effects.* There has also been a shearing movement, which resulted in the formation of the flat-lying fissures of the Young Australia group. To this movement are probably due many of the disturbances in the other veins, such as the peculiar horizontal displacements which have affected some of the veins.

* Daubrée, "Géologie Expérimentale," 1879, p. 306.

The fault-lines in all the veins are gold-bearing, and often carry thin stringers of quartz. Unless this is due to secondary enrichment, the filling of the fissures must have extended over a considerable period of time. The order of movement seems to have been: (1) Formation of radiating fissures: (2) formation of flat fissures or shear-planes, with disturbance of the radiating fissures; (3) final adjustment of the fissured area, with faulting of the flat fissures. In other words, the evidence seems to indicate that the formation of the radiating fissures was the cause of all the movements which followed, these latter being due to forces called into play to readjust the strain on the fissured area.

The formation of the fault on the east flank of the range, which was subsequent to and independent of these local movements, also doubtless disturbed the veins, but it is not possible to say to what extent.

Localisation of Ores.—A striking feature is the occurrence of the antimony-ore limited to the extreme west of the fissured area, no more than a trace of antimony being found in the sulphide minerals of the other veins. This is evidently due to processes of ore-segregation beneath.

Gold.—In the oxidized zone, which extends to a depth of about 60 ft., the gold is free and easily extracted, and from a comparison of the very high values which have been obtained on the surface with the much lower value of the unoxidized ore it is evident that an immense amount of secondary enrichment has taken place.

The unoxidized ore is impregnated with a sulphide having by analysis the empirical formula $FeAs_2S_3$, evidently a mixture of iron and arsenical pyrites. J. S. Maclaurin recently made a series of extraction tests on samples of quartz from the Carrick Range,* with the following results: Fire assay—Gold, 17 dwt. 8 gr. per ton; silver, 3 dwt. 3 gr. per ton. "No gold was visible in the stone, but panning-off showed a little free gold." Amalgamation—Extraction, 55 per cent. Chlorination without previous roasting, 33 per cent. Cyanidation, 62·7 to 72·3 per cent. Cyanidation with subsequent amalgamation, 91·3 to 96·4 per cent.

These results indicate that the gold is largely associated with sulphides, partly as a coating, most of which amalgamation would remove, and partly involved in the sulphides, which explains the small extraction from unroasted ore by chlorination. With a lens a little free gold can always be seen in the quartz, and much more coating the sulphides in irregular strings.

Stibnite.—This is highly crystalline, often shows a marked comb-structure parallel with the vein-walls, and is rather quartzose and low-grade. It occurs in bunches easily freed from the soft lode-formation (at least, in the oxidized parts), but requires much dressing to make it marketable.

Similar Groups of Veins.—The Old Man Range, near Alexandra, carries on its flanks a number of small veins similar in character to those of the Carrick Range. White's reef is the best-known. It is significant that a small antimony-vein occurs at Alexandra, thus completing the parallel between the two groups of veins.

(4.) *The Bendigo Veins.*

The veins of Bendigo lie on the north-west flank of the Dunstan Range, three miles from the Clutha River. The country rock is a firm and highly plicated quartz-mica-schist, lying almost horizontally. The veins, which are small and narrow, occupy a series of well-defined parallel fissures running

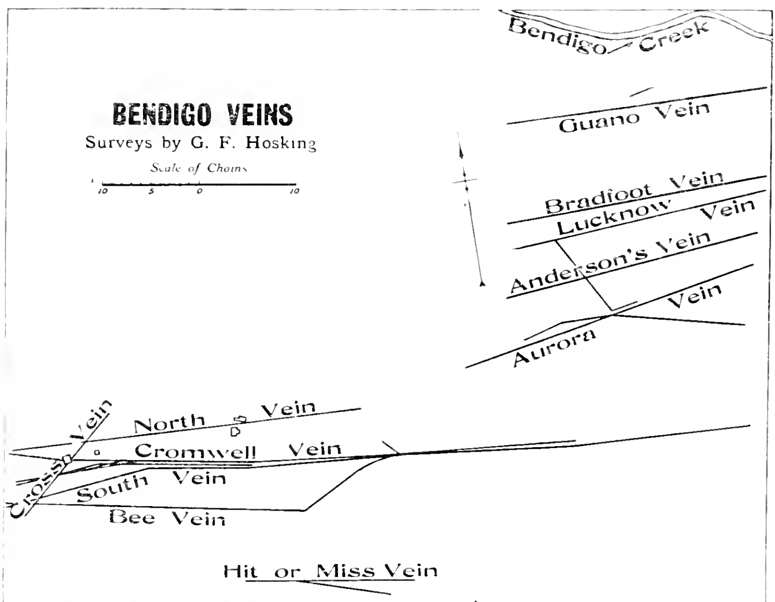
* Government Mines Report (Wellington, 1905), p. 9.

east and west, and standing almost vertically. These are well shown on the plan, and it will be seen that there is also a subordinate series of diagonal veins crossing them.

The lode-matter consists of crushed and altered schist, impregnated with pyrites and traversed by defined and continuous seams of quartz, which may run on either or both walls, occasionally occupying the whole width of the vein, with frequent splits and branch stringers. The quartz seams often show a very fine comb-structure.

In the upper levels the ore was oxidized, and extraordinary values were frequently obtained from small patches near the surface. In depth the ore is reported to be refractory, and sulphides—pyrite, galena, and blende—become prominent.

The individual veins have been described in detail in Bulletin No. 5, N.Z. Geological Survey. The group also includes the Alta scheelite-vein, which lies about three miles to the east of the main group. This seems another instance of the segregation of ores.



The System of Fissures.—The Bendigo group illustrates the sheeting of rock by fissures, discussed many years ago by Emmons in his "Structural Relations of Ore-deposits."* It is also noteworthy that the best ore was largely obtained from the neighbourhood of intersections with the cross-fissures—an instance of ore-shoots at intersections. The minor cross-veins, in fact, besides being payably auriferous, served as reliable indicators. At the intersections a mutual displacement frequently occurred—a phenomenon characteristic of crossing fissures, even when formed simultaneously.

The cross-veins are doubtless the result of shearing stresses set up in the rock at the time of formation of the main fissures, the compound fissure-lines being opened in such directions as would best relieve the strain.

* Emmons, "Structural Relations of Ore-deposits," Trans. Amer. Inst. Min. Eng., vol. xvi, p. 821.

The Vein-filling.—The quartz shows throughout a distinct banding, parallel to the vein-walls. The crystal-axes of the quartz are distinctly seen at right angles to the banding, and frequently very fine cavities with comb-structure are to be seen (Plate II, 1*a*). Brecciation is common, the quartz cementing fragments of country rock impregnated with pyrites, and indicating that movement occurred subsequently to the first mineralisation of the fissures (Plate II, 1*b*).

Chemical tests and microscopic examination of the sulphides show that the habit and association of the gold is very similar to that of the Carrick Range. The quartz, according to Ulrich and to the statements of miners, occurs in shoots dipping east along the strike of the veins. This is a matter which cannot be investigated at present, as the old workings are all closed.

The very high values which have been picked up near the grass on several of the veins are evidently the result of prolonged secondary enrichment.

Microscopically the ore is seen to be banded in alternate lines of coarse and fine granules, and carries also bunches of fine granular quartz thickly studded with pyrite crystals (Plate II, 2.)

Professor Park calls the Bendigo veins "immature replacement lodes,"* but the highly drusy and crustified nature of the quartz frequently observed argues rather for fissure-filling, and is a decided argument against Professor Park's theory.

The deepest workings in Otago were on this group, the Cromwell shaft having been sunk to a depth of 500 ft.

Other Veins allied to the Bendigo Veins.—The Conroy's Gully vein, near Alexandra, is similar to these or to the Carrick veins. The group of small east-and-west veins at Rough Ridge, now almost forgotten, are very similar to the Bendigo type.† Lastly, the Nenthorn group,‡ east of the Taieri Gorge, whose exploitation lasted for a period of two years, from 1889 to 1891, may be put under this heading. They comprise a similar set of narrow parallel veins, striking east and west, and dipping either north or south at a steep angle.

(5.) *Veins of Macrae's District.*

These are an important group of scheelite-veins, which I described in a previous paper.§ They are typical bedded or segregated veins, being the only group of this nature in Otago.

(6.) *Veins of Waipori and Southern Districts.*

Ulrich has described four of these veins—the O.P.Q., Canada, Gabriel's Gully, and Saddle Hill veins.‖ He states that they are characterized by shoots or blocks of quartz which "show an endlong dip in strike." The feature, he says, "may be considered as an oblique banded structure on the large scale," the banding being marked by alternate blocks of quartz and mullock. He also remarks that the gold occurs in shoots in the quartz blocks, in the centre or on either wall.

The O.P.Q. (Otago Pioneer Quartz-mining Company's), or Shetland, Vein.—This vein, near Waipori Township, strikes at about 160°, and dips eastward at an angle of 56°. The country rock is a slaty quartz-schist, striking north-

* Park, Bull. No. 5, N.Z.G.S., 1908, p. 63.
† Ulrich, "Geology of Otago," 1875, p. 229.
‡ McKay, Rep. N.Z. Geol. Explorations, 1890, p. 50.
§ Finlayson, "Scheelite-deposits of Otago," Trans. N.Z. Inst., 1907, p. 112.
‖ Ulrich, "Geology of Otago," 1875, pp. 159, 191.

east and dipping south-east at an angle between 10° and 25°. The walls are fairly defined with seams of gouge, and the vein has been opened up for nearly two miles along the strike, but the workings are now inaccessible. Its thickness varies; in places it is no more than 2 ft., but the average distance between walls is about 10 ft. The rusty quartz from near the surface was in patches extremely rich, while the deepest levels (200 ft.) averaged from 7 dwt. to 12 dwt. per ton. The quartz is, in general, seamy, and distinctly banded by parallel streaks of pyritic matter. The quartz shoots may occupy the whole width of the vein or only a short width on either wall. The dip of the shoots is regular and characteristic, although they generally wedge out in lens fashion when followed down, to make again on the same track at a greater depth.

Microscopically the quartz is mostly fine-grained, with occasional coarse granules enclosed in it, giving a pseudo-porphyritic structure. Frequent strings and veins of calcite are present, and the mass of fine-granular quartz is crowded with pyrite. Evidently the quartz is very largely a result of replacement, and the very distinct banding occasionally seen is best explained as due to progressive replacement of sheeted rock by ore.

In general the vein bears strong resemblances in structure to those of Skipper's and Macetown. A fuller description is given by Mr. T. A. Rickard in a very graphic article.*

Canton Vein.—This is similar to the last. It lies close to that one, and strikes in a direction to join it, the probable junction lying in a gravel-filled basin. These two veins in their field-relations may be compared with the two branches of the Nugget and Cornish vein.

Bella Vein.—This lies four miles from Waipori Township, in Long Gully, a branch of the Waipori River. It strikes east and west, and stands almost vertically. It has fairly defined walls, and varies from 3 ft. to 5 ft. in thickness. Where exploited, it consisted at the surface of a shoot of payable quartz from wall to wall. This block was stoped out for a depth of 50 ft., when it ran over to one wall and wedged out, although the width between walls was maintained. The vein carries a little scheelite, which is found in some quantity in several little-known veins in this district.

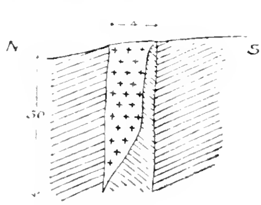


FIG. 2.—SECTION OF BELLA VEIN.

Cox's Vein.—This lies on the flanks of the Lammerlaw Range, about four miles from Waipori in a northerly direction. On the line of fissure,

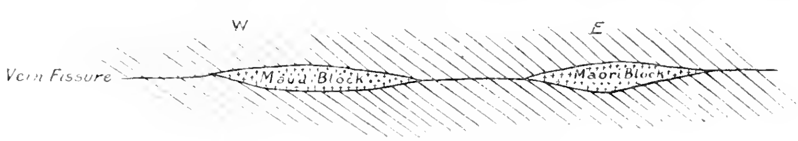


FIG. 3.—SKETCH-PLAN OF COX'S VEIN.

which strikes about east and west, and stands vertically, two shoots of stone were opened out on the surface, dignified by the names "Maori" and "Maud," with a contraction of the fissure between them.

* Rickard, "Goldfields of Otago," Trans. Amer. Inst. Min. Eng., vol. xxi. p. 416.

On the Burnt Range and Lammerlaw Range there are a number of small veins or leaders, some carrying good gold. Their strike is for the most part east and west, and they dip in either direction, with varying underlie. They show similar characters to the O.P.Q.—namely, the occurrence of lenses of quartz in the fissure-zone. The smaller veins, however, carry generally a stronger and more continuous body of quartz than the larger.

Waipori Antimony-vein.—This occurs on the right bank of Stony Creek, nine miles above the township. It has a strike of 105°, and a northerly dip of about 45°. The outcrop has been proved for half a mile. The vein is from 3 ft. to 4 ft. wide, and consists of quartz seamed with mullock, and poor in gold. It carries frequent bunches of quartzose stibnite. At one spot a pocket of scheelite was found and extracted, and gypsum was found where the scheelite and stibnite were intermingled. This is no doubt a secondary product, formed by the oxidation of sulphur and combination with the lime of the scheelite.

The veins at Gabriel's Gully, near Lawrence; at Table Hill, near Milton; and at Saddle Hill, near Dunedin, described by Ulrich in 1875, are now all closed down.

(7.) *The Barewood Claim.*

This is the best-known vein in the Taieri Gorge district, which includes several veins prospected at Hindon, Matarae, and elsewhere.

The country rock is a quartz-mica-schist, lying almost horizontally. The vein strikes north-west and south-east, and dips north-east at an angle of about 60°. It is worked by an underlay shaft, which cuts the vein at a depth of 130 ft. At 180 ft. and 240 ft. crosscuts open up Nos. 2 and 3 levels, while a winze from No. 3 level has been sunk for a further distance of 30 ft. This is one of the few veins now being worked on the goldfield. It averages from 4 ft. to 5 ft. in width, but widens out to 15 ft. in the upper levels. It is composed of solid quartz throughout, divided by subordinate clay heads or partings parallel to the well-defined walls. The foot-wall is uninterrupted, but the hanging-wall carries small leaders (from 6 in. to 12 in. wide), which wedge out a short distance up. These leaders generally carry good gold.

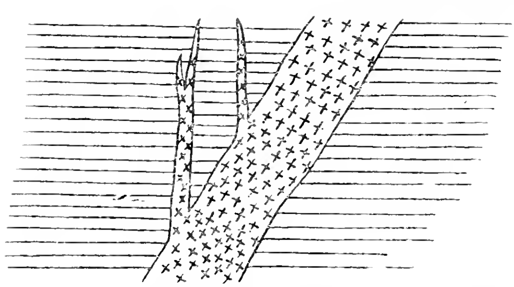


Fig. 4.—Hanging-wall Leaders at Barewood.

Slickensides are often well developed, generally on the hanging-wall. In places the quartz adjoining the walls, and also the adjacent wall-rock, are highly brecciated. This has been seen on both walls in No. 3 level, and on the hanging-wall in No. 1, while it is absent in No. 2.

Horizontal Distribution of Gold.—The gold, so far as workings have disclosed, is uniformly distributed along the strike, and shows as yet no tendency to occur in localised shoots.

Vertical Distribution of Gold.—The present depth of workings has disclosed an interesting variation in value from the No. 3 level winze to the surface. The accompanying section shows the values at different points, taking the average value through the whole cross-section of the vein :—

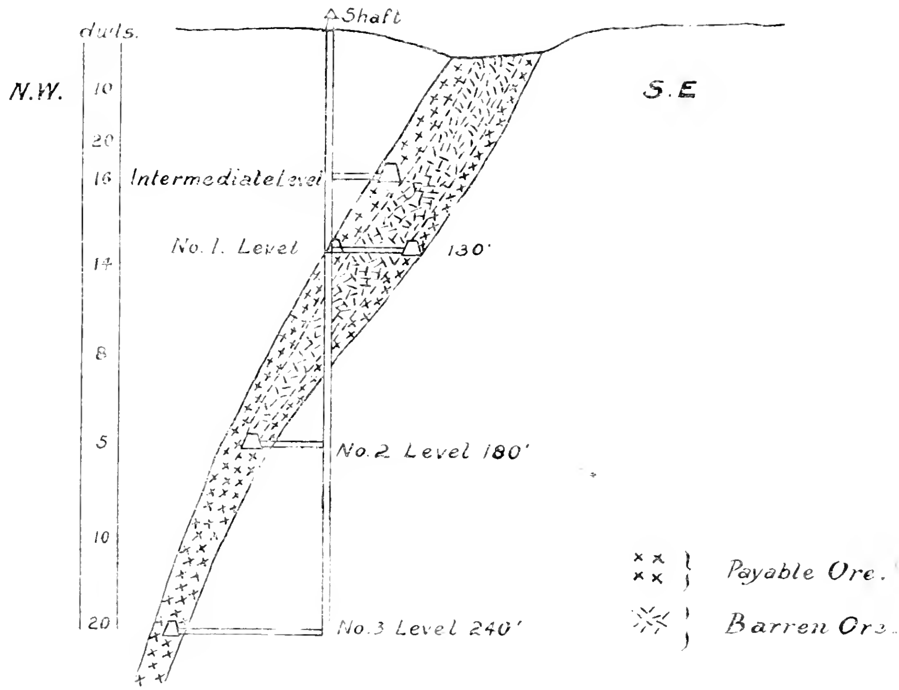


FIG. 5.—CROSS-SECTION OF BAREWOOD VEIN.

From the surface to a depth of 50 ft. the value rose from ½ oz. to 1 oz. per ton. From here to the intermediate level the value fell to 16 dwt., and then more slowly, till at three stopes below No. 1 level it was 14 dwt. From here to No. 2 level the mean value became very low—approximately, 5 dwt. Between Nos. 2 and 3 there was an equally rapid rise, and at No. 3 it varies from ½ oz. to over 1 oz. per ton, while at the foot of the winze the assay value is uniformly over 1 oz., and rich specimen-stone, particularly the brecciated variety, may be picked up showing much coarse gold. It is peculiar also that at this point the gold is often dark in colour and rusty.

At No. 3 level, below it, and for some distance above it, the gold is pretty evenly distributed across the vein. Rising to No. 2 level, a barren block of glassy quartz comes in, and the seamy gold-bearing quartz is pushed over to the two walls, and divided by clay partings from the barren centre block, which corresponds practically to a "horse" of country rock. This block wedges out when followed in either direction along the strike, and it also has an easterly pitch or dip along the strike of the vein. Both these features may be seen on the accompanying plan of the workings, where it will be observed that in each level the foot-wall and hanging-wall seams have been driven on, leaving the centre block intact.

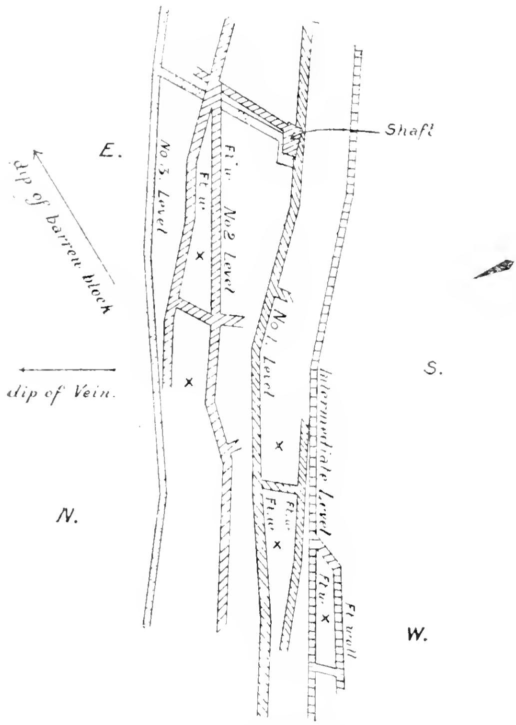


FIG. 6.—MINE-PLAN. BAREWOOD.
X Barren block.

Thus in the wider portion of the vein the gold has been deposited in two shoots along the walls. The gold-bearing quartz differs from the barren "dog's-tooth" quartz in being seamed and mottled with pyritic mullock, and under the microscope is finer in grain. These facts point to a certain amount of replacement along the walls, while the barren block has been formed by simple deposition in an enlarged fissure.

In places in Nos. 2 and 3 levels there occur peculiar siliceous concretions (Plate II, 3), cavernous and irregular in form, with a fine chalcedonic banding. They are dark, and coated thickly with very fine pyrites. In appearance they suggest "clinkers" in coal, or fossil forms.

Associated Minerals.—The dominant sulphide is pyrite, in fine crystals and grains. It is absent in the clear glassy quartz, and thickly distributed in the auriferous quartz. In the No. 3 level there was found within the vein, and near the hanging-wall, a narrow cavity containing a cluster of large stalactites of pyrite. Stibnite, galena, and scheelite occur occasionally. The only one of importance is stibnite, which is becoming common in the deeper levels.

Habit of the Gold.—The gold is largely free, the assay value of pyrite being low. It is probable, however, that at a greater depth the ore will become refractory.

Alteration of the Wall-rock.—The country rock is little altered, except for about 2 ft. from the vein-walls, where the alteration is considerable, the rock being soft and "mullocky." There is, further, frequently found on the walls a type of greasy yellowish rock, devoid of pyrite, and very similar to the corresponding rock described above in the Nugget and Cornish Mine. It accompanies the brecciated ore, the payable seams being well developed in No. 3 level and the winze.

The following analyses indicate the alteration of the normal rock :—

	1.	2.	3.	4.
H_2O	1·68	2·11	1·58	— 0·10
SiO_2	62·02	65·30	48·97	—13·05
Al_2O_3	11·15	14·70	11·15	..
Fe_2O_3	5·58	4·12	3·09	— 2·49
FeO	7·26	2·41	1·80	— 5·46
CaO	6·11	3·76	2·82	— 3·29
MgO	0·65	0·79	0·60	— 0·05
K_2O	1·71	1·28	0·96	— 0·75
Na_2O	3·34	2·05	1·54	— 1·80
MnO	0·17	0·21	0·15	— 0·02
TiO_2	1·01	0·37	0·27	— 0·74
FeS_2 . ..	..	3·82	2·85	+ 2·85
	100·68	100·92	75·78	+ 2·85
				—27·75
				—24·90

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

The alteration in this case is more intense than at Skipper's, although more local, and the loss of material greater. It is, however, of a similar nature—namely, sericitic.

Analyses made of the yellowish or bleached variety of wall-rock show that, like that at Skipper's, it is a kaolinized type of the ordinary sericitic rock, evidently formed by the action of descending waters.

Ore-shoots of Primary Origin.—The characteristic hanging-wall and foot-wall seams described above doubtless originated during the primary deposition of the gold, through the influence of the wall-rock.

Ore-shoots of Secondary Origin—Secondary Sulphide Enrichment.—A number of facts indicate that the No. 3 level winze has encountered a zone of enriched sulphides (pyrite and stibnite). These are as follows: (1.) The occurrence of the gold in the free state, and its frequent rusty colour. (2.) The occurrence of stalactites of pyrites. (3.) The peculiar siliceous concretions, probably due to solution and redeposition by subsequent leaching processes. (4.) The brecciation, signifying subsequent movement, would give readier access to descending solutions. (5.) The kaolinization and bleaching of the yellowish wall-rock, and the absence of pyrite in it, are evidently due to descending surface waters, and it is notable that it occurs associated with the brecciated ore and with the richest seams. (6.) Finally, the impoverishment in the upper levels, supported by the above data, points to the work of secondary enrichment, which has largely leached the gold out of the upper levels and redeposited it with sulphides in the zone now being opened up. It is probable that when this zone is passed through the ore will become lower grade and refractory, as at Bendigo and on the Carrick Range.

(8.) *Copper-veins.*

There are two veins in the district carrying auriferous chalcopyrite—one at Moke Creek, near Queenstown, and one in Reedy Creek, near Waitahuna. I examined the outcrop of the Moke Creek vein, but little can be seen, and no information of importance was obtained. The ore is low grade, and the veins are small and of uncertain ore-content. Under the microscope there is seen to be a good deal of carbonate in the gangue (Plate II. 4). Ulrich described both these veins in 1875, and Rowe later described the Waitahuna vein (see Bibliography).

(9.) *Cinnabar-vein.*

One cinnabar-vein has been located—namely, the Waitahuna vein, in a gully at the foot of the Waitahuna Hills, half-way between Berwick and Waipori. The vein is a small one, filled with pyritic mullock, which carries bunches and veins of very high-grade cinnabar. The mineral is highly crystalline in the frequent small cavities, the crystal form being prismatic with rhombohedral terminations (r, $10\bar{1}1$).

Cinnabar is frequently found in the alluvial gravels throughout the Waipori district, and there is no doubt that there are other veins of this mineral in the neighbourhood. Such veins might escape detection owing to their small size, and to the soft and perishable nature of the vein-filling. The country is, moreover, unfavourable for the prospecting of such veins, being largely worn down into rolling foothills covered with tussock.

A good deal of alluvial cinnabar has also been found in the Nevis and Nokomai district, and a vein doubtless exists there also, although none has yet been found.

(10.) *Fault-fractures and Barren Quartz Reefs.*

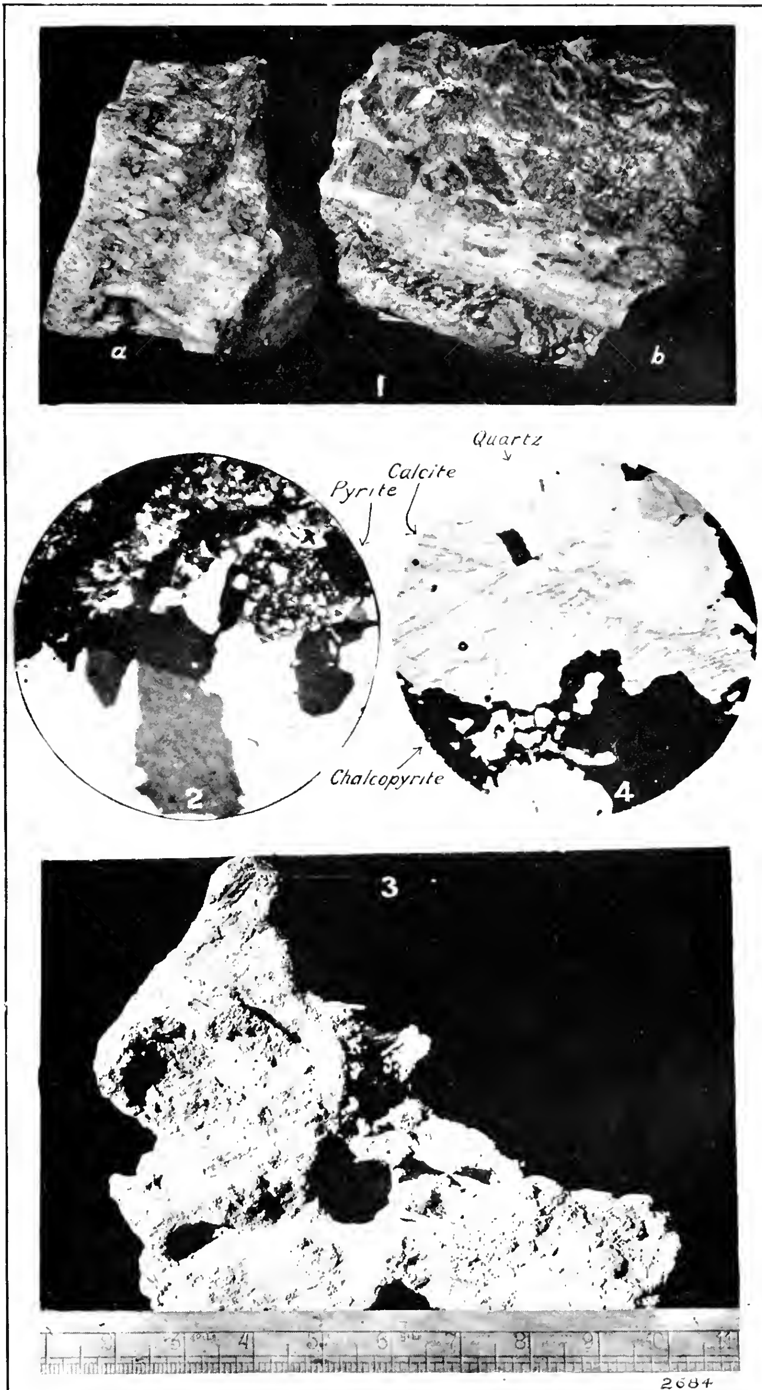
The occurrences described under this head have, as far as can be seen, no economic value.

Fault-fractures.—The faults and crush-zones which extend through the goldfield are occasionally mineralised, and carry a few grains or more of gold to the ton. One of these occurs about three miles to the east of Bendigo, running about north-west and south-east.* In several places on the line of the fault prospecting-work has been carried on, and a little payable work done, but the irregular and very low-grade nature of the formation caused operations to be soon suspended. The workings disclose a belt of crushed schist traversed by small irregular veins of quartz.

Green's reef, at Ophir, described by Ulrich† and by Park,‡ is another instance of this type. Some years ago it gave a good return to its sole prospector. The occurrence of gold at Green's reef is cited by McKay as an instance of the occurrence of free gold in the schist.§

Ulrich has suggested that these "lode-formations" will, if developed, lead to a simple defined vein in depth. It is much more probable that

* Park, Bull. No. 5, N.Z.G.S., p. 56.
† "Handbook of New Zealand Mines," 1887, p. 75.
‡ Park, Bull. No. 2, N.Z.G.S., p. 29.
§ McKay, "Gold-deposits of New Zealand" (Wellington, 1903), p. 67.
Ulrich, "Geology of Otago," 1875, p. 185.



QUARTZ VEINS OF OTAGO GOLDFIELDS.—Finlayson.

Face p. 80.

they will peter out altogether, and certainly their gold-content will not justify sinking on the outcrop. That they have had their indirect value, however, is undoubted, and they must have helped in some measure to supply the alluvial gold of the drifts.

Barren Reefs, or Buck Reefs.—These are peculiar types, and correspond to similar occurrences on the Hauraki goldfields, in California, and in a great many other vein districts. In Otago they consist of very wide, massive, bold outcrops of "hungry" glassy quartz, often traceable for considerable distances. They are practically barren, devoid of pyrite, and composed of quartz throughout.

A typical buck reef occurs near the Hawksburn Homestead, six miles south of Bannockburn. Several occur at Quartz Reef Point, on the Clutha River, four miles above Cromwell. Another occurs at Nenthorn, and another in the Nokomai district. An interesting buck reef occurs near Waipori, on the road to the Waipori antimony-vein. Where it outcrops it consists of 2 ft. of quartz, much of which is in very fine pseudomorphs after calcite, and preserves excellently the rhombohedral cleavage. It is, however, not proved that this is a buck reef, as no tests have been made of the quartz.

GENERAL OBSERVATIONS ON THE VEINS.

(1.) *The Vein-fissures.*

Nature of the Fissures.—The fissures which carry the veins of Otago vary greatly in nature, according to the physical character of the particular zone of schist through which they pass. Where the schist is resistant and quartzose the fissures are simple, being narrow and defined, as at the Carrick and Bendigo; where the rock is softer the fissures are compound, ill-defined, and longer, and become shear-zones of some width, as at Skipper's and Macetown. Finally, at Macrae's the shear-zones follow the foliation-bedding planes, so that here we have a group of bedded or segregated veins. Thus the division of the veins into groups, first used by Ulrich, is made possible by the above fact—the varying nature of the schist and the consequent varying nature of the veins in different localities.

Professor Park speaks of the vein-type at Bendigo as a twin fissure containing a band of schist between.* I can see no evidence of this, and I regard such a vein as a single fissure filled by quartz, except where portions of country rock have been detached from the walls of the fissure by subordinate cracks, giving the quartz vein a varying thickness.

Orientation.—The mean strike of the gold-bearing fissures is west and east, or slightly to the north of west, although locally the strike varies through all points of the compass, as on the Carrick Range.

Distribution.—The local distribution of fissures as shown on the map is in part more apparent than real, for there is no doubt that the whole goldfield is traversed by veins, even in localities where they have not been located. This is due in part to the absence of prospecting in less inviting districts, and in part to the fact that veins might readily be overlooked in tussocky country where shoots or blocks of quartz did not happen to outcrop. Nevertheless, there is evidence of a localisation of fissures into more or less defined groups. This is probably due to local factors, such as the nature or previous disturbance of the schist, which aided or retarded the fissuring-forces.

* Park, Bull. No. 5, N.Z.G.S., 1908, p. 63.

It is noticeable that the vein-bearing district spreads out in a fan from the head of Lake Wakatipu to Macrae's in the north and Lawrence in the south. This fan encloses all the known auriferous veins of Otago, although it must be remembered that veins exist at Preservation Inlet, in the far south-west, and also probably in the Longwood Range, in Southland. Nevertheless, the fact remains that the gold-veins of Otago proper are contained within the area indicated.

Origin.—The fissures are evidently due to compression-forces, as they have all the typical features of compression veins, described by Emmons. For the cause of this compression there are two alternatives: (1.) It may have been caused by a tectonic force acting from west to east and south-east, with its greatest intensity at the head of Lake Wakatipu, in the near vicinity of the belt of igneous rocks which were intruded during the Jurassic mountain-formation. Such a compression movement would conceivably extend its area of effect as suggested by the above "fan," and would gradually diminish in intensity as it passed towards the coast. This would be favourable to the formation of bedded shear-zones, as seen at Macrae's. (2.) It may have been caused, as Professor Park claims,* by local intrusions of igneous rocks which did not reach the surface. As against this view, it is strange that none of the intrusives are to be seen exposed. The evidence is not yet sufficient to decide which view is the correct one, but from a consideration of the gold-bearing veins throughout the South Island there is strong evidence for concluding that the fissures were formed during adjustment of the strains set up by the alpine folding at the end of the Jurassic.

Age.—On this view the fissuring is Post-Jurassic, and probably occurred during subordinate earth-movements following on the main extensive folding. They may be regarded as of Cretaceous or early Tertiary age.

The fault-fissures are much younger, being, from geological considerations, of late Pliocene or even younger date.

(2.) *The Vein-formation.*

The vein-formation varies, as has been seen, according to the nature of the fissures, and all gradations may be traced from quartz-filled fissures to replacement veins. The typical quartz vein is seen at Barewood; Bendigo is also a good instance of fissure-filling. At Skipper's, Waipori, and Macrae's, replacement has been the chief process.

The characteristic metasomatic alteration, as revealed by analysis, is sericitization of the wall-rock, accompanied by a reduction of specific gravity and a decrease in volume. A calculation of the constituents of the altered rock at Barewood shows that about 33 per cent. of sericite is present. As regards changes in constituents, the altered rock shows generally a considerable loss in silica, greatest in the case of veins which carry segregated quartz (Macrae's), in iron and titanium, in the earths and in the alkalies. The added constituents are generally sulphur and carbon-dioxide. The nature of the metasomation is somewhat similar to that of the Freiberg gneiss, examined by Scheerer and Stelzner.†

Ore-shoots.—Nearly all those veins which have been reported to contain ore-shoots are now unworked, and I was unable to investigate the subject. It is therefore inadvisable to speculate or make statements based on rumour and on records of doubtful value.

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* Park, Bull. No. 5, N.Z.G.S., 1908, p. 63.

† Beckweed, "Nature of Ore-deposits," 1905, p. 397.

Changes of Primary Ore-content in Depth.—The deeper workings appear to show that in most cases the gold in depth becomes largely involved with sulphides, the free gold diminishing in proportion. The metal is still largely free at Barewood, but this appears due to secondary enrichment, and primary or unleached ores in Otago are all probably refractory.

In regard to variations in the sulphides at different depths, the data are either unreliable or too meagre to indicate anything.

Paragenesis. — The following are the known cases of paragenesis in Otago: (1) Gold, iron-pyrites; (2) gold, iron-pyrites, stibnite; (3) gold, iron-pyrites, stibnite, galena; (4) gold, iron-pyrites, galena, zincblende; (5) gold, iron-pyrites, bournonite, zincblende; (6) gold, iron-pyrites, scheelite; (7) gold, iron-pyrites, scheelite, stibnite; (8) gold, iron-pyrites, scheelite, stibnite, galena; (9) gold, iron-pyrites, cinnabar; (10) gold, iron-pyrites, copper-pyrites.

(3.) *Subsequent Changes in the Veins.*

1. *Movement along the Fissure-walls.* — Subsequent movement of the fissures is shown by the frequently brecciated ore, but there is nothing to indicate enrichment by uprising thermal waters during the movement.

2. *Secondary Sulphide Enrichment.* — Gossan enrichment is best seen at Bendigo and the Carrick, and illustrated by the manner in which workings were largely confined to the oxidized zone. The phenomenally rich patches of ore recovered near the surface in the early days are further evidence.

The occurrence of film or paint gold on clay selvages, as at Skipper's, is another proof of enrichment, and the yellow kaolinic wall-rock seen here and at Barewood is no doubt due to the same cause.

A zone of enriched sulphides occurs, as discussed above, at Barewood, and probably in other veins as well.

3. *Denudation.* — During the frequently recurring periods of elevation since the vein-formation denudation would be active, and the upper enriched portions of the veins would be continually shorn off, the gold going to supply the alluvial wealth of Otago, for which the district is more justly famed. A consideration of the relative amounts of vein and alluvial gold obtained in Otago shows that the value of the veins has been largely indirect. Denudation has, indeed, gone on to such an extent that the Otago veins must be considered as practically vein-roots, and when it is possible to calculate the amount of denudation that has taken place we will have a legitimate field for speculating on the depth to which the veins will be payable.

4. *The Source of Alluvial Gold.* — The early diggers in Otago, as in all other goldfields, maintained that the alluvial gold was derived from quartz veins. Messrs. McKay* and Rickard,† however, claim that the quartz veins are insufficient in quality and quantity to have supplied the gold, and they maintain that the gold has been derived mainly from the schist. In another paper I have pointed out that the occurrence of gold in the schist is an unproven hypothesis.‡ Further, after a careful study of the great number of veins which exist, and of the prolonged enrichment and enormous denudation which have taken place since the veins were formed, I have come to the conclusion that the early diggers held the correct view—that the quartz veins were a sufficient source of supply, and that no other source supplied any appreciable quantity.

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* McKay, "Gold-deposits of New Zealand" (Wellington, 1903), p. 67.

† Rickard, "Goldfields of Otago," Trans. Amer. Inst. Min. Eng., vol. xxi, p. 442.

‡ Finlayson, "Notes on the Otago Schists," Trans. N.Z. Inst., 1907, p. 77.

(4.) *Genesis of the Veins.*

In the light of present views in regard to the genesis of ore-deposits, we must conceive that the vein-fissures when formed gave access to thermal waters charged with precious metals, which rose from a magma beneath, wherein rock-differentiation and ore-segregation had taken place.

The universal occurrence of gold and pyrites, and the very frequent presence of antimony-ore and scheelite, indicate a pretty uniform degree of segregation beneath. The isolated occurrences of copper-ore and cinnabar are no doubt due to some local segregations at points beneath.

Fault-fractures.—These were formed at a much later date, probably when thermal magmatic waters had ceased their activity. Moreover, being gravity faults, they would not extend to such a depth as compression fractures, even allowing for a reduced thickness of the schists due to denudation.

Buck Reefs.—The explanation of these occurrences is difficult. Their presence in so many gold-bearing districts would lead us to infer that they have been formed by similar processes to the gold-veins, and probably at the same time. The quartz appears to have been deposited in a wide fissure, or at least in a fissure which widened as it was being filled, while the solutions were either of meteoric origin or had been robbed of their metallic content some distance below the present surface. It is even possible that the solutions were barren of metals, and that these buck reefs illustrate the extreme siliceous product of magmatic differentiation in a portion of the magma where the conditions were not favourable to the segregation of ores.

(5.) *Future Prospects of the Goldfield.*

The history and development of quartz-mining in Otago have been sketched by Mr. Robert Mackintosh, who has also some observations on the future prospects of the district.* The following matters may be emphasized from the standpoint of economic geology:—

1. Timber is scarce all over the field, while water and fuel are also often at a premium. These factors are obstacles in the way of extensive working.
2. The small size of the veins, and the fact that the ore is frequently refractory and low-grade, are also objectionable features.
3. The uncertain occurrence of quartz blocks in the larger veins, and their uncertain quality when found, entail extensive development, and the returns from such workings are not likely to be highly remunerative.
4. Finally, in consideration of the fact that the veins are practically roots, and that the ore is almost certain to be low grade after a depth of about 300 ft., deep sinking is less likely to be successful than development along the strike. There is no doubt that a great deal of payable ore still exists in undeveloped portions of the veins, and that the judicious exploitation of the upper levels would maintain the field for some years to come.

EXPLANATION OF PLATE II.

Fig. 1. Comby quartz (*a*), and brecciated quartz (*b*), from the Cromwell vein, Bendigo.

Fig. 2. Vein-quartz, Bendigo. The photo shows the association of coarse and fine granules. Magnified 27 diameters.

Fig. 3. A siliceous concretion from the No. 2 level, Barewood, formed evidently during secondary enrichment by meteoric circulation.

Fig. 4. Chalcopyrite, from Moke Creek. The photo shows some ore (opaque) in a gangue of quartz and twinned calcite. Magnified 27 diameters.

* R. Mackintosh, "Mineral Resources of New Zealand," *N.Z. Mines Record*, 16th Jan., 1907.

ART. XVI.—*The Geology of the Reefton Gold-veins.*

By A. M. FINLAYSON, M.Sc., A.O.S.M.
Communicated by Dr. Marshall.

[*Read before the Otago Institute, 14th July, 1908.*]

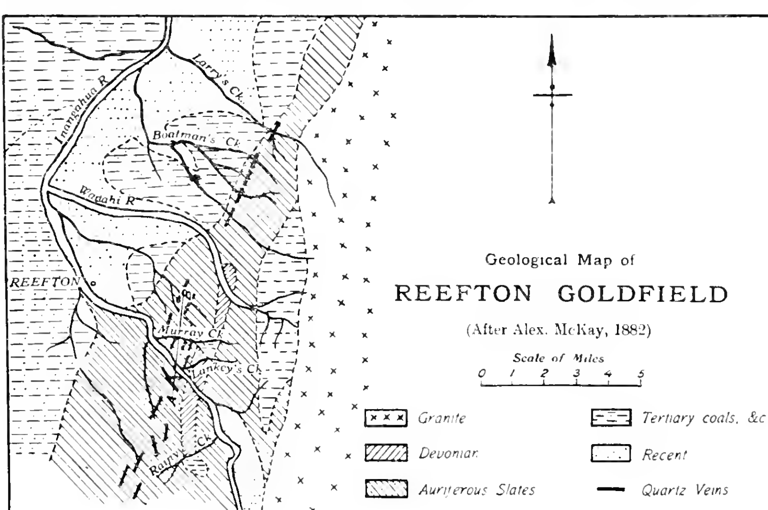
INTRODUCTION.

THE quartz-mining district of Reefton has many claims to distinction among the mining camps of the Dominion. Although late in development, the mines when opened up made rapid strides, and the goldfield has survived alike the wild-cat period and the period of booms and crashes. The Town of Reefton was the first in New Zealand to be lit with electric light, by power from the Inangahua River, and, although none of the mines compare with Waihi for magnitude of operations, the field offers good opportunities for studying the cyanidation of low-grade ores. The veins themselves are interesting from the point of view of structural features rather than of genesis.

I wish here to express my great indebtedness to Mr. A. Spencer, surveyor for the Consolidated Company, for the great assistance he rendered me by giving me access to the mines and to the mine-plans.

GENERAL DESCRIPTION OF THE DISTRICT.

The district of which Reefton, a town of two thousand inhabitants, is the commercial centre, occupies the valley of the lower Inangahua River,



which emerges from the gorge, flows past Reefton, and runs north for about twenty miles to join the Buller River where the old Township of Lyell is situated. The upper Inangahua flows north-west, and crosses in its gorge the best-known part of the gold-belt. This latter further extends some distance to the south, passing over a low saddle into the watershed of the Grey River.

The district thus indicated lies in a valley between two granitic ranges—the Paparoa Range on the west, and the Victoria-Brunner Range on the east. The Inangahua River receives in its course several tributaries, the most important being on its right, or east, bank. The largest are the Waitahu River, which joins it a few miles below Reefton, then Boatman's and Larry's Creeks. In the gorge it receives on its right bank Lankey's and Murray Creeks, and on its left Rainy and Devil's Creeks. These are small mountain-streams, whose names are closely linked with the early history of the goldfield.

The mountain-slopes from the 3,000 ft. level to the valley have been for the most part heavily timbered, and still are in the less settled parts of the district. But the forests are being rapidly destroyed to supply timber for the mines and for other purposes, and to clear the land for grazing.

The district is well watered by its numerous streams, and, in common with other parts of the West Coast, it has an abundant rainfall. There is more than sufficient water for mining purposes, and the available water may still be turned to account as a source of power. The climate is mild for the most part, though somewhat cold in winter, and the town during that season is frequently enveloped for days at a time in a thick low-lying fog.

The district is connected with Greymouth by a forty-mile train service, and with Westport by a coach *via* the Lyell. Nearly all of the Reefton traffic goes by the former route.

Previous Geological Work.

The veins themselves have never been systematically examined since their exploitation, which is a matter for regret both from an economic and from a scientific standpoint. The geology of the district has, however, received some attention from Hector,* Cox,† and notably McKay.‡ The last named also has some incidental references to the veins. Murray, in a report on deep quartz-mining in New Zealand,§ has also some notes on the Reefton mines. The only other available information is contained from year to year in the annual reports of the Mines Department.

Geology.

The district is bounded on both sides by granite massifs, in the Paparoa Range and the Victoria and Brunner Ranges. The space between is occupied by a belt of slates—the gold-bearing series, considered by Hector's Geological Survey to be the equivalents of the Maitai series.‖ These slates are much folded into a series of sharp anticlines and synclines, and also much disturbed by faulting. The age of the slates is not definitely known. They have been referred to the Carboniferous, but may be much younger.

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* J. Hector, Reps. N.Z.G.S., 1873–74, p. 85.

† S. H. Cox, "Geology of Westland," Reps. N.Z.G.S., 1875–76.

‡ A. McKay, "Geology of Reefton District," Reps. N.Z.G.S., 1882, p. 91.

§ R. A. F. Murray, "Report on Deep Quartz-mining in New Zealand," parliamentary paper C.–6, 1894.

‖ A. McKay, "Geology of Reefton District," Reps. N.Z.G.S., 1882, p. 132.

The belt of quartz veins runs through them in a north-and-south direction along their strike.

Erosion along an anticline in the slates has exposed beneath them in places a series of cherts, slates, and limestones containing fossils of Devonian age.

As regards the relations of these three formations, the granites on both sides are intrusive into the slates, as seen by the intense local contact-effects in Larry's Creek and elsewhere, and to their intrusion is doubtless due the intense folding and crushing of the included belt of slates. These latter are claimed by Hector and McKay to rest with pronounced unconformity on the Devonian rocks,* and from other considerations this is probably the case, but good sections showing the junction between the two formations are difficult to obtain owing to the faulting and disturbance that the rocks have undergone. McKay has described in some detail the Devonian sequence exposed in the Inangahua Gorge, Lankey's Gully, Waitahu River, and Rainy Creek.† North and south of these limits the Devonian rocks have not been recorded.

Next in age comes the early or middle Tertiary series of coal-bearing rocks, well developed at Boatman's and at the head of Murray Creek. In these localities good seams of high-grade bituminous coal occur, from which over 100,000 tons of coal has been won. This coal is a valuable asset to the district, and is in high favour for household purposes. Accompanying the coal-bearing rocks are auriferous gravels and cements (which have been worked in places), sandstones, and, further north, limestones. The base of the series is occupied by coarse greywacke breccias, well exposed in the Buller Gorge, on the east flanks of the Paparoa Range. The rock series thus described as exposed in the Reefton district is typical of the great coal-bearing series of the West Coast, whose age is still a matter of doubt. They have been classed by Hector and McKay as Cretaceo-tertiary,‡ but the limestone fossils indicate a much younger age. Whatever their age, they rest with marked discordance on the older rocks, and are also deeply involved in the structure of the ranges on which they occur, as is well seen in Murray Creek.

The Inangahua Valley is occupied by gravel terraces of Pliocene or Pleistocene age, and by recent gravel-deposits. The gravels, both in the main valley and in the tributary streams, have yielded a considerable quantity of alluvial gold, and are even yet in places profitably worked by small parties.

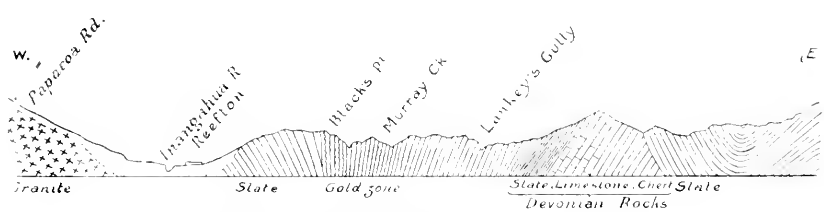

FIG. 1.—SKETCH SECTION ACROSS REEFTON GOLDFIELD.

The above sketch section across the district from west to east indicates the geological structure.

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* A. McKay, "Geology of Reefton District," Reps. N.Z.G.S., 1882, p. 130.
† *Loc. cit.*, p. 108.
‡ *Loc. cit.*, p. 140.

Dykes.

The granitic rocks are penetrated here, as elsewhere on the Coast, by numerous basic and semibasic dykes, including varieties of diorite, porphyrite, camptonite, and similar types.

The slates are also intruded by a series of dykes which, so far as yet known, are exclusively of diabase. The outcrops are difficult to locate, owing to the extensive alteration which the dykes have undergone, some of them being slightly schistose. They have generally been exposed in mine-workings only, and, as many of the mines are now closed down, observations cannot readily be made. They have been found in the Specimen Hill, Inglewood, and Keep It Dark Mines, but the only one that I saw was in the last-named, and its occurrence is described under the description of that mine.

It is notable that these dykes seem confined to the gold-bearing belt, but their intrusion seems to antedate the vein-formation. Their intense alteration is probably due to solutions acting at this period, and their occasional schistosity indicates that they have been subjected to considerable pressure, probably during the period of folding of the slates. There is thus evidence for assuming that they are the oldest known intrusives in the district.

Petrography of Diabase.

Megascopically the diabase is a rather soft dark-green rock, full of black cleavage-faces of small augite crystals.

Under the microscope the rock, when fresh, has the typical ophitic structure of a diabase. It is composed of twinned laths of andesine-feldspar containing some secondary sericite and calcite arranged evenly along the centre of the crystals. Augite is fairly fresh and pale in colour, the crystals filling up interspaces between the feldspars, or occurring as small detached crystals. The individuals are occasionally twinned. The relative proportions of augite and feldspar vary somewhat; at times augite predominates, with the local disappearance of other constituents. It is then coarse and in better-outlined crystals. Olivine is occasionally seen in some quantity, but very largely replaced by a mesh of serpentine, without the separation of much iron-oxide. It is probably not a highly ferriferous variety. Of other constituents, a good deal of magnetite (both primary and secondary), a little basaltic hornblende (often chloritized), and needles of apatite are present.

The alteration of this rock close to the vein is well shown under the microscope. In the first stage the feldspars become more and more replaced by carbonates till the twinning is indistinguishable, and they practically consist of sericite-calcite pseudomorphs. Olivine is replaced by chlorite and serpentine, augite by magnetite (or ilmenite) and a leek-green serpentine. The ophitic structure can, however, still be traced.

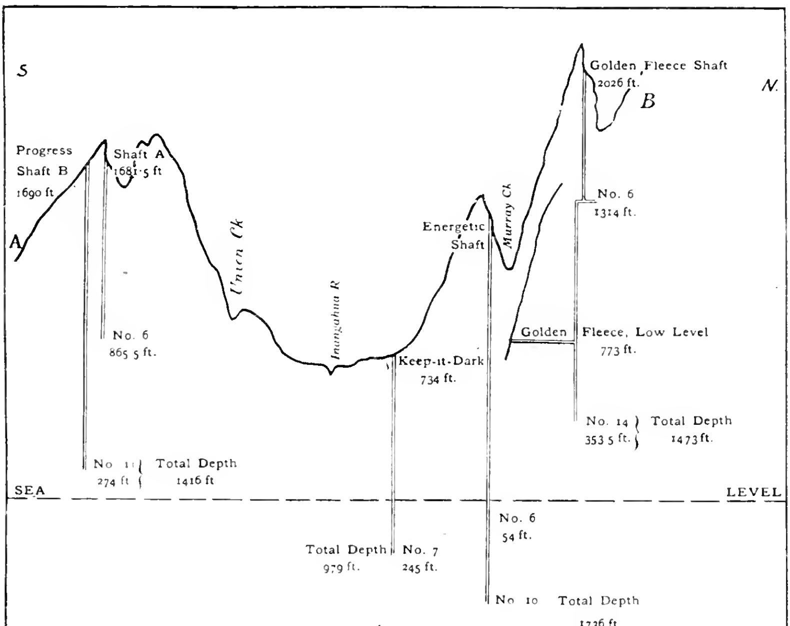
With further alteration all structure is lost, even the outlines of crystals being obliterated. The rock becomes an aggregate of carbonates and sericite, with a good deal of opaque iron-oxide, and a little quartz, probably introduced. Strings and patches of pale-green chlorite are present at first, but these are eventually altered to sericitic matter. Pyrite crystals are also frequently present.

Thus we are able to trace the progressive steps of alteration. The lime-soda feldspar is changed to carbonates and sericite; the augite and olivine first to transitional chlorite and serpentine, with separation of iron-oxides, and finally to the same end-products, these two minerals composing in the end the mass of the altered rock.

THE VEIN-SYSTEM.

The gold-belt, which occupies a zone running nearly north and south, passes through the broken foothill country of the Victoria and Brunner Ranges, on the east side of the Inangahua Valley. It extends almost continuously from the Lyell to Black's Point, near Reefton, in the Inangahua Gorge, and, crossing the river, passes south as far as Snowy and Blackwater Creeks, in the Grey River watershed.

The belt thus indicated is, in its broader aspect, merely a portion of the continuous reef-bearing zone of the West Coast. Thus, passing northwards, we come to the reefs at Mokihinui and on the Owen Goldfield, and



SECTION THROUGH REEFTON GOLDFIELDS, SHOWING SHAFTS.

APPROXIMATE SCALES:

Horizontal, 6,000 ft. to an inch.

Vertical, 800 ft. to an inch.

finally to the Golden Ridge district, near Collingwood. To the south, wherever the belt of slates appears, we find reefs in the same line—in the Taipo River and the Wilberforce. This belt of reefs is certainly irregular in its course, but it cannot be geologically subdivided, as all the veins have the same features, which will be described in detail under the next heading.

On the Reefton Goldfield, commencing at the north end, we find first the Alpine Consols and other lesser-known claims at the Lyell. Passing south we reach Larry's, where the Caledonian Mine is situated. Next, at

Boatman's, occur a group of small but well-known mines—the Specimen Hill, Welcome, Fiery Cross, Hopeful, and Just in Time. Approaching Reefton, the belt has apparently a much greater width, probably due to the wider exposure of slates, while the veins are larger and have been more extensively developed. On the west side occur Anderson's and the Invincible, two properties on which little has been done. Then occurs the Energetic - Wealth of Nations - Keep It Dark group, the most productive on the field. The Ulster, Ajax, Golden Fleece, and Royal occur in a line to the east of these, and lastly come the Inglewood, Victoria, and Golden Treasure Mines. Fig. 2 shows the distribution of mines in the Murray Creek district.

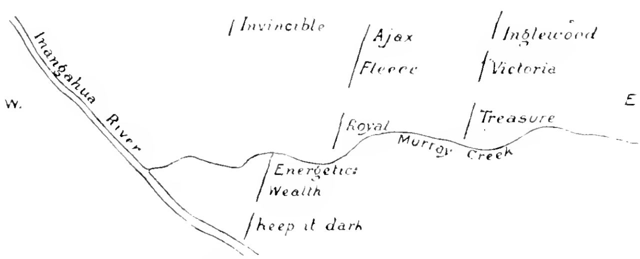


Fig. 2.—Sketch-plan of Murray Creek Veins.

Crossing the gorge of the Inangahua River, we reach the well-known Globe - Progress Mine, the vein in which runs almost east and west, deviating widely from the usual north-and-south course. A few old properties, including an antimony-mine described by McKay,* occur to the west of this vein. Following south, we pass in succession the Inkerman, Sir Francis Drake, Cumberland, Golden Lead, and A1 Mines, the last situated at the head of Rainy Creek, in the Merrijigs district.

Still further south, on the Big River, lies the Big River Mine, about twenty miles from Reefton; and lastly, near it, the lately developed Blackwater Mine, in the Snowy Creek watershed.

Characteristics of the Veins.

The auriferous belt consists of a zone of crushed and fissured slate of varying width (maximum, about two miles), and it is to be observed that this zone lies parallel with the line of strike of the slates, with the granitic intrusions on either side of it, and with the observed outcrops of the older Devonian rocks to the east, while it practically corresponds with the line of occurrence of the altered diabases. These coincidences have a structural significance.

If the intrusion of diabases was the first phenomenon, it is probable that they caused a line of weakness along the strike of the slates. Later, with the granitic intrusions and the intense crumpling of the slates between, this line of weakness would be the locus where crushing and faulting would be concentrated. The junction between the soft slates and the hard Devonian cherts would also be a line along which movement would readily take place—in fact, the belt of resistant Devonian rocks, which were indurated and folded prior to the deposition of the slates, would evidently act as a central buffer during the later folding movements, and would

* A. McKay, "On an Antimony Lode at Reefton," Reps. N.Z.G.S., 1882, p. 88.

further concentrate movement and shattering into a comparatively narrow zone in the slates.

The absence of veins in the Devonian rocks is not surprising, as they would not be amenable to extensive fissuring, more especially as the relief of strains would be readily effected by faulting of the weaker slates. Moreover, fissuring and faulting would take place where the stress due to folding was greatest—that is, in the apex of the main syncline of the slates.

Throughout the width of the zone of disturbance there are places where more defined fissuring has taken place, giving access to thermal solutions. It is in these places that the veins proper occur, and the position of the chief veins is indicated by the position of the mining claims.

Turning to the individual veins, if they can be so regarded, a vein consists of a series of lenses of quartz, with constriction of the vein-walls between. The lenses follow each other more or less continuously to considerable depths, with short barren patches of "vein-formation" between the lenses. The vein, as indicated by its walls and the included band of crushed slate which contains the lenses, conforms as a rule to the bedding of the country rock, though frequently it may cut across it.

The lenses vary considerably in dimensions in different parts of the field, the smallest occurring at Boatman's and the largest in the Inkerman Mine. In most cases they show a steep pitch to the north along the strike of the vein. The gold, of fineness 960, and worth over £4 an ounce, is free-milling, and varies from coarse to fine. The former is caught on the battery-tables, and the latter recovered by cyaniding the tailings. It is scattered for the most part through the lenses, though occasionally it lies in shoots on the walls. Of sulphides, auriferous pyrite is always present, the pyritic concentrates being worth approximately £20 per ton. Stibnite is also very frequently present, some veins carrying a notable proportion of it. It is mostly low grade, and mingled with quartz. When present in quantity it occurs in seams and bunches. As an accessory it is scattered sporadically through the stone, and greatly increases the consumption of cyanide. To remedy this, the Keep It Dark Company now treat their tailings with a solution of caustic soda previous to cyaniding.

Metasomatic Action.—The results of analyses made of the fresh and altered slates show a considerable loss of silica and alkalies; the effect of the ore-bearing solutions on the slate has been sericitization, with a decrease of specific gravity. The effects are thus quite analogous to those which I have described in the case of the veins of Otago.* Both Reefton and Otago, it may be noted, carry a very similar class of vein and ore throughout, although most of the Otago veins cut across the bedding of their country rock.

FEATURES OF THE MINES.

(1.) *Boatman's Group.*

The veins of this group were characterized by quartz blocks of small size and high value, but at greater depths they became less frequent and too small to extract with profit. The position of the different mines is shown in the sketch-plan.

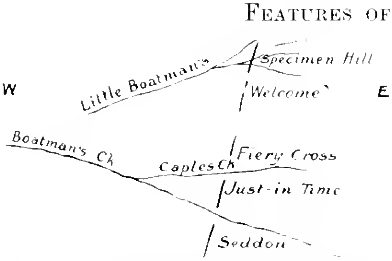


FIG. 3.—SKETCH-PLAN OF BOATMAN'S VEINS.

* This volume, p. 82.

The following section (fig. 4) shows how the groups of quartz lenses pitched strongly to the north along the strike of the vein.

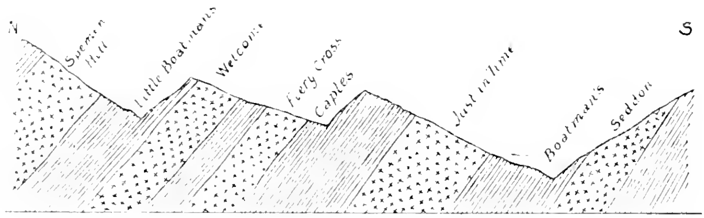


FIG. 4.—SECTION AT BOATMAN'S.

The quartz-zones shown were the points of attack of the several companies that operated in the district, each zone consisting of a series of more or less disconnected blocks or lenses of quartz. The vein dipped uniformly to the east, except in the Specimen Hill lease, where the dip was very irregular. This was also the poorest part of the ground. The Welcome, which was for many years the best dividend-payer of the group, was worked immediately below the Specimen Hill, but apparently on a different belt of quartz. A good deal of antimony-ore occurred in this mine, and gold film or "paint" on clay selvages was frequently met with, doubtless indicating secondary enrichment. Mining at Boatman's has declined very much, and work is now limited to intermittent tributers and occasional prospectors.

(2.) *Murray Creek Group.*

Energetic - Wealth of Nations Mine.—This mine is worked on a main or hanging-wall line of blocks, with a subordinate line of quartz on the footwall of the formation or zone, about 200 ft. to the east. This latter has been worked in former times in Nos. 6, 7, and 8 levels. Both lines are practically vertical, with local irregularities, but the hanging-wall line shows a slight westerly dip in the northern workings. Further, this hanging-wall line appears to carry two more or less definite seams of quartz, about 20 ft. apart, with a belt of altered rock between (fig. 5).

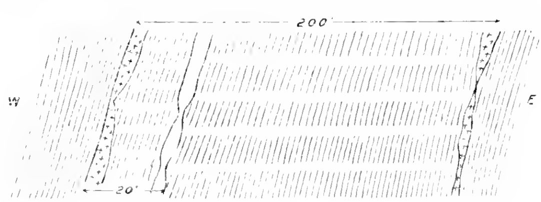


FIG. 5.—SECTION OF WEALTH OF NATIONS VEIN.

The blocks generally run in a continuous line from the surface downwards, with frequent pinches in their course, and a fairly uniform northerly dip along the strike (fig. 6).

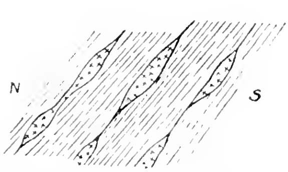


FIG. 6.—QUARTZ LENSES, WEALTH OF NATIONS MINE.

The blocks show great variations and irregularities, and are becoming smaller in the deeper levels. They are frequently split by "horses," and the stone is generally mottled and seamy.

The gold may occur on a foot-wall (of a block), on a hanging-wall, or right across in even value, and the appearance of the stone is little guide to its quality. A block has never been barren throughout, but the good blocks are more uniform in value, and the inferior blocks more patchy. Some very good gold was taken from the foot-wall seam of a block in No. 8 level. Its habit is illustrated in fig. 7.

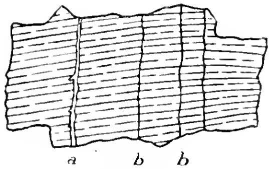


FIG. 7.—OCCURRENCE OF GOLD, WEALTH OF NATIONS MINE.
a. Seam of gold. *b.* Seams of pyrite.

Keep It Dark Mine.—This lies to the south of the last, and its vein is practically a continuation of it, though there is evidence of a patch of barren ground between the two. This one also dips to the west for the most part, though with much irregularity, and with local changes in strike. Like the Wealth, it lies steeper (practically vertical) in the deep levels. It contains a number of blocks which vary in width, and are generally short. They wedge out very quickly, passing into mullock or "formation." The accompanying figure (8) illustrates this change.

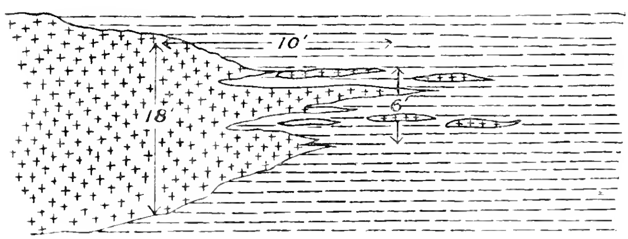


FIG. 8.—PLAN OF QUARTZ BLOCK, KEEP IT DARK MINE.

The blocks pitch to the north and are similar in all respects to those in the Wealth. The gold is free and generally fine, and the ore is poorer in the deeper levels. Auriferous pyrite runs generally in seams and strings through the ore. Stibnite occurs in patches throughout the mine, sometimes accompanying good gold, sometimes the reverse. As a rule, the gold is evenly distributed, though sometimes it clings to the walls of blocks. In the accompanying section of a face at the north end of No. 7 level good visible gold occurred right across, quite independent of the nature of the stone. It is generally found that coarse gold indicates good ore; where the gold is not visible the ore is poor.

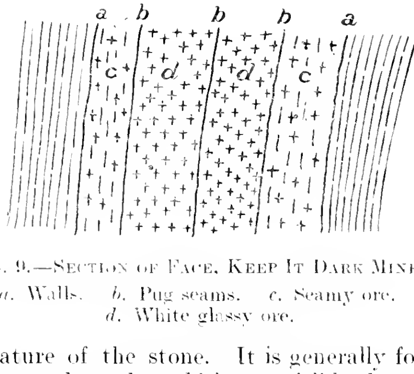


FIG. 9.—SECTION OF FACE, KEEP IT DARK MINE.
a. Walls. *b.* Pug seams. *c.* Seamy ore.
d. White glassy ore.

In No. 5 level (800 ft.) a dyke of altered diabase was encountered at one spot on the hanging-wall of the vein (fig. 10).

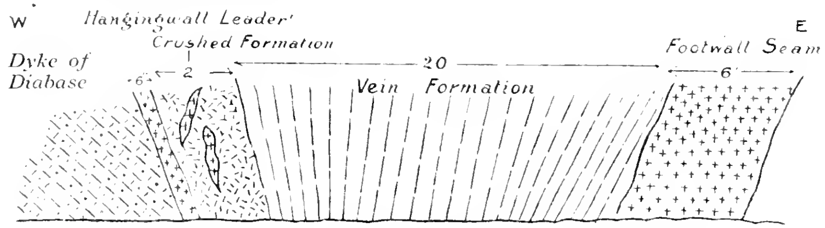


Fig. 10.—Section of Vein and Dyke, Keep It Dark Mine.

The dyke is cut off from the hanging-wall leader shown by a defined pug or clay face. Small quartz veins ramify into and through the diabase from the leader, varying from mere threads up to 2 in. thick, and the larger ones show a very fine comb-structure. These facts strengthen the view that the diabase is older than the period of vein-formation. It has not, as far as can be ascertained, influenced the gold-content in its vicinity.

Golden Fleece.—This mine was formerly worked by Kit Mace (of Macetown, Otago) and others, on Ajax Hill. The first five levels were driven before the mine was taken over by the Consolidated Company, in 1897. Then the low-level crosscut, which had been started by Government subsidy, was pushed on, and ultimately struck the vein after a mile and a half of driving. In its course it struck no stone and no indication of a vein, although it was only about 500 ft. below the level of Anderson's prospecting drive. The crosscut leads into No. 10 level.

The vein strikes north-east and dips north-west. The blocks of ore are irregular, and the vein in the deeper northern levels shows a tendency to turn to the east, while the blocks generally have a northerly pitch along the strike.

The vein stands nearly vertical on Ajax Hill, but in the deeper levels it becomes gradually much flatter. The average width of blocks is 2 ft. From No. 6 down to No. 14 level the blocks became much smaller, although their value was maintained. Thus during the last few years all the levels from 6 to 14 had to be stoped to supply sufficient ore, and working became expensive.

The remaining line of Murray Creek veins—the Golden Treasure and Inglewood—were of good value, but their blocks were rather small. The Golden Treasure carried in places a good deal of stibnite

(3.) *Globe-Progress Group.*

This property comprises two older claims, both worked on the one vein, which strikes approximately east and west.

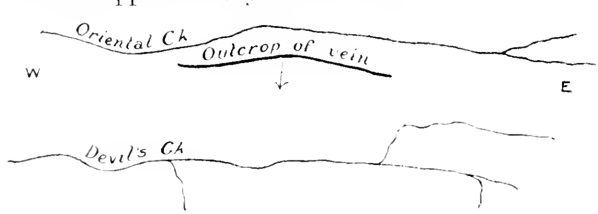


Fig. 11.—Locality Plan, Globe-Progress Vein.

The vein lies in a zone of soft crushed slate, surrounded by harder sandstone. Down to No. 6 level it has a dip of 60° to the south; below that it flattens out, and from No. 8 to No. 11 level—a distance of 400 ft. vertical—it made 1,500 ft. of base. It is worked by two shafts—one, the eastern, opens up 5 and 6 levels; the other, the western, opens up the deeper levels. The shaft-head is 1,600 ft. above sea-level, and No. 11 is 1,460 ft. deep.

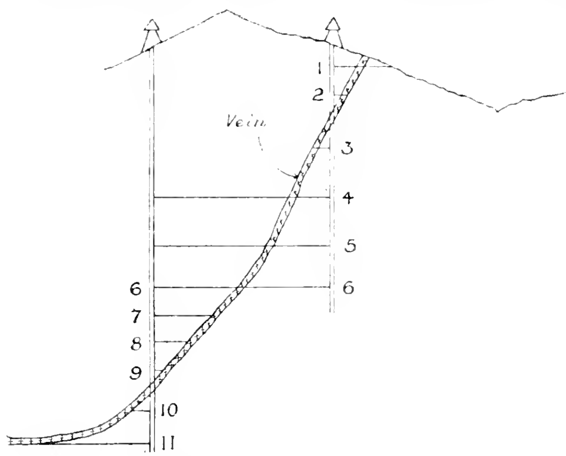


FIG. 12.—SECTION OF WORKINGS, GLOBE-PROGRESS.

Except in the harder sandstone some distance from the reef, the country is soft, and stands badly. The estimated annual cost of timber in this mine during the last ten years has been £3,000. The walls are generally poorly defined, and rarely do a footwall and hanging-wall occur together; they are often obscured, while quartz merges gradually into slate.

The quartz occurs in lenses of varying size and value, frequently much disturbed by small faults. The following varieties of ore are met with:—

(1.) Seamy: The most characteristic form. It is seamed with strings of pyrite and mullock, and is nearly always gold-bearing.

(2.) Brecciated: This is only occasionally found.

(3.) White glassy or "dog's-tooth" quartz: This varies in its gold-content. In blocks of this quartz which have been regarded as poor or barren, gold is frequently found in good payable patches. Miners claim that it is possible to distinguish good and poor ore in this mine by means of its appearance to the naked eye; but this is very doubtful. Frequently quartz set down as poor has been found to give good returns.

The difference between the seamy and white glassy varieties seems to be largely due to processes of replacement in the former case, and to simple deposition without replacement in the latter.

The quartz blocks are in the main low-grade throughout, and poorer in the lower than in the upper levels. The gold is patchy in its distribution, does not run in shoots, and is very fine. This vein carries the finest gold on the field. It occurs both free and involved with pyrite, which is the common sulphide.

Stibnite occurs, frequently and patchy. In places it has been found in seams up to 30 ft. thick, but of low-grade (30 per cent.) ore. In this mine antimony-ore is found generally to accompany poor values in gold.

The blocks or lenses of quartz follow in the main three roughly distinct shoots, which all show a certain pitch to the south-west. They are all fairly continuous, though with frequent pinches and makes.

The main shoot has been worked right down to No. 11 level. Between 8 and 11 it flattened considerably, as shown in figure, and in No. 11 it lies practically horizontal. This is the most peculiar feature in this mine.

The vein thus appears to occupy the limb of a syncline; but further development is required to test whether the other limb exists, and whether it carries ore. Owing to the great confusion of strike and dip of the slate I was unable to find evidence of a synclinal arrangement from surface observations. The flattening observed may, indeed, be only a local phenomenon, or an irregularity in the course of the vein. At any rate, the evidence in favour of a syncline is not yet conclusive.

In the development of this mine the diamond drill has played a considerable part, sometimes with much success. Much care has, however, been found necessary in interpreting its indications. Thus, in veins of this interrupted type a bore may be put in and may miss a block altogether. Again, it may pass through a block at such an angle as to give a very exaggerated idea of its thickness. A bore was put down from a point near the shaft-chamber in No. 11 level for a depth of 1,000 ft., or 2,500 ft. below the surface: no promising indications were found, but the bore is interesting as being the greatest depth reached in a New Zealand mine. The results of other bores made have given no indication of the existence of a synclinal vein.

The deeper levels of the mine, as of all others in the district, are conspicuously dry and dusty, except for surface-drainage in the vicinity of the shaft.

(4.) *Rainy Creek or Merrijigs Group.*

The Rainy Creek group, particularly the Inkerman, is noted for the large size and low value of its quartz blocks. One block in the Inkerman reached a width of 130 ft., but averaged less than $2\frac{1}{2}$ dwt. to the ton. The strike of the vein is north-east, and it dips steeply to the south-east. It contained several large blocks—the Big Blow, the Antimony Block, and the Balaclava Block—which all showed a slight pitch to the north-east along the strike. Antimony-ore is common in the Inkerman and in adjacent claims.

The zone of reefs in this part of the district follows an irregular north-and-south line, with frequent divergences and irregularities in strike and dip. Of the others, the A1 and Golden Lead were worked for some time, but returns were never encouraging, and mining at Merrijigs is now at a standstill.

(5.) *Big River Group.*

New Big River.—This lies near the head of the Big River, about twenty miles south of Reefton. It strikes north and south, and the main block or series of blocks pitches to the north. Fig. 13 shows the disposition of quartz in the vein.

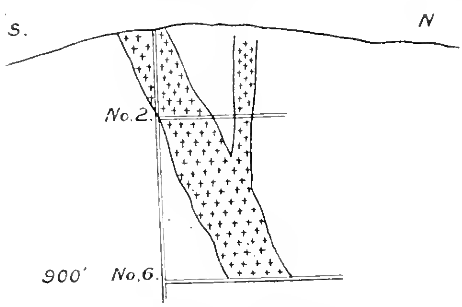


FIG. 13.—SECTION, BIG RIVER VEIN.

Blackwater.—This is a narrow type of vein. It strikes north and south, and dips to the west at about 70°. The direction of dip of the quartz blocks has not yet been definitely ascertained, as the mine is only being developed. The gold is free, evenly distributed, and often coarse. There are frequent blocks of stone, mostly of uniform value, but a few patchy. The blocks have an average width of from 2 ft. to 4 ft. It is probable that, as at Boatman's, the values here have been improved by secondary enrichment.

This is the most thriving portion of the district. The Big River mine is undergoing vigorous development, and both mines promise to be good dividend-payers for some time to come.

Genesis of the Veins.

The period of vein-formation probably followed closely on the intrusion of the granite masses and the folding of the belt of slates. A zone of slate was highly crushed and fractured (a shear-zone) along the axis of a synclinal fold, and this gave access to thermal solutions, arising presumably as after-effects of the granitic intrusions.

The character and occurrence of the quartz, as well as the great loss of material suffered by the altered rock, indicate that the quartz lenses which comprise the workable portions of the veins are due largely to replacement of rock and segregation of silica. Further, the manner in which the quartz gradually peters out into the lode-formation also strongly suggests replacement.

McKay is inclined to believe that the period of vein-formation was prior to the folding of the slates.* The evidence I have collected leads me, as I have stated, to the opposite conclusion.

As regards the dip of the quartz blocks, this feature appears to have originated as follows: When fissuring took place differential movement between the walls of the fissures would be in a direction slightly inclined to the vertical, if there was a combination of vertical gravitation forces and more or less horizontal minor shearing-forces. Thus, where pressure was greatest crushing would presumably be concentrated along inclined lines in the fissure-zone. Subsequently, with the ascent of the mineralising solutions, deposition and replacement would naturally follow those lines along which crushing and comminution of the rock had been most intense. The fact that the dip of quartz blocks is practically the same throughout the district, indicating a uniform direction of resultant movement, seems to support this explanation, and it is also, I believe, applicable to explain the similar dipping quartz shoots in the various groups of Otago veins

History of Mining at Reefton.

Quartz-mining at Reefton dates from 1870, when Anderson discovered the Invincible line, Shiel the Ajax and Golden Fleece line, and Adam Smith the appropriately named Wealth of Nations line. Boatman's and Rainy Creek districts were prospected in 1872, and the Globe Mine was first opened up in 1882. The poorest of these was the Rainy Creek, which has never given good returns, although a good deal of desultory work has been done. The various companies at Boatman's got high returns for some years, and the best of them—the Welcome—has only just lately closed down. The early workers had many difficulties to contend with, owing to the absence of roads and tracks, but a good deal of work was done till about 1896, when quartz-mining reached a low ebb. About this time Mr. David Ziman took over a large number of claims on behalf of an English company, and formed the Consolidated Goldfields of New Zealand (Limited), which held the Wealth, Fleece, Welcome, Inkerman, and several others, as well as a large

* A. McKay, "Geology of Reefton District," Reps. N.Z.G.S., 1882, p. 134.

interest in the Globe-Progress Mine. Since that date the yield of quartz has rapidly increased, and reached its height about 1904.

The mines at present in operation are the Wealth, Progress, Big River, Blackwater (Consolidated Company's mine), and Keep It Dark (dating from 1873). Their statistics, operations, and plants are fully described in the New Zealand Mining Handbook for 1906.

The section accompanying this paper shows the position and depth of the principal shafts and workings in the different mines.

Future Prospects.

Any future developments will occur, as indicated, along the auriferous zone, and prospecting is rendered difficult by the fact that reefs are not readily located except when blocks of quartz happen to outcrop. There can be no doubt that a great deal of payable ore still exists in many parts of the field, but the difficulty of locating it is an obstacle which demands considerable initial outlay in prospecting.

In regard to the prospects of deep mining, we have seen that at about sea-level the blocks of quartz are notably smaller in all the mines, although the gold-content is generally still payable. As the blocks get smaller the expenses of working increase, and it seems very probable that the limit of profitable mining will be reached not many hundred feet below the present deepest workings. In other words, the blocks will become too few and too scarce to justify further development in depth.

Lastly, the very high returns secured in the early days (2 oz. to 4 oz. per ton) from the upper levels indicate secondary enrichment, and it is therefore obvious that in any future work the upper levels will be the most remunerative.

Art. XVII.—*Geology of Rarotonga and Aitutaki.*

By Dr. P. Marshall, M.A., D.Sc., F.G.S., University of Otago.

[*Read before the Otago Institute, 10th November, 1908.*]

Rarotonga.

But few statements have hitherto been made as to the geological nature of this island, and they are very general. Mr. Percy Brown has lately been good enough to forward me specimens of rock from several localities on the island, and from the study of these, as well as the statements of Mr. Brown, Mr. James Allen, M.P., and those in the Government Year-book, the following description has been compiled.

Relatively few soundings have been made near Rarotonga, but there is at present no reason to doubt that it is surrounded on all sides by water between 2,000 and 3,000 fathoms in depth. It is situated to the east of the deep trench which extends from New Zealand almost to Samoa.

The volcanic rock appears to rise directly from the ocean-shore without any intervening fringe of raised coral rock, though the island is surrounded with a fringing reef of coral. This appears to prove that no change in elevation has taken place since the volcanic action ceased.

In the neighbouring island of Tonga Mr. Lister has proved an elevation of 1,000 ft., while the atoll of Palmerston and others seem to prove considerable depression in their neighbourhood, if the brilliant results acquired by a study of Funafuti borings can be extended to other isolated atolls.

The rocks of Rarotonga appear never to have been described. Those that were sent to me were obtained from Muri Point, in the north-west, and Black Point, in the south-east. Between these two points is the high land which Mr. Brown says is called locally "the dividing-ridge." This ridge, which at its highest point attains an elevation of 2,940 ft., appears to show the features of rainfall erosion in tropical islands so well described by Dana and Dutton in Hawaii. Other specimens came from near the Totokoito Creek, and some Native weapons dug up in a plantation were also forwarded to me.

The rocks from Muri Point and Black Point are a nephelinitoid phonolite. The former is rather the coarser type. It contains no feldspar, but an abundance of nepheline. At a certain stage of growth ægirine inclusions were gathered into the nepheline, so definite crystalline forms of the mineral are outlined. At a later stage the ægirine material was completely crystallized, and pure nepheline fills the interspaces. With the exception of a few crystals of apatite, the only other mineral is ægirine-augite, with an extinction-angle of 30°. In the specimen from Black Point there is a very small amount of feldspar.

Analysis.

SiO_2	54·60
Al_2O_3	17·48
Fe_2O_3	5·72
FeO	1·02
TiO_2	0·80
CaO	3·10
MgO	1·44
Na_2O	9·32
K_2O_5	5·61
H_2O	1·56
	100·65

From Totokoito Creek a rolled fragment of dolerite was sent. The augite and olivine are in large crystals, as well as the iron-ore, which is probably titaniferous. Feldspar is restricted to the groundmass, where it is associated with augite and magnetite.

This rock recalls the descriptions of basalts from Tahiti,* though the specimens which I possess are of a wholly different character. The occurrence of alkaline rocks in this island is of great interest, and perhaps serves to suggest a relationship with Tahiti, where nepheline syenites have been recorded by La Croix. They are quite different from anything yet found in New Zealand.

The occurrence of such rocks in a mid-Pacific island appears to throw doubt upon the accuracy of Dr. Prior's generalisation† in regard to the association of andesitic rocks with the Pacific type of coast-line, and of alkaline rocks with the Atlantic type of coast. Occurrences in New Zealand, as pointed out by Gregory,‡ are also opposed to this view.

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* La Croix, "Comptes Rendus," vol. cxxxix, p. 892.

† Prior, Rec. Antarctic Expedition: Geology.

‡ *Nature*

The rock here described from Muri Point would, from the complete absence of feldspar, be classed as a nephelinite according to Rosenbusch's scheme. It is retained here amongst the phonolites because its chemical and mineralogical composition show much closer relationship to the phonolites than to the basalts.

The Native weapon forwarded by Mr. Brown is of quite different material from the rocks described. The absence of olivine and the abundance of feldspar place it among the augite-andesites. It is quite conceivable that it was made from one of the Tongan rocks.

Aitutaki.

Mr. C. Cameron, R.M., kindly forwarded me samples of rock from this island. The following notes were made by him on the specimens: "Sample A, from the mainland, is fairly common, sometimes in large blocks, and was occasionally used in ancient times for building round the priests' *marae*. It is easily shattered by fire. Sample B is from a small island called Rapoka, in the lagoon, about a mile from the mainland. It is often used by the women for their native ovens, as it stands fire better than A, though not entirely well."

A. A relatively coarse basaltic rock, with much olivine and an abundance of idiomorphic augite, and but little feldspar, which is labradorite. The colour of the augite shows that it is strongly titaniferous. No nephelin could be distinguished in section, but the rock-powder gelatinises readily on treatment with dilute HCl, and crystals of salt are formed when the solution is evaporated.

B. Very fine grained compact rock. Olivine is very abundant, and is often stained with limonite on the margin. Augite granular, and restricted to the groundmass, where it is associated with much magnetite and a predominance of minute crystals of nepheline, without sharply crystalline boundaries. The rock is clearly a nephelinite or nepheline-basalt.

The accompanying map, copied from the Admiralty chart, shows the form of the island. It is at once seen that the mainland is at the northern side of the interior of the circular coral reef, and is situated near the margin. Rapoka Island is near the south-east portion of the interior of the reef.

The form of the island suggests that submergence has taken place, but it may be that the coral reef has arisen on the margin of a shoal formed by wave-action dispersing the material of a loose scoria cone, as has been exemplified in the case of Falcon Island, in the Tonga Group. It will be remembered that this origin has been suggested by Mr. Lister to explain the occurrence of atolls in the southern portion of the Tonga Group of islands, although there is clear evidence of elevation of as much as 1,000 ft. in the north-east portion of the group.

The rocks from Aitutaki are not closely related to any types that I have seen in the south-west Pacific. They resemble the Auckland basanites more closely than any of the others.

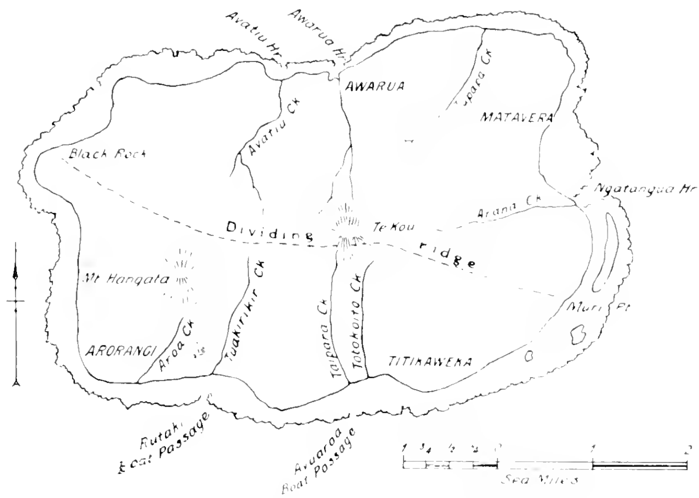
EXPLANATION OF PLATES III AND IV.

Plate III.

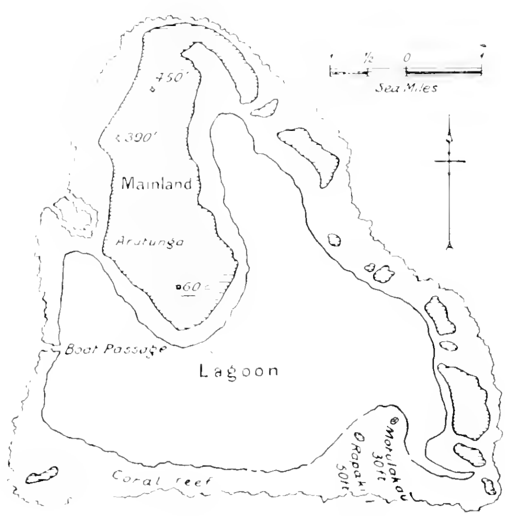
Sketch-maps of Rarotonga and Aitutaki.

Plate IV.

Fig. 1. Micro. section of nepheline-phonolite, Rarotonga. The clear portion is nepheline; the dark material is ægirine. Magnified 30 diameters, ordinary light.



Sketch Map of Rarotonga.



Sketch Map of Aitutaki.

GEOLOGY OF RAROTONGA AND AITUTAKI. Marshall.

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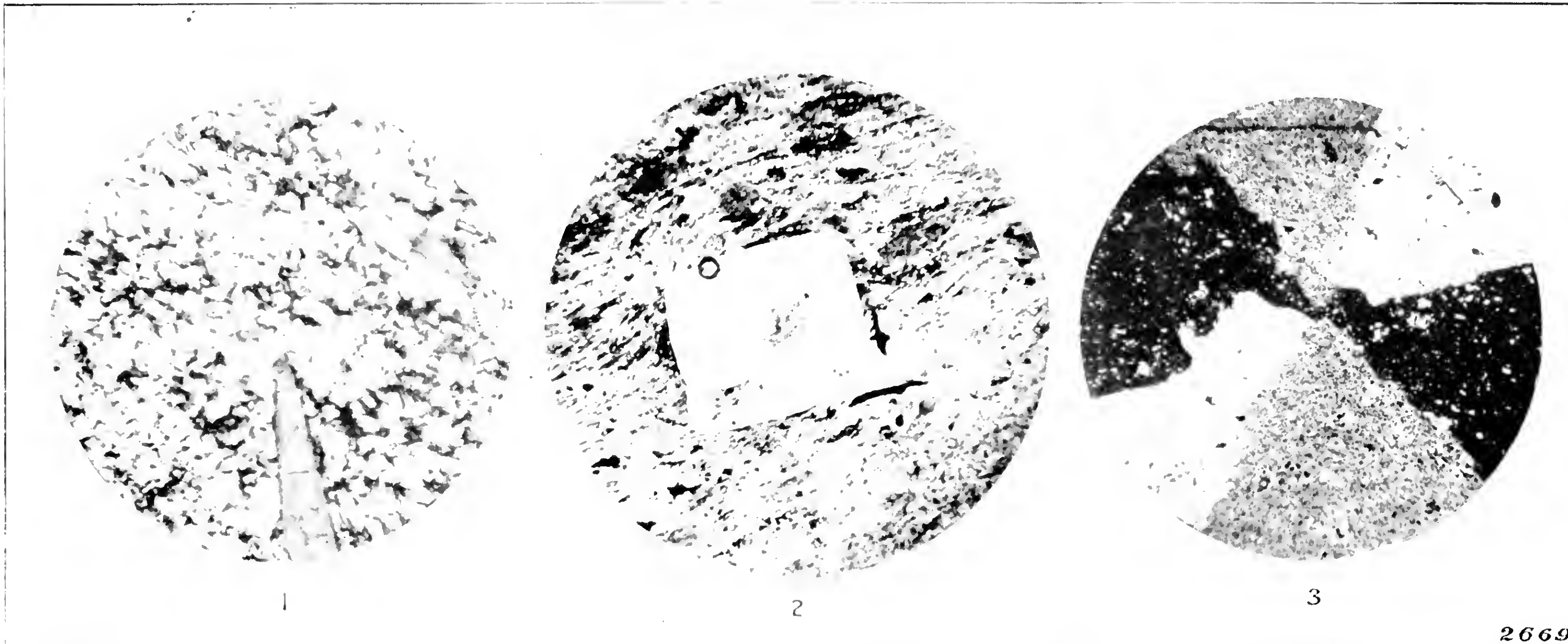

(1) GEOLOGY OF RAROTONGA AND AITUTAKI. (2, 3) CONTACT ROCKS OF WEST NELSON.—Marshall.

Art. XVIII.—*Contact Rocks from West Nelson.*

By Dr. P. Marshall, M.A., D.Sc., F.G.S., University of Otago.

[*Read before the Otago Institute, 10th November, 1908.*]

During a visit to Collingwood and West Wanganui, Mr. E. D. Isaacson recently collected certain rock-specimens which contain minerals formed by contact metamorphism, hitherto not recorded from New Zealand.

All geologists who have visited this district have recognised the fact that large granite intrusions have been forced through older (probably Palæozoic) sediments. The granitic masses of part of the district have lately been accurately mapped by Dr. Bell and his assistants, Messrs. Webb and Clarke. During the course of this work certain altered sedimentaries were encountered near the zone of contact, and in some of them andalusite was recognised.

The specimens now referred to are as follows :—

1. Chiastolite Slate.

Cleavage is highly imperfect. The chiastolite is not recognisable in hand-specimens. There are irregular grey spots $\frac{1}{4}$ in. in diameter, which from their softness appear to consist of some secondary mineral.

The section shows that the greater part of the rock consists of minute grains of quartz mingled with graphite-specks. The chiastolite crystals are as much as 0·15 mm. in diameter, and twice as much in length. They are perfectly fresh, and contain the characteristic inclusions of carbonaceous matter with a cruciform arrangement. Small crystals of staurolite are rather abundant, with the characteristic pleochroism and birefringence. The section contains much pyrite. The areas which appear grey in the hand-specimens become a pale-brown in section, with a high birefringence. They appear to be pinite pseudomorphs after cordierite.

Other specimens of chiastolite slate are abundant as boulders in the gravels of the Aorere River, but sections show that the large crystals of chiastolite 100 mm. in length and 10 mm. broad have been completely changed to crowded plates of muscovite.

2. Cordierite Schist.

Hand-specimen black, with distinct fractured black crystals.

Section : The greater part of the rock consists of cordierite, perfectly clear and fresh, but crowded with minute inclusions of biotite and pyrite. Fluid-cavities are also common. None of the inclusions are surrounded with pleochroic halos. Some of the cordierite crystals are trillings, as shown in the figure. The crystals are 60 mm. long and 30 mm. wide. The rest of the rock consists chiefly of a reddish-brown biotite in irregular plates. Regular plates of muscovite are fairly common, and there is much pyrite. There is very little quartz.

Analysis.

SiO_2	59·08
Al_2O_3	17·60
Fe_2O_3	4·17
FeO	6·69
TiO_2	0·65
CaO	0·70
MgO	3·20
Na_2O	3·38
K_2O	2·42
H_2O	2·40
	100·29

It is probable that these rocks come from the metamorphic aureole surrounding the great granitic intrusion which extends from the west coast to the head-waters of the Aorere River, and from the Big River to the south of the Karamea. No doubt actual occurrences *in situ* will be recorded when the geological survey of the area now in progress is completed.

EXPLANATION OF PLATE IV.

Fig. 2. Micro. section of chiastolite slate from West Wanganui Inlet, West Nelson. A large chiastolite crystal is shown, with characteristic carbonaceous inclusions. The light part of the rest of the section is quartz, the darker portion is biotite. Magnified 25 diameters, ordinary light.

Fig. 3. Micro. section of a trilling of cordierite, showing numerous inclusions. Magnified 25 diameters, crossed nicols. Specimen from Aorere River, West Nelson.

Art. XIX.—*Crater of Ngauruhoe.*

By Dr. P. Marshall, M.A., D.Sc., F.G.S., University of Otago.

[*Read before the Otago Institute, 10th November, 1908.*]

The earliest accounts of the crater of Ngauruhoe, by Bidwill and Dyson, show that considerable changes have taken place since these pioneers made the ascent of the cone. The former, in 1839, describes it as "the most awful abyss that I ever looked into or imagined." The stones thrown in did not strike the bottom in less than seven or eight seconds. It was impossible to get into the inside of the crater, as the sides seen were, if not quite precipitous, actually overhanging. Bidwill states that Ngauruhoe was in a state of activity at the time of his visit, and the steam prevented him from seeing more than 8 or 10 yards into the crater.

This description applies perfectly to the crater at the present day if the volcano be more than usually active and the crater is reached on the south or east side. From other statements made by Bidwill it appears probable that he ascended the mountain on the north or west, and on those sides at the present time the crater-floor is almost level with the wall. It is reasonable, therefore, to suppose that the crater is now very different in form from what it was when Bidwill saw it.

Dyson, in 1851, stood on the northern side of the crater. He says the lip was sharp, and inside there were large overhanging rocks of a pale-yellow colour. It was impossible to descend into the crater. This account corroborates Bidwill's statement, and emphasizes the fact that the crater had, in the middle of last century, steep walls all round—or, at any rate, on the northern side.

Professor Thomas, in 1888, called attention to the form of the crater, and recorded that Mr. Jackson Palmer, then engaged in work near the mountain, had noticed that after a long spell of bad weather in 1888 a gap had been formed in the east side of the crater-wall.

In 1887 Mr. Hill ascended the mountain, and at that time, and at a subsequent visit in 1892, the crater was in the same condition as it was in when I first saw it in 1891. Fig. 1, Plate V, gives an idea of its appearance. The small north-west-rim crater, called by Mr. Hill the "yellow crater," was then rather active, and steaming vigorously. The main crater had a floor nearly level throughout. We entered the crater on the western side. Near this side there was a violent escape of steam, though less in amount than that which escapes from Karapiti. Smaller steam-jets were issuing in many places, and most of them escaped from the summit of a cone of bright-yellow sulphur 2 ft. or so in height. The effect of all these small cones was very pleasing. It was possible at that time to walk all over the floor of the main crater, though the ground was hot and in some places soft.

In 1893 the appearance of the crater had absolutely changed, though the small north-west crater still remained, but steamed much less than previously. All the small sulphur cones had disappeared, and near the centre of the main crater there was a deep black explosion-cavity. The explosion to which the formation of this was due had scattered mud and volcanic ash over the floor of the main crater, and had covered up the little sulphur cones. The explosion-cavity was then about 30 yards in diameter, and there was level ground between it and the north-west crater, and more between the cavity and western wall.

In 1891 a report was published by Mr. Cussen on the Tongariro Mountains, and with it an excellent map; but it is stated in the text that though Ngauruhoe was twice ascended, the clouds of steam that issued from it prevented the surveyors from obtaining a clear view of the crater. It is, however, stated that the crater was circular, and the small crater on the north-west side is described. In the map another small crater is indicated, on the south side. This is probably an error, for no mention is made of it in the text, and it was certainly not there in January of that year. Dr. Benedict von Friedlander was the first to call attention in writing to the "hole" in the south-west of the crater. He visited the mountain in 1896, and was unable to see to the bottom of the "hole" because of the large amount of steam that issued from it. He does not state the extent to which the "hole" encroached upon the crater on the north-west rim, to which he, like all other observers, refers.

In January, 1898, I was able to walk between the explosion-cavity, or "hole" of Dr. Von Friedlander, and the small north-west crater, though the explosion-cavity was then much enlarged, and the level ground between it and the north-west cone was much reduced. The cavity had also extended considerably to the west, though there was still some level ground between it and the north-west crater. As in 1893, I was unable to see to the bottom of the cavity, because of the large body of steam that issued from it, though a long time was spent on its edge. The activity did not seem so pronounced as in 1893, for in that year from time to time a rumble was heard in the interior of the mountain, and dense clouds of steam and dust were shot up. It is probable, however, that there was not much difference in this respect, for after returning to camp a rumble was distinctly heard, and soon after the dark cloud rose up from the crater.

Another visit was paid in December, 1906, when the mountain was more than usually quiescent. It was found that the cavity had extended considerably towards the west, where now there was no flat ground between it and the exterior wall of the main crater. It had also extended towards the north-west crater, and had encroached on the small cone in which that crater was situated. During an interval when the steam lifted it was possible to see to the bottom of the cavity. It appeared to be nearly 200 ft. deep, with vertical walls on the east and north, but elsewhere bounded by steep walls, which on the west were a continuation of the wall of the main crater. The walls of the cavity were covered with jets of steam, and were encrusted with sulphur. At the bottom was a small lake of greenish-yellow water, on which masses of scum—probably sulphur—were floating, and there were specially strong steam-jets near the level of the water. At this time the crater certainly did not deserve the title of "bottomless pit," given to it a little later by a Press reporter.

In February, 1907, the mountain became more active, and another visit was paid to it to find out whether the activity had caused any noticeable changes in the crater, and also to find out the exact nature of the violent explosions that occurred from time to time. A start was made early in the morning, when a dark cloud was rising 3,000 ft. above the crater. The appearance was then similar to that presented on the following morning, when the photograph was taken. When within 1,000 ft. of the summit it was found that the surface was covered with slimy mud to a depth of 1 in. The depth of mud increased as the summit was approached, when it attained a depth of 6 in. When 500 ft. from the summit the wind failed, and the black cloud rained mud on to the surface of the mountain. We were soon covered with mud from head to foot, but persevered in our ascent, though inky blackness enshrouded all the mountain-summit, and the air seemed filled with sulphur-dioxide. At the top it was impossible to see anything, nor were the sounds very different from those we heard on previous visits. Everything indicated that an explosive paroxysm had just ceased. The cold wind was so piercing that it was inadvisable to remain long at the top. We stayed as long as possible, but the air did not clear, and we had the satisfaction of seeing after our return that the black cloud still rested on the summit. The mud that fell on us had a strong acid character, for it bleached the colour from a print blouse that my wife was wearing. Previously, in 1906, Mr. Flower, of Christ's College, Christchurch, had agreed with me that the smell of sulphur-dioxide was much more pronounced than that of sulphuretted hydrogen, which goes to prove that the activity of the crater was at an unusually low ebb when Dr. Von Friedlander could detect the latter only during his visit in 1896. During this visit we were unable to see what changes had taken place in the crater, but it was evident from the foot of the cone that the exterior wall had suffered no changes. The gap in the eastern wall, to which attention was then called, was, as previously stated, formed in 1888. Although some overhanging crags at the side of the gap are in an extremely unstable state, and might be dislodged by the vibrations caused by a steam-explosion, no rocks have, so far as I know, fallen from it since the year 1891, when I saw it.

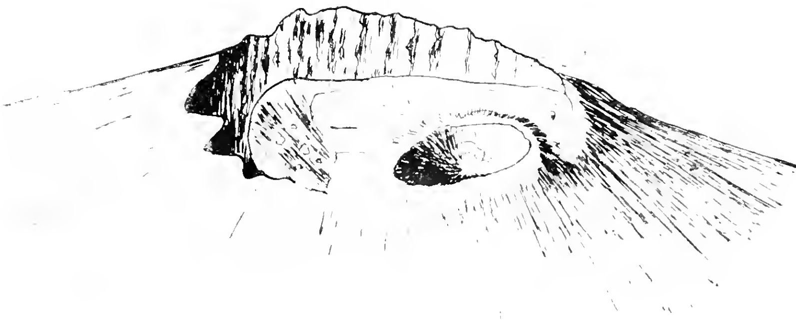

Fig. 1. Crater of Ngauruhoe in 1891

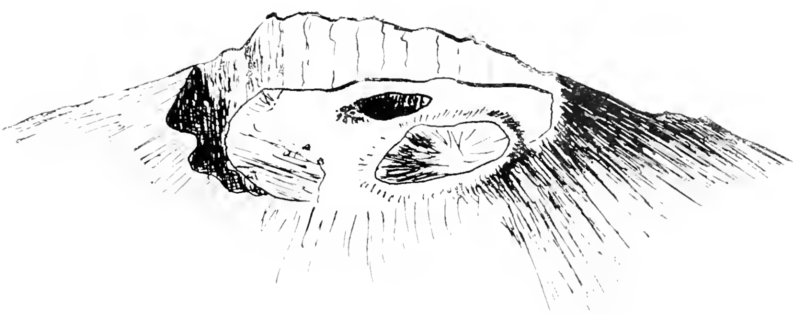

Fig. 2. The same in 1907.

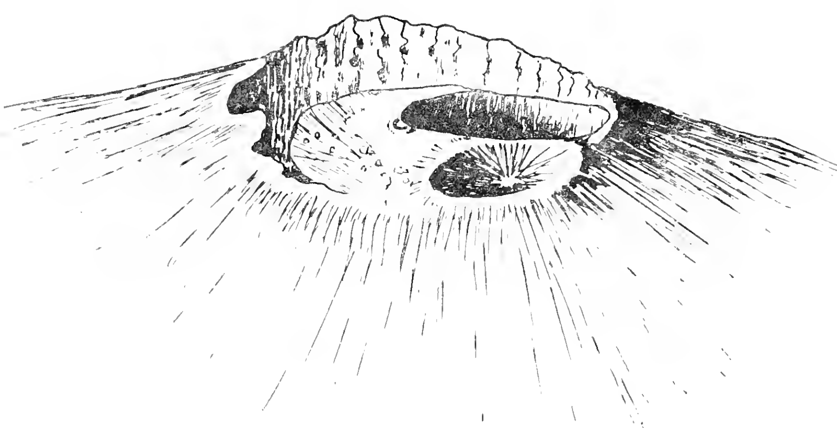

Fig. 3. The same in 1906

CRATER OF NGAURUHOE.—Marshall.

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CRATER OF NGAURUHOE. Marshall.

CRATER OF NGAURUHOE.—Marshall.

The photographs taken by Mr. Browne at Easter, 1907, and by Mr. Cockayne this year, do not show any material change as a result of the rather violent activity that was in progress when the photograph (Plate VI) was taken. It appears, however, that the extension of the deep cavity westward and northward has been continued to a slight extent. In all my visits to the crater the escape of steam from it has been much more voluminous than is shown in the photograph of the crater taken by Mr. Cockayne.*

There is one point about which I am not certain. A small mud-crater is to be seen on the east side of the big explosion-cavity. When it was formed I do not know; it certainly was not there in 1891. It may have been formed at the same time that the explosion-cavity was blown out, though I have no note of its presence in 1893.

To sum up:—

1. The form of the crater appears to have been very different in 1839 and 1852 from its present shape.
2. In 1891 the floor was level, except where the north-west crater was situated, which was then the most active spot.
3. In 1893 the north-west crater was less active, and the explosion-cavity was of small diameter near the middle of the crater, and was steaming vigorously.
4. Since that time the explosion-cavity has extended westwards and northwards, and the activity of the north-west crater has dwindled.
5. No escape of lava has occurred within historic times.
6. The main-crater walls have not changed since 1891.

EXPLANATION OF PLATES V–VII.

PLATE V.

Fig. 1. Crater of Ngauruhoe in 1891.
Fig. 2. The same in 1907.
Fig. 3. The same in 1906.

PLATE VI.

Upper part of cone of Ngauruhoe, at 8 a.m., 14th March, 1907. Photo taken from the south-east; distance, five miles.

PLATE VII.

Highest point of crater-wall of Ngauruhoe—the south-east side.

ART. XX.—*Additions to the List of New Zealand Minerals.*

By Dr. P. MARSHALL, M.A., D.Sc., F.G.S., University of Otago.

[*Read before the Otago Institute, 10th November, 1908.*]

IN the year 1890 Sir James Hector compiled a list of New Zealand minerals for inclusion in the "Transactions of the Australasian Association for the Advancement of Science" (vol. ii, 1890). Since that time a large number of papers have been written by a variety of authors on New Zealand geology. In these papers many references have been made to minerals that are not included in Sir James Hector's list. In the present paper these references

* "Tongariro National Park": L. Cockayne. Parliamentary paper C.-11, 1908.

are collected together, and additions are made of other species and localities known to the author but not hitherto mentioned in any publication.

It is probable that the present list is still far from complete, but it will, at any rate, serve as an index to the various discoveries that have been made of late years, and may also be useful as a guide to those who may seek for general information as to the occurrence of mineral species in the Dominion.

The arrangement followed is that adopted in Dana's "System of Mineralogy," 6th edition, 1906.

SULPHUR: Very good orthorhombic crystals at Rotokawa, near Lake Taupo.

ZINC (3): It appears somewhat doubtful whether this specimen was native or was produced by artificial means.

GOLD: No important new discoveries have been made. Crystalline gold has been recorded (8). Microscopic work has been done on some occurrences at Ohinemuri (2).

SILVER (4): In addition, flattened grains of alluvial silver have been found in some diggings in the Shotover River.

COPPER (9): Crystallized copper of very recent deposition at Kawau Island.

LEAD (11): The same occurrence as that mentioned in Hector's list.

PLATINUM (18), (19): The quantity of the mineral in these localities is small, and is of no economic value.

METEORIC IRON: An analysis of the Wairarapa meteorite mentioned in Hector's list has been made by Mr. Donovan.

MOLYBDENITE: Large deposits in the Mount Radiant district, Karamea, in lodes traversing granite country.

ORPIMENT (23), (31).

REALGAR (23), (31).

PETZITE (1).

ARGENTITE (23).

GALENA (23) occurs in some quantity in the Jupiter and Pluvius Mines, Te Aroha.

CINNABAR (23) has been found at Waipori, Otago, but has not been mined successfully.

PYRRHOTITE (28). Large quantities at the Champion Mine, Nelson.

CHALCOPYRITE: The new discovery at Mount Radiant appears to be important.

PYRITE: Good octahedral crystals are found in chlorite-schist at Parapara. Cubes are common in phyllite near Mount Aurum, Otago.

NAGYAGITE (1).

KERMESITE (23), (31).

PYRARGYRITE is said to occur at Puhipuhi, near Whangarei; also 32.

TETRAHEDRITE (1).

KERARGYRITE (23): Several pounds' weight, from Waikoromiko Valley.

COTUNNITE (1).

QUARTZ: The quartz of the Waihi Mine is sometimes platy in structure. It is said to be pseudomorphous after barite.

PRECIOUS OPAL has been found in small quantity at Cabbage Bay.

HYALITE: Incrustations are common on dolerite at Dunedin.

TRIDYMITE (7), (19), (26), (27): Quite common, but in very minute aggregates, in the rhyolites of the volcanic region of the North Island.

SENARMONTITE (6): Common at Mount Radiant.

MOLYBDITE: Not uncommon at Mount Radiant.

ARSENOLITE (23), (31).

CORUNDUM: A purplish-red variety, in crystals of moderate size, occurs with green muscovite in boulders in the sluicing-gravels at Rimu, near Hokitika.

ILMENITE: Typical crystals, but of microscopic size, occur in nepheline-basanite of the Domain crater, Auckland.

PICOTITE (16).

MAGNETITE (15): A chrome variety occurs in hartzbergite, Milford Sound. Small octahedrons are common in chlorite-schist, Otago.

RUTILE (16), (22), (28): Microscopic crystals in granulites of south-west Otago; also in schists, Otago.

PYROLUSITE (23).

TURGITE (20): Occurs with limonite at Parapara.

GOTHITE (20).

PSILOMELANE: Small nodules in decomposed scoria, Seaview, Dunedin.

DOLOMITE (32): Pearl-spar, in the May Queen Mine, Thames.

MAGNESITE (15): A decomposition product of enstatite in hartzbergite at Milford Sound.

RHODOCROISITE (23).

ARRAGONITE: Pseudo-hexagonal crystals at Oamaru and Dunedin, in cavities in volcanic rocks.

CERUSSITE (6): Tui and Pluvius Mines, Te Aroha.

ORTHOCLASE: Crystals with Baveno development, though not twinned, occur porphyritically in the granite of Separation Point. The finer portion of the groundmass disintegrates readily, and the crystals form the sands and gravels of the beaches. The variety sanidine (5), (17), is common in alkaline rocks, Dunedin.

MICROCLINE (22): In many granites, notably at Golden Bay, Stewart Island; Kahurangi Point and Dea's Cove, Thompson Sound.

ALBITE, OLIGOCLASE, ANDESINE, BYTOWNITE, and ANORTHITE: All of these species are mentioned in various petrographical papers as occurring in many rocks of igneous origin. No occurrences deserve any special mention.

ANORTHOCLASE (17): Abundant in many alkaline rocks at Dunedin. Also at Campbell Island.

PERTHITE (16), (17): At Stewart Island and at Dunedin.

LEUCITE: The locality mentioned by Hector in the list quoted was apparently an error. Microscopic crystals occur in a leucitophyre at Puket raki, near Dunedin.

ENSTATITE (15): Very large crystals in a hartzbergite at Milford Sound; also mentioned by Hutton in North Island volcanic rocks; occurs also at the North Cape, in a hartzbergite.

HYPERSTHENE (16), (19), (26), (27): Hutton has mentioned the occurrence of this mineral at Lake Taupo, where crystals washed out of pumice form a black sand. Abundant in the volcanic region of the North Island, and in norites at Milford Sound, especially in the gravels of the Cleddau River and at the Bluff.

BRONZITE: This mineral has been referred to in geological reports on the Dun Mountain, but it appears that diallage was mistaken for it.

BASTITE (25): Noted by Hutton in a rock at the Dun Mountain, where it is associated with diallage. Occurs also in a hartzbergite at the North Cape.

AUGITE : Good crystals are obtained from weathered tufas at Otago Peninsula and Banks Peninsula.

ÆGIRINE (5), (17): Abundant in alkaline rocks at Dunedin. Also at Rarotonga, but of microscopic size only.

HORNBLENDE : Many varieties have been recorded in different petrographical papers. The common green variety occurs widely in the diorites of the south-west Sounds (16); brown or basaltic hornblende at Dunedin and Banks Peninsula (5), (17); barkevicite (17) in alkaline rocks at Dunedin.

RIEBECKITE (30): In granite boulders near Brunner, Westland; also at Campbell Island.

ARFVEDSONITE (29): Small crystals in trachyte of the Cass Peak, Port Hills, Lyttelton.

TREMOLITE : With garnet forming boulders in gravels at Lake Kanieri and other Westland localities.

ACTINOLITE (22): Abundant in West Coast schists and in Otago.

ÆNIGMATITE (Cossyrite) (17): Quite abundant in phonolites and trachydolerites at Dunedin. Also at Campbell Island.

IOLITE : Abundant in some contact rocks near Aorere River, west Nelson. The form of crystal composed of trillings occurs in these rocks (P. Marshall, this vol., p. 101).

NEPHELITE (5), (17), (19), (26): Abundant in large crystals in tinguaites, basanites, and trachydolerites, Dunedin. Also in basanite at Auckland, and in tinguaite boulders at Brunner (30).

SODALITE (17), (19): Small crystals in phonolites and trachydolerites, Dunedin.

GARNET (16), (18), (20), (21), (22): Abundant in schist rocks, Otago and Westland. A somewhat remarkable form in Otago, where a rock occurs of a pink colour, containing a multitude of extremely minute crystals of almandine.

GROSSULARITE (24): Occurs with diallage in a garnet gabbro of the Dun Mountain, Nelson.

UVAROVITE (28): Minute crystals at Dusky Sound.

CHRYSOLITE : Forms rock-masses of dunite at Milford Sound, as well as the other localities mentioned by Hector.

MELILITE (17): Plates in basanite at Puketiraki, near Dunedin.

ZIRCON : Abundant in a porphyry at Campbell Island.

ANDALUSITE (20): Relatively large crystals in schists.

CHIASTOLITE : Found by Mr. Isaacson in the north-west of Nelson (P. Marshall, this vol., p. 101).

STAUROLITE occurs with chiastolite (P. Marshall, this vol., p. 101).

SILLIMANITE : With tourmaline in a specimen brought by Professor Black from Stewart Island; also in minute needles in a mica-schist from Dusky Sound.

ZOISITE (18): Occurs with epidote in schistose rocks in Westland.

EPIDOTE (17), (18): Abundant in quartzite and schists, especially in Westland.

TOURMALINE (19): Large crystals at Richmond Hill, Parapara, in chlorite-schist; also in smaller groups of radiating crystals at the same locality.

ANALCITE (17): A rock-constituent, and in cavities in camptonite, at Dunedin.

MUSCOVITE : Large crystals in granite between George Sound and Lake Te Anau; also widely distributed in minute flakes in schists in Otago and Westland.

BIOTITE: A rock composed of large crystal plates at Port Pegasus, Stewart Island.

FUCHSITE (28): Also said to occur in Central Otago.

PARAGONITE: A green variety, in boulders in Jacob's River, Westland.

PHLOGOPITE (21): A mica between this and lepidolite, in the Alexandra area.

CLINOCHLORE: This is the variety of chlorite most commonly present in the Otago schists.

GENTHITE (6).

SERPENTINE (18): Often mentioned, but no new localities deserving of special mention.

BOWENITE (18), (15): Excellent specimens have lately been obtained from Anita Bay, Milford Sound. At Teratama it is found with ordinary serpentine.

TALC (18): In schist, Westland, and at the Caples River, Lake Wakatipu.

GLAUCONITE: Common in Miocene sandstones and limestones throughout New Zealand.

TITANITE: Granite of Separation Point, and common in granulites of the West Coast Sounds.

MOSANDRITE: Minute crystals in trachyte at Perseverance Harbour, Campbell Island.

PEROFSKITE (17): In diorite, Bell Hill, Dunedin; also in a porphyry, Campbell Island.

MONAZITE: Small quantities have been found in sands at Greymouth.

APATITE: An earthy phosphorite, in limestones at Millburn, Otago.

PYROMORPHITE (6).

HEDYPHANE (23), (31).

VIVIANITE (6): Earthy form common; also good crystals in moa-bones, Waitati.

BARITE: Tabular form at the Thames.

ANGLESITE (6).

GYPSUM: Crystals at the Thames and at Oamaru.

EPSOMITE (1): Thames.

MELANTERITE (6): Thames.

CHALCANTHITE (6): Thames.

ALUM: In the Hot Lakes District, at Waiotapu and Orakeikorako.

RETINITE: In brown coals throughout New Zealand.

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Art. XXI.—*Geology of Signal Hill, Dunedin.*

By C. A. Cotton, M.Sc.

[*Read before the Otago Institute, 10th November, 1908.*]

General Geology.

The rocks of Signal Hill, being all volcanic, contain no internal evidence of their geological age. They form, however, a part of the Dunedin group of volcanics, which are known to overlie unconformably at Caversham and at Sea View a calcareous sandstone of the Oamaru system.* The Oamaru system was placed by Captain Hutton in 1875 in the Lower Miocene, but in his later works he classed it as Oligocene.† Hector includes the Oamaru rocks in his Cretaceo-tertiary system;‡ Park places them in the Miocene.§

The volcanic rocks are not in any case involved in the disturbances of the Oamaru rocks, nor have faults of any magnitude been observed in them. A considerable amount of elevation and depression has, however, since occurred, for the main valleys have been eroded far below the present base-level, and at Sandy Mount and elsewhere marine terraces are found at a considerable elevation.

Most observers have supposed the first volcanic outbursts at least to have occurred during the same period in which the Caversham sandstone was deposited. Professor Park, however, taking into account the erosion of the Caversham sandstone, suggests the beginning of the Pliocene as the first period of volcanic activity.‖ There was either a prolonged period of volcanic activity, or there were two shorter periods separated by a period of quiescence, for conglomerate to a thickness of 100 ft., containing pebbles derived from the earlier volcanic rocks, lies in places upon the sedimentary rocks, and is covered by the later volcanic lavas. In places, also, fine shales with leaf-impressions occur above the sandstone and below the conglomerate. If, as suggested by Professor Park,‖ these are of Pliocene age, the later eruptions which followed cannot be older than Pliocene. The occurrence of the conglomerate and the evidence of two periods of volcanic activity explains the unconformity between the earlier and later lavas of Signal Hill.

Physiography.

Signal Hill is a flat-topped elevation, extending as a ridge from Logan's Point in a north-easterly direction for a distance of three miles. The ridge then bends to the north and north-west, towards Mount Cargill. The greatest elevation of Signal Hill is 1,214 ft. Less than half a mile to the

* Marshall, "Geology of Dunedin," Quart. Journ. Geol. Soc., lxii, 1906.

† Hutton, "Geology of Otago," 1875; "Sketch of the Geology of New Zealand," Quart. Journ. Geol. Soc., 1885; "Geological History of New Zealand," Trans. N.Z. Inst., 1899.

‡ Hector, "Outline of New Zealand Geology," 1886.

§ Park, Trans. N.Z. Inst., 1904.

‖ Park, "On the Geology of North Head, Waikouaiti," Trans. N.Z. Inst., 1903.

south-east of the main peak is a steep rocky peak of about 1,000 ft.; and to the south-west of the main peak are several smaller peaks, all, however, with gentle slopes. Three-quarters of a mile along the ridge to the north-east of the main peak is a small elevation known as McGregor's Hill. On the south and east the hill slopes down to the shallow waters of Otago Harbour, and at the south-western end to an enclosed bay known as Lake Logan. The gullies on the eastern and southern sides are of slight depth, and are occupied by small streams.

A valley of considerable breadth and depth runs down to Lake Logan, and is occupied by the Opoho Stream, which rises in a swampy area near the summit of Signal Hill. On the north-west the ridge is bounded by the North-east Valley Stream. This stream always carries a considerable volume of water, and has eroded for itself a deep valley. The sequence of the rocks appears to indicate a great antiquity for this stream-valley. The stream has two branches, one of which rises on Mount Cargill, while the other has worked its head back in an easterly direction, and is cutting down the saddle to the north of McGregor's Hill. The upper part of this branch is still eroding its bed, but the lower part, and also the main stream, have reached base-level, and have filled the floor of the valley with alluvium. The North-east Valley Stream is fed by numerous small tributaries, the middle courses of which are generally through steep-sided gullies.

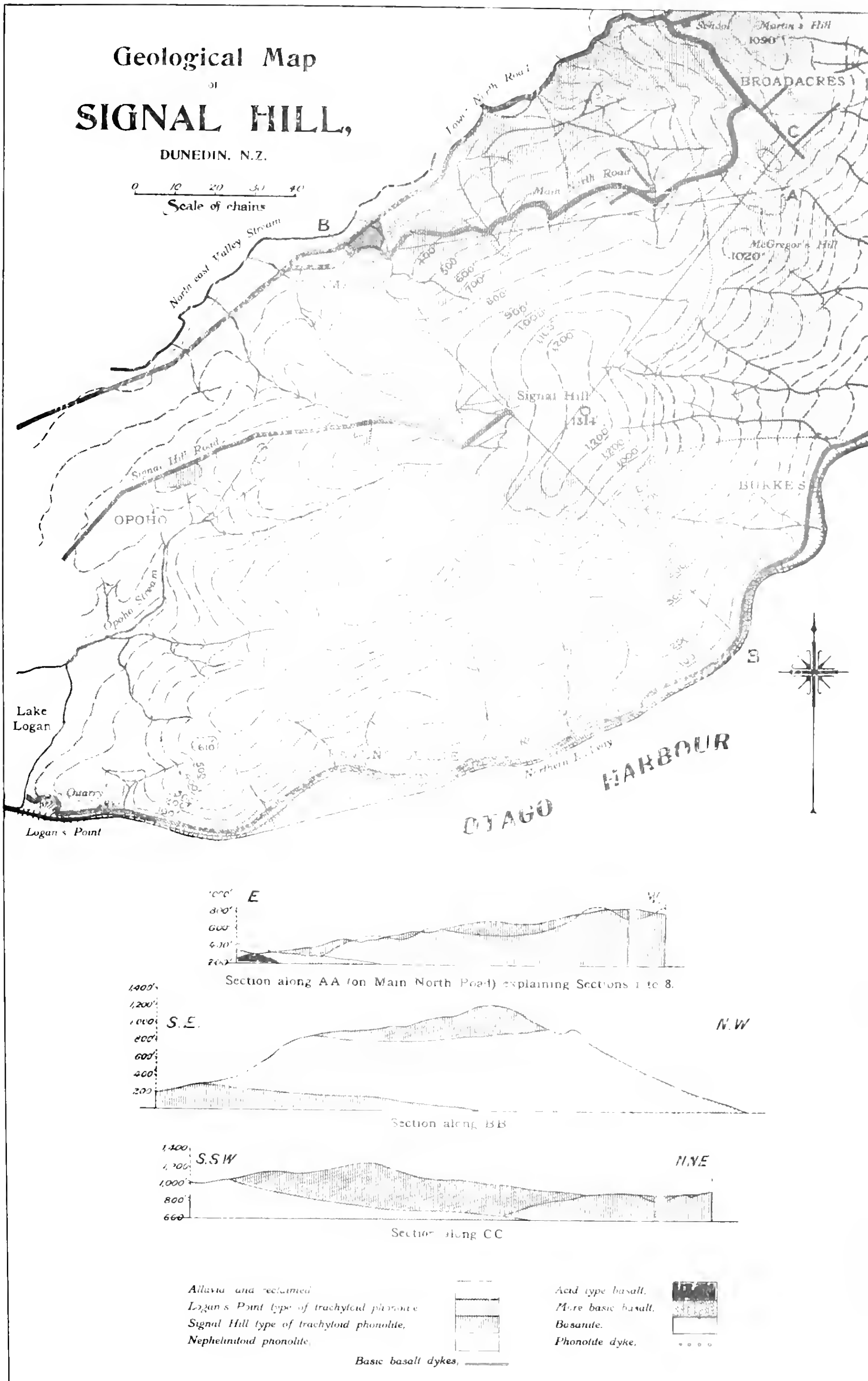
Occurrence of the Rocks.

The rocks of most widespread occurrence within the Signal Hill area are the phonolite of the Logan's Point type, the trachytoid phonolite of the Signal Hill type, and a basalt-flow which I describe as basalt No. 1. The basalt covers the top of Signal Hill, and extends across the upper part of the depression of the North-east Valley. The Logan's Point phonolite extends from near the summit of the hill to Logan's Point, forms a steep peak on the side of Signal Hill overlooking the harbour, and reaches to a point near Burke's. The Signal Hill phonolite has rather a wide occurrence about McGregor's Hill, and is found also in the North-east Valley.

Besides these there is a distinct variety of nephelinitoid phonolite, occurring probably as an intrusion, on the saddle to the north of McGregor's Hill; and there are several other basalts. The latter vary in composition from a very basic variety, occurring as a dyke on the Main North Road, which appears to be the youngest rock described, to a variety approaching andesite, which appears to be the oldest rock exposed. The least basic of the basalts, which I have called No. 5, clearly underlies the Logan's Point phonolite at a point on the Main North Road a quarter of a mile from Normanby. In the valley below this point it is not to be found, being obscured by slips of phonolite from above. Between the phonolite and the underlying basalt in the section exposed there is a stream-deposit, with boulders derived from the basalt, proving an intermediate period of erosion.

The Logan's Point trachytoid phonolite mass is of great thickness on the southern slope of Signal Hill, being continuous from below sea-level at Logan's Point to an elevation of 1,100 ft. near the summit. Towards the west, however, it thins out, until on the Main North Road there is a thickness of only 50 ft. between basalt No. 5 below and the main basalt-flow (No. 1) above.

In the valley below, the Logan's Point phonolite gives place to the Signal Hill phonolite, but the junction is obscure. There is difficulty also in tracing the boundary between the two rocks on the eastern side. It is,



GEOLOGY OF SIGNAL HILL.—Cotton.

To face p. 112.

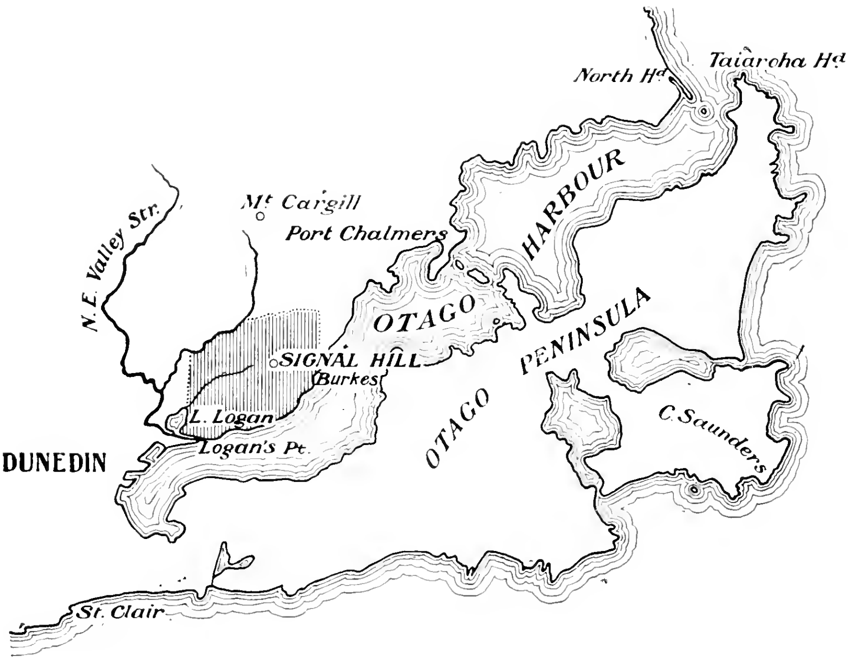


Fig. 1.

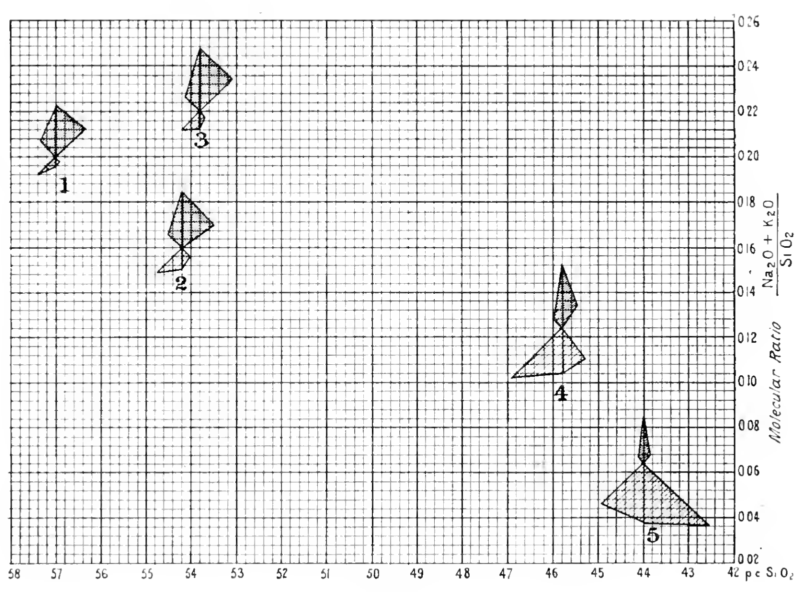
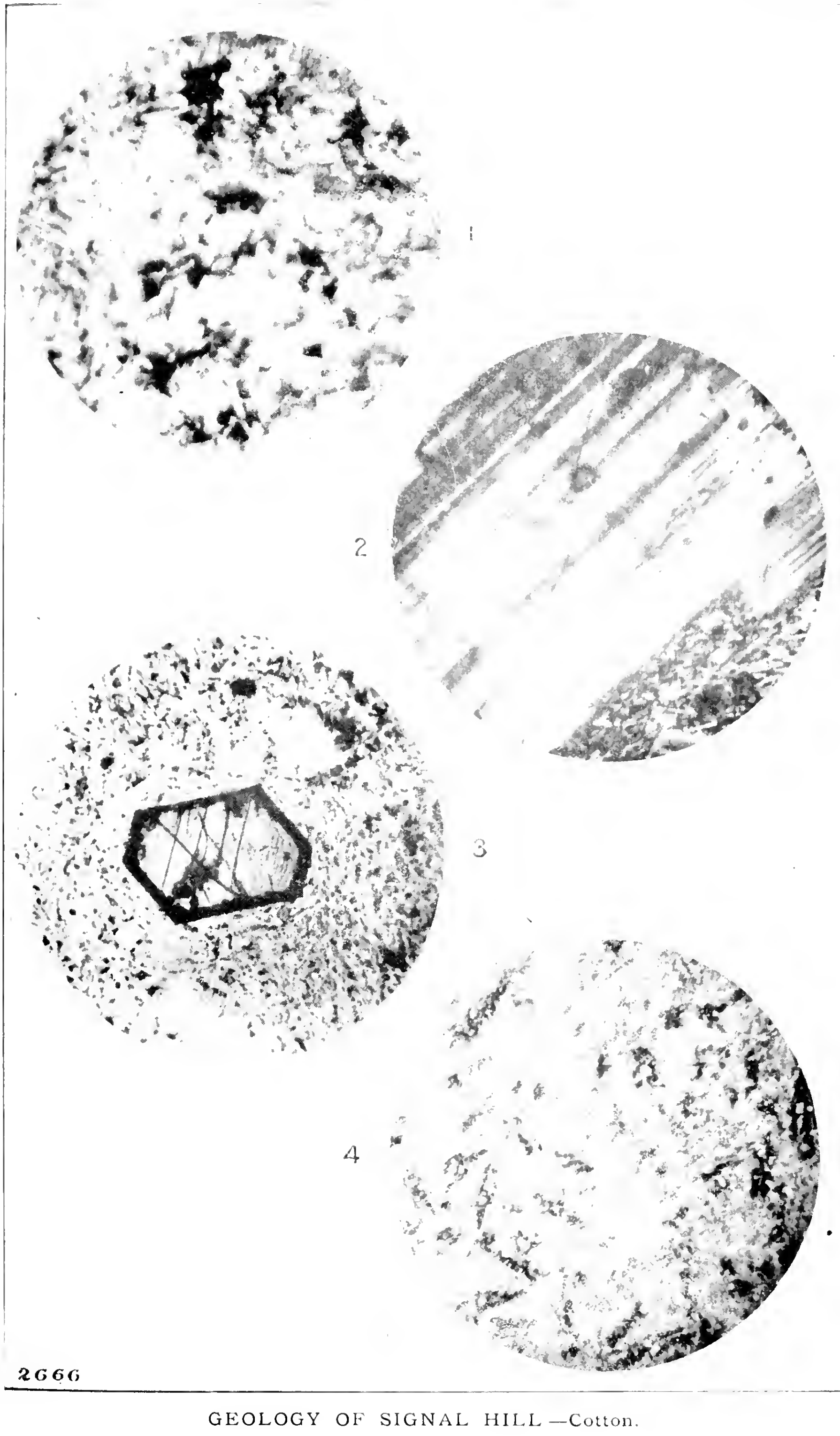
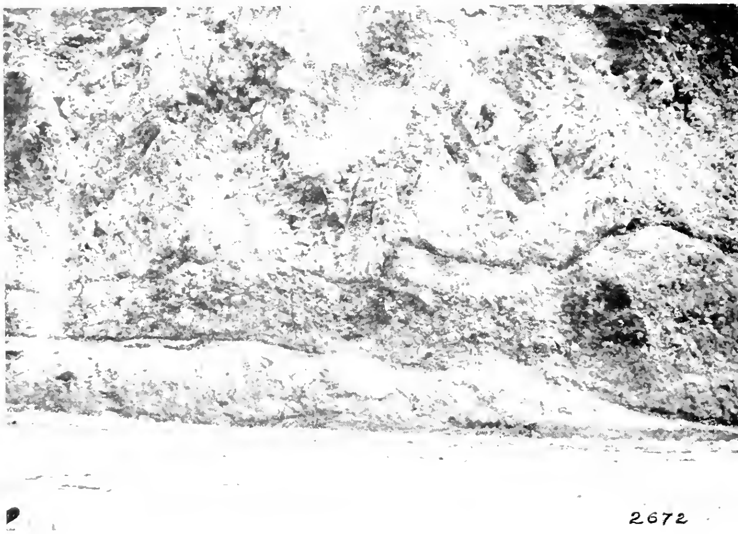


Fig. 2.

GEOLOGY OF SIGNAL HILL.—Cotton.



GEOLOGY OF SIGNAL HILL.—Cotton.



(a)

(b)

GEOLOGY OF SIGNAL HILL.—Cotton

however, practically certain, from sections exposed elsewhere—notably that at North Head, figured by Dr. Marshall*—that the oldest rock is the Logan's Point type, and that the Signal Hill type, which is closely related to the andesitic type of the North Head, rests upon it. The intervening basalt and basanite flows are not represented at Signal Hill, although a first inspection of the sections exposed along the Main North Road might lead to the belief that basalt intervenes between the flows of the two types of phonolite.

Going up the road from Normanby one passes successively Logan's Point phonolite, basalt, and Signal Hill trachytoid phonolite. A closer inspection shows that, while the basalt overlies the Logan's Point rock, it also overlies the Signal Hill type, and is continuous with the main basalt-flow which covers the summit of the hill, and has the peculiar distribution to be described later. This mass of basalt evidently filled a depression which existed near the line of junction of the two types of phonolite, and which may have been the result of erosion, or perhaps was caused by the rapid solidification of the relatively acid phonolite lava. Section No. 1 gives the distribution of these rocks.

In connection with both types of trachytoid phonolite it may be stated that, in places where the rocks are exposed *in situ*, the cleavage is approximately horizontal.

Above the phonolite of the Logan's Point type there occurs, on the Signal Hill Road, about the 800 ft. contour-line, a bed of scoria 30 ft. in thickness. From an undecomposed core in this a specimen of basalt was obtained of a much more acid type than the main basalt-flow which followed it. It is described as basalt No. 4.

The main basalt-flow, described as basalt No. 1, covers the summit of the hill, and on the south-eastern side extends down only a short distance. It continues, however, much farther in a north-westerly direction, and to the north extends in a narrow belt across the head of the eastern arm of the North-east Valley towards Mount Cargill. This distribution is very peculiar, and it might be suggested that the basalt covering this area consists of a number of lava-flows, some of which alternate with flows of trachytoid phonolite. This explanation, however, is not upheld by field evidence.

The sections exposed on the Main North Road, and numbered consecutively 1 to 10 on the accompanying map, are as follows:—

(1.) Direction, N.E. S.W. Height above sea-level, 330 ft. Basalt lies horizontally upon Logan's Point phonolite.

(2.) Direction, N.W. S.E. Height above sea-level, 480 ft. Basalt lies upon trachytoid phonolite (Signal Hill type), dipping N.W. 12°.

(3.) The section is not clear, but basalt appears to overlie Signal Hill phonolite nearly horizontally. Height above sea, 520 ft.

(4.) Direction, N.W. S.E. Height above sea-level, 550 ft. Basalt lies upon Signal Hill phonolite, dipping 12½° N.W.

(5.) Direction, N.E. S.W. Height above sea-level, 580 ft. Basalt lies upon Signal Hill phonolite, dipping 4½° N.E. The basalt is then continuous for about half a mile.

(6.) Direction, E.N.E. W.S.W. Height above sea-level, 750 ft. Basalt lies upon Signal Hill phonolite, dipping W.S.W. 8°.

At (7) and (8) the sections are not clear, but between these points basalt is continuous.

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* Marshall, "Geology of Dunedin," Quart. Journ. Geol. Soc., lxii, 1906.

(9.) Direction, N.W.–S.E. Height above sea-level, 860 ft. Basalt overlies Signal Hill phonolite horizontally.

(10.) At Junction School. Height, 920 ft. Basalt lies upon a convex surface of Signal Hill phonolite, dipping both N.W. and S.E. at an increasing angle.

The diagrammatic section along AA shows the relations of the rocks.

It is thus seen that the basalt-flow is everywhere later than the phonolite. Moreover, when all the above-mentioned basalt-outcrops are followed up they are found to be continuous with the flow covering the top of Signal Hill, and the flow is continuous across the deep valley to the north. At various levels, also, isolated patches of the same basalt occur on the spur leading down to Opoho.

It thus appears that the basalt flowed over a surface quite as uneven as the present surface of the hill, and filled up the depressions. That the basalt did not follow the phonolite in quick succession is proved by the occurrence of a considerable thickness of baked soil on the surface of the phonolite and below the basalt. No direct evidence of erosion, such as the occurrence of phonolite conglomerate beneath the basalt, has been observed, but it seems necessary to postulate a long period of erosion before the extrusion of the basalt which then filled up the depressions, and perhaps solidified on some of the slopes without filling up the valleys below. If, however, the basalt be supposed to have flowed from Mount Cargill, the valley which then occupied the site of the present North-east Valley must have been filled to a depth of 1,000 ft. with basaltic lava. From the lower part of the valley the basalt, if ever it occurred there, has been completely removed by erosion.

The ridges running down towards the North-east Valley are composed of basalt, while the gullies are eroded in the phonolite, which at the heads of the gullies is at a considerably higher level than the basalt at the lower parts of the ridges. This, together with the fact that the tongues of basalt occur in trough-like depressions in the phonolite, shows that the present ridges occupy the sites of ancient gullies.

The basalt mass is made up of numerous successive flows. At many points there are interbedded layers of scoria, and also red bands, which appear to be baked surface clays. If this is correct, considerable intervals must have elapsed between the successive extrusions of basaltic lava. These beds or layers cannot, however, be correlated on account of their resemblance to one another and of the similarity of the basalt of the different flows. The beds do not appear in any case to lie horizontally, nor to have a uniform dip and strike.

The strip of basalt filling the upper part of the North-east Valley is surrounded by older rocks at a higher level on all sides except in the direction of the mouth of the valley. Here the older rocks (phonolites) are at a lower level. Hence it appears that the ancient valley into which the basalt flowed had the same general direction as the North-east Valley. The ancient valley was nearly as deep as the present North-east Valley, and, if it be granted that there has been no subsequent tilting, had a gradient not quite so steep.

A small area of basanite occurring on the Lower North Road scarcely comes into the area discussed. Its relation to the basalt is not apparent. It occurs at a considerably higher level than the neighbouring Signal Hill trachytoid phonolite, and so is considered younger than that rock. It is distant about half a mile from the clear sections on the Main North Road.

Several intrusions of both phonolitic and basaltic rock are found. The most striking of these occurs on the saddle north of McGregor's Hill. The rock, which is nephelinitoid phonolite, is not found *in situ*, but fragments are found on the surface over an area 40 yards by 150 yards, with its greatest elongation in the direction W.N.W. E.S.E. Great variations occurring in the mineral characters of this rock in specimens collected within a few feet of each other, and its isolated occurrence, lead to the conclusion that it is intrusive. It is surrounded by a ring of basalt, an isolated remnant of the basalt-flow, which is here cut down by the action of streams approaching each other from opposite sides of the saddle. The intrusion, therefore, is later than all the lava-flows.

A group of dykes of a very basic basalt occur on the Main North Road. One is vertical, and 5 ft. in thickness; two others are irregularly inclined, and vary from 2 ft. to 3 ft. in thickness. Lower down the hill is a vertical dyke of the same character, 15 ft. in thickness. The strike of these dykes is about east and west.

In the upper part of the North-east Valley, about 500 yards south of the Junction School, there appears traversing the basalt a dyke of decomposed rock. On account of its decomposed nature, no detailed examination has been made of this rock. It has a fine lamellar structure, developed to such an extent that the lamellæ may be pulled apart by the hand. Its colour is a creamy grey, and it shows numerous white crystals of feldspar not entirely decomposed. Some of these are very large, and some of medium size. Their occurrence gives the decomposed rock a micaceous sheen. On account of the abundance of feldspar crystals, the rock has been tentatively classed as a trachytoid phonolite.

SEQUENCE OF THE ROCKS.

From the above description the following appears to be the sequence:—

1. Basalt of an acid type.
2. Logan's Point phonolite.
3. Signal Hill trachytoid phonolite.
4. Eruptions of basaltic scoria of an intermediate type.
5. Main basalt-flows.
6. Dykes of extremely basic basalt. Intrusion of nephelinitoid phonolite. Dyke of rock of doubtful composition, perhaps trachytoid phonolite.

SOURCE OF THE LAVAS.

Nothing definite can be stated as to the position of the vents from which the various lavas issued.

In the case of the Logan's Point phonolite the greatest thickness of rock occurs in the southern portion of Signal Hill. On the western side it thins out, and to the north dips below younger rocks. In the precipitous peak on the south-eastern side of Signal Hill the cleavage-planes of the rock are highly inclined, while elsewhere they are horizontal. Possibly this peak may be the neck or plug which solidified in the ancient crater; but the surrounding rock does not show signs of having flowed from this point. Similar rocks also are described from Mount Cargill, from the opposite shore of Otago Harbour, and from Otago North Head, where a bedded flow occurs; but such a great thickness does not elsewhere occur as that in the main Signal Hill mass.

* Marshall, "Geology of Dunedin," Quart. Journ. Geol. Soc., lxii, 1906.

The trachytoid phonolite of the Signal Hill type does not occur over so great an area, nor, so far as is known, to so great a depth in the area described, but a similar rock has a wide occurrence to the north, as described by Dr. Marshall, and occurs also as a bedded flow at North Head. It may, then, be supposed to originate at some point north of Signal Hill.

The acid basalt underlying the phonolites does not appear to have any close allies in the neighbourhood, although I have compared it with a large number of sections kindly lent for the purpose by Dr. Marshall. It cannot, therefore, be traced to its origin.

The main basalt-flow closely resembles a basalt occurring as a neck on Mount Cargill. This may perhaps be its source. If so, the ancient valley intervening must have been filled to a great depth. The occurrence of the basalt at various levels on the inclined surface of the phonolites on Signal Hill is more easily explained on the assumption that basalt overflow occurred there, and the lava flowed down the slopes.

It is difficult to draw conclusions as to the nature of the magmas from which the rocks were derived, but they are best explained by supposing the rocks to be derived from two magmas, a basaltic and a phonolitic. The basalts became progressively more basic as vulcanism died out. The interval between the first basaltic flow and the next must, however, as before stated, have been great.

The phonolitic magma which supplied the lava of the Logan's Point type and the very much later nephelinitoid intrusion were similar in composition, and probably identical. The Signal Hill phonolite is chronologically intermediate between these two, but not intermediate in composition. It is much poorer in alkalies and richer in iron, and appears to be related to the trachydolerite of Mount Cargill.* It may have originated from a mixture of the basaltic and phonolitic magmas.

No explanation based on the theory of magmatic differentiation is applicable to the alternation of types, but the basalts, taken separately, may be conceived to be derived from a differentiating magma in its final stages.

Petrography.

Trachytoid Phonolite (Logan's Point Type).

This rock is mentioned under the above name by Dr. Marshall.† At the typical locality (Logan's Point Quarry) the rock is distinctly trachytoid, and near the summit of Signal Hill even more so; but in the south-east peak feldspar is almost absent, and the rock should be classed as nephelinitoid.

Macroscopic Characters.—In hand-specimens the rock is of a greenish-grey colour, flecked with green streaks. It cleaves readily into flakes.

Microscopic Characters. — The structure is uniformly fine-grained in typical specimens, and holocrystalline. Flow structure is common wherever there is a considerable development of feldspar. In the typical rock from Logan's Point there are no phenocrysts. The chief constituent is orthoclase or sanidine, but in some places feldspar becomes scarce. It occurs as bundles of fine needle-shaped crystals, some of which are of considerable

* Marshall, "Geology of Dunedin," Quart. Journ. Geol. Soc., lxii, 1906.
† Marshall, "Geology of Dunedin," Quart. Journ. Geol. Soc., lxii, 1906.

length—up to 0·5 mm.—but all are very narrow. Some show Carlsbad twinning. The crystals are often bent, and generally interwoven.

The constituents next in importance are nepheline and ægirine-augite. The nepheline is not distinguished without staining, but in a stained section fully one-third of the rock is seen to consist of nepheline, chiefly in short hexagonal prisms, and partly as fine allotriomorphous grains. The maximum size of the prisms is 0·1 mm. in length and breadth. Very small isotropic spots with low refractive index are put down as sodalite. The ægirine-augite occurs as flakes and needles without definite crystal outlines at Logan's Point. Near the summit better-defined elongated crystals occur, which are also larger, being as much as 0·5 mm. in length.

The maximum extinction-angle is 38°.

The colour is bright green, and the pleochroism as follows: (*a*) grass-green; (*b*) lighter green; (*c*) apple-green. With this may be compared the pleochroism of ægirine from Låven, given by Rosenbusch:* (*a*) pure green to blue-green; (*b*) olivine-green; (*c*) yellowish grass-green.

Associated with the ægirine-augite are numerous minute crystals of deep-brown, almost opaque cossyrite, varying in size from minute grains or needles to crystals 0·1 mm. in thickness. The form of the crystals is rather indefinite, but as nearly as can be made out the prismatic angle is that of typical cossyrite (66°). The mineral exhibits a deep-brown pleochroism. The grains are scattered evenly throughout the rock, being often associated with crystals of the green ægirine-augite.

Magnetite is fairly abundant, in fine grains, while apatite occurs very rarely, in fine needles. No glass is present.

The high percentage of both ferrous and ferric oxides may be noted as peculiar to the rocks of this district. Treatment of the finely ground powder with hydrochloric acid dissolves a considerable amount. This points to the presence of a large proportion of nepheline; and the unusual amount of ferric iron obtained in solution by this method points perhaps to the solubility of cossyrite.

Variations of the Logan's Point Phonolite.—On the peak above Burke's mossy ægirine-augite is very abundant, and phenocrysts also occur up to 0·3 mm. in length. Feldspar is very rare, and the rock should be classed as nephelinitoid. Cossyrite and magnetite are abundant.

Near the top of Signal Hill the feldspar is relatively abundant, showing flow structure. At Normanby nepheline is abundant, as also is ægirine-augite, both as mossy growths and as phenocrysts of considerable size. These phenocrysts attain a length of 3 mm. or more, but are very narrow. They have sometimes a core of pinkish-grey augite. The extinction-angle of the ægirine-augite is 36°, and of the augite 40°. Orthoclase needles are moderately abundant. Cossyrite and magnetite occur.

The Logan's Point rock has been compared by Rosenbusch, in a private letter to Dr. Marshall, with the apachite of Osann.† The chief resemblance, however, appears to be the presence of cossyrite. According to Rosenbusch,‡ the distinctiveness of the apachite type is stated by Osann to be the richness in the younger amphibole minerals, the microperthitic nature of the feldspars, and the presence of ænigmatite. The last appears to be the only point of similarity.

* Rosenbusch, Mikr. Phys., 1905.
† T.M.P.M., 1896, xv, 394.
‡ Mikr. Phys., vol. ii, p. 823.

In chemical composition the Logan's Point rock is similar to a tinguaite from Edda Gyorgis, Abyssinia,* the analysis of which is quoted for comparison :—

	Trachytoid Phonolite, Logan's Point.	Tinguaite, Edda Gyorgis, Abyssinia.	Phonolite,† Losuguta Type, British East Africa.
SiO_2	57·00	57·81	58·37
Al_2O_3	16·06	18·74	16·65
Fe_2O_3	5·53	5·76	4·09
FeO	3·22	0·42	3·03
MgO	0·64	Trace	0·37
CaO	1·51	1·28	1·66
Na_2O	8·00	9·35	7·28
K_2O	6·18	4·52	5·46
H_2O	2·10	1·50	2·36
TiO_2	0·39	..	0·21
Cl	0·45	..	..

The analysis is also quoted of a rock from British East Africa, called by Prior the Losuguta-type.‡ This rock contains cossyrite, and its groundmass in particular appears closely to resemble the Logan's Point rock. Rocks with abundant cossyrite, which occurs in a manner analogous to its occurrence in the Logan's Point rock, are described by H. I. Jensen from Queensland.§ The Logan's Point phonolite was first described by Captain Hutton‖ as an augite-andesite. He considered the groundmass to be chiefly glass, and mentions chlorite and a purple pleochroic augite. What he describes as chlorite is probably ægirine-augite, and the purple augite is not to be found. He evidently also mistook the cossyrite for magnetite.

Trachytoid Phonolite (Signal Hill Type).

This rock has been so named by Dr. Marshall.¶ It is certainly a trachytoid phonolite, with only a small amount of nepheline, but it contains amphibole as its chief ferro-magnesian constituent. Corresponding to the large amount of ferro-magnesian minerals and iron-ores, the content of both ferric and ferrous oxides is unusually high, as shown by the chemical analysis, given later. The rock is thus an exceptional one.

Macroscopic Characters.—The colour is greyish-green, and the texture rather coarse. Numerous cleavage-faces of feldspar are to be seen, and also crystals of amphibole of various dimensions, some being as much as 1 cm. in length and breadth. Sometimes a horizontal platy structure is noticeable, but the weathering is often spheroidal, and isolated boulders have the appearance of basalt.

Microscopic Characters.—The structure is porphyritic and holocrystalline, and the feldspars of the groundmass in places show flow structure.

* Prior, Min. Mag., xii, p. 269, 1900.
† Contains also MnO, 0·43 ; P_2O_5, 0·08.
‡ Prior, Min. Mag. xiii, 61, Feb., 1903, p. 238, and plate v, fig. 2.
§ Jensen, "Geology of East Moreton and Wide Bay Districts, Queensland," Proc. Linn. Soc. N.S.W., 1906, pt. i.
‖ Hutton, Proc. Royal Soc. N.S.W., 1889, p. 134.
¶ Marshall, "Geology of Dunedin," Quart. Journ. Geol. Soc., lxii, 1906.

The largest phenocrysts are feldspar of different varieties in slightly corroded crystals. Anorthoclase is common in large crystals. It shows fine lamellar twinning, crossed at right angles by another set of very fine and rather indefinite lamellæ. As will be seen from the accompanying photograph (Plate X, fig. 2), these are too narrow and not regular enough to be attributed to pericline twinning of a feldspar of the albite-anorthite series. In thicker parts of the section extinction between crossed nicols is irregular. For these reasons this feldspar is regarded as anorthoclase.

As sections parallel to the cleavage are not obtainable, the extinction-angle cannot be verified.

Clear crystals of monoclinic feldspar with Carlsbad twinning are also common. They are referred to sanidine.

Oligoclase phenocrysts are also common, with polysynthetic albite twinning. Sections perpendicular to 010, having equal extinction-angles measured from the twin line, on either side of it, extinguish at an angle of 5° from the twin line.

Perthitic intergrowths are rather common.

The feldspars all occur in broad prisms, up to 3 mm. or 4 mm. in length.

Numerous phenocrysts of a deep-brown amphibole occur. They have definite crystal outlines when not entirely resorbed. Prisms and clinopinacoids are developed, giving hexagonal cross-sections. The crystals are elongated parallel to the $\overset{|}{c}$ axis. The optical characters observed are as follows: $\overset{\backslash}{a} = a$, $\overset{\perp}{b} = b$, $\overset{|}{c} \wedge c = 15^\circ$. The axis c lies in the plane of symmetry. Pleochroism: (*a*) Pale yellowish-brown; (*b*) deep brown; (*c*) deep brown. These characters show it to be intermediate between barkevikite and basaltic hornblende. The crystals are largely resorbed, being bordered, and in some cases entirely replaced, by fringes of magnetite grains associated with augite and a little calcite.

This amphibole has evidently been one of the first minerals to crystallize, having probably an "intratelluric" origin. It has afterwards become unstable in the magma owing to altered conditions, perhaps of pressure. The feldspar needles surrounding the amphibole phenocrysts have a fluxional arrangement.

An interesting comparison may be made between this mineral and the amphibole of a somewhat similar rock described from the "Beagle" collection.* In that rock the amphibole is converted to ægirine-augite, and no mention is made of magnetite. This is considered to be the source of all the ægirine-augite in the rock.

The size of the amphibole phenocrysts in the Signal Hill rock varies from 0·3 mm. in length and breadth up to 1 cm. or more.

Pyroxene phenocrysts are rare, and of small size. They are augite of a slightly sodic variety. The extinction-angle is 42°. The mineral is rather pale in colour, with very slight pleochroism, as follows: (*a*) pale green; (*b*) greyish, almost colourless; (*c*) slightly yellowish-green.

A few stout prisms of grey-coloured apatite occur, up to 0·2 mm. in length.

Olivine occurs rarely, and is largely altered to serpentine. A glomeroporphyritic inclusion has been observed. In the centre is a large cross-

* Geol. Mag., March, 1907, p. 100.

section of grey augite, surrounded by a mass of allotriomorphic crystals of lime-soda feldspar and grains of magnetite.

Groundmass.—The groundmass consists of lath-shaped feldspars, pale-green augite, numerous magnetite grains, and interstitial nepheline.

The feldspar is chiefly orthoclase or sanidine, but oligoclase also occurs, with the same characters as in the phenocrysts. The feldspar laths vary in size up to 0·5 mm. in length and 0·05 mm. in breadth.

The pale-green ægirine-augite occurs in irregular crystals. It has the same characters as in the phenocrysts. The pleochroism is very slight. The maximum size of the crystals is 0·5 mm. by 0·1 mm.

Nepheline does not appear without staining, but a stained section shows a moderate amount of interstitial nepheline. Associated with the nepheline is a little sodalite. There is no glass, and there is no cossyrite. The absence of the latter is rather remarkable, considering its abundance in the Logan's Point phonolite.

Chemical Composition. The proportions of ferric and ferrous oxides are both very high, corresponding to the large amounts of ferro-magnesian minerals and magnetite present. The nepheline-syenite of Red Hill, New Hampshire, U.S.A.,* has a somewhat similar composition, excepting that its content of ferric oxide is much lower. An analysis of it is quoted for comparison :—

	Trachytoid Phonolite, Signal Hill.	Nepheline-syenite, Red Hill, New Hampshire.
SiO_2	54·15	59·01
Al_2O_3	16·09	18·18
Fe_2O_3	7·35	1·63
FeO	4·90	3·65
MgO	1·61	1·05
CaO	3·86	2·40
Na_2O	5·94	7·03
K_2O	4·41	5·34
H_2O	1·40	0·65
TiO_2	0·41	0·81
P_2O_5	0·42	Trace
Cl	0·40	0·12

Order of Crystallisation.—(1) Some magnetite and all the apatite; (2) amphibole; (3) feldspars (after this corrosion of the feldspars and resorption of the amphibole took place, with liberation of magnetite); (4) more magnetite and pyroxene; (5) feldspar of the groundmass; (6) nepheline.

Nephelinitoid Phonolite.

Macroscopic Characters.—The rock varies in colour from lead-grey to green. It is dense, and fine-grained. Specks of dark pyroxene and large phenocrysts of feldspar, as much as ½ in. in breadth, occur. The green kind in particular has a platy structure.

Microscopic Characters.—The structure is holocrystalline and porphyritic, the phenocrysts, however, being rare. The groundmass in some cases appears cellular, and in other cases, where the nepheline is not so idiomorphic, there are alternate streaks of clear, fine-grained nepheline and mossy green ægirine. When phenocrysts occur they are large.

* Bayley, B.G.S.A., iii, p. 250.

Phenocrysts.—Large clear crystals of sanidine occur with Carlsbad twinning and cross-parting. In some cases they are elongated, and vary in length from 1 mm. or less to 1 cm. or more.

Nepheline occurs in sharply idiomorphic short prisms, but only rarely. They are as much as 1·5 mm. in breadth.

Groundmass.—Feldspar is very rare. Orthoclase occurs rarely in fine needles, showing Carlsbad twinning.

Nepheline is the chief constituent. It occurs abundantly in good idiomorphic crystals, in size about 0·06 mm., and also interstitially. It gives the section a honeycombed appearance.

Associated with the nepheline is abundant mossy ægirine or ægirine-augite of a deep-green colour. It occurs in very small crystals without definite outlines. The extinction-angle measured from the direction of greatest elongation is in many cases low, although it is impossible to determine it accurately. The pleochroism is from green to yellowish-green. At least some of the mineral is, therefore, probably ægirine; but ægirine-augite may also be present, though to a small extent.

Magnetite grains are very rare.

No glass is present, and no cossyrite.

Order of Crystallisation.—(1) Magnetite; (2) sanidine and nepheline phenocrysts; (3) mossy ægirine and the nepheline of the groundmass.

Chemical Composition.—The analysis of a tinguaite from Alnö, Sweden,* is quoted for comparison:—

	Nephelinitoid Phonolite, Signal Hill.	Tinguaite, Alnö, Sweden.
SiO_2	53·80	50·26
Al_2O_3	18·72	20·15
Fe_2O_3	4·99	3·67
FeO	3·59	2·62
MgO	0·86	1·43
CaO	2·80	3·28
Na_2O	8·82	8·09
K_2O	5·20	4·67
H_2O	1·90	3·85
TiO_2	0·30	0·24
Cl	0·14	..

Basalt No. 1.

Numerous flows of this rock occur, making up the chief basalt mass. All are very similar. Only one, which differs somewhat in texture, is briefly noticed separately as basalt No. 2.

Macroscopic Characters.—The rock is black and basaltic-looking, with numerous crystals of olivine and feldspar. No true columnar structure is to be seen, but some weathered boulders have the appearance of square prisms. Spheroidal weathering is general, and everywhere the solid rock is covered by a mantle of clay with spheroidal cores.

Microscopic Characters.—The structure is holocrystalline and porphyritic. Large phenocrysts of feldspar, augite, and olivine occur in a groundmass

* Rosenbusch, Elemente, p. 215, 1898.

consisting of feldspar, magnetite, and augite, without glass. Flow structure is apparent in some localities and absent in others.

Phenocrysts.—Plagioclase phenocrysts vary in size up to 1·5 mm., and are abundant. Polysynthetic albite twinning is universal. The extinction-angle of adjacent lamellæ in sections perpendicular to 010 is 30°. The feldspar is therefore labradorite.

Augite phenocrysts are large, being as much as 7 mm. or 8 mm. in length and 2·8 mm. in thickness. The colour is grey, and the maximum extinction-angle 41°. The crystals are idiomorphic, and some show twinning, with the orthopinacoid as composition plane.

Magnetite occurs in crystals and rounded grains up to 0·4 mm. in diameter.

Olivine occurs in rounded crystals up to 0·5 mm., and, more rarely, larger. It is pale in colour. The olivine crystals are often replaced by serpentine pseudomorphs.

Groundmass.—The groundmass consists chiefly of irregularly arranged small needles and laths of labradorite and numerous irregular grains of grey augite and magnetite. At some places feldspar is very abundant, with flow structure, and at others no flow structure is to be seen, while magnetite and augite are relatively more abundant.

Chemical Composition.—For comparison the analysis of a dolerite* from Dyer's Pass, Canterbury, is quoted :—

	Basalt No. 1, Signal Hill.	Dolerite, Dyer's Pass, Canterbury.
SiO_2	45·80	48·60
Al_2O_3	17·91	17·87
Fe_2O_3	6·14	6·20
FeO	8·69	5·76
MgO	3·92†	4·32
CaO	8·10	9·11
Na_2O	4·71	4·66
K_2O	1·77	2·06
H_2O	2·10	1·78
TiO_2	0·35	..
Cl_2	0·11	..

Basalt No. 2.

This basalt is not found *in situ*, but only as spheroidal cores in a deep clay. It has a cubical fracture. The minerals are similar to those in No. 1, and occur in the same proportions. The groundmass is similar to that of No. 1, the only difference being in the phenocrysts. The feldspar phenocrysts are much larger than in No. 1, and the olivine is nearly all decomposed.

Basalt No. 3.

This rock, which occurs in a dyke, is very hard and dense in appearance. Olivine crystals are seen in abundance.

Microscopic Characters.—In sections the rock is holocrystalline and porphyritic. The groundmass is much more coarsely crystalline than that of the lava basalts.

* R. Speight, Trans. N.Z. Inst., vol. xxvi, p. 409.
† MgO appears low to be associated with such a low amount of SiO_2.

Phenocrysts.—The phenocrysts are augite, olivine, feldspar, and magnetite. Of these, olivine and augite are by far the most abundant. The olivine crystals are large, and are partly altered to serpentine. They are almost colourless. The augite crystals are grey in colour and up to 1 mm. in breadth. They have no pleochroism, and the extinction-angle is 41°.

Feldspar phenocrysts are rare. They are of basic labradorite, chiefly untwinned, and are about 1 mm. in length.

Magnetite grains occur up to 0·1 mm. in diameter.

Groundmass.—The groundmass is holocrystalline, and is coarser-grained than in the other basalts described. It consists chiefly of allotrimorphous grey augite, with labradorite laths averaging 0·3 mm. in length. The extinction-angle on either side of the albite twin line in sections perpendicular to 010 is 32½°. There are also abundant grains of magnetite. No glass is present.

This rock, owing to the scarcity of feldspar and abundance of augite and olivine, approaches a magma basalt or augitite.

Chemical Composition.—The chemical composition proves that the rock is derived from an extremely basic magma. For comparison the analysis of a basic basalt from Punta Delgrada, San Miguel, Azores,* is quoted :—

	Dyke Basalt, No. 3, Signal Hill.	Basalt, Punta Delgrada, S. Miguel, Azores.
SiO_2	44·00	44·06
Al_2O_3	14·07	15·10
Fe_2O_3	5·16	5·23
FeO	10·87	7·93
MgO	11·18	9·84
CaO	10·28	12·56
Na_2O	1·74	2·20
K_2O	1·98	0·93
H_2O	1·40	0·30
TiO_2	0·47	1·80
P_2O_5	..	0·53
Cl	0·11	..
MnO	..	0·36

Basalt No. 4.

This basalt occurs in fragments in a scoria-bed on the Signal Hill Road, lying above the Logan's Point phonolite and below the main basalt-flow.

Macroscopic Characters.—The structure is porphyritic, the matrix being grey and fine-grained, with numerous white phenocrysts of feldspar and occasional black specks of augite.

Microscopic Characters.—In sections the porphyritic structure is strongly marked, augite and feldspar occurring in two generations. No flow structure is discernible.

* C. v. John, Jb. G. R.-A., Wien, xlii, p. 291, 1896.

Phenocrysts.—The most numerous and conspicuous phenocrysts are feldspar. These vary in size from 0·3 mm. to 3 mm. They show polysynthetic albite twinning. The extinction-angle of adjacent lamellæ in sections perpendicular to 010 is 28°. The feldspar is therefore labradorite.

Less numerous are phenocrysts of grey augite and small pseudomorphs of serpentine with the form of olivine. The augite crystals vary in size from 0·2 mm. to 0·7 mm., and the olivine has been present in crystals 1 mm. or 2 mm. in length, and regular grains of magnetite up to 0·5 mm. occur.

Groundmass.—The groundmass consists of small laths of feldspar with a considerable amount of fine granular augite and magnetite. The feldspar is labradorite, and the augite is similar to that occurring as phenocrysts.

Basalt No. 5.

This basalt underlies the Logan's Point phonolite on the Main North Road, near Normanby, where fresh spheroidal cores are obtained, imbedded in a red clay.

Macroscopic Characters. — The rock appears dense and black, with occasional large phenocrysts of feldspar. It has a very irregular fracture.

Microscopic Characters.—The structure is holocrystalline and porphyritic. The groundmass is very dense, and the feldspar needles appear to have flowed around the phenocrysts.

Phenocrysts.—Feldspar is abundant, in irregular and lath-shaped crystals, showing polysynthetic albite twinning. The extinction-angle of adjacent lamellæ in sections perpendicular to 010 is 27°. The feldspar is therefore an acid labradorite bordering on andesine. Some of the crystals, especially the lath-shaped ones, are small; others are as much as 5 mm. in length.

Grey augite occurs very sparingly, in rounded grains, and there is a small amount of olivine in crystals up to 1 mm. in length.

Magnetite occurs in grains and octahedrons.

Groundmass.—In the very dense groundmass feldspar is moderately abundant, in fine needles. The remainder consists of grains of magnetite and augite.

Order of Crystallization for the Basalts.

(1) Magnetite; (2) olivine; (3) augite; (4) feldspar; (5) magnetite, augite, and feldspar of the groundmass.

Quantitative Classification of the Rocks.

The rocks have been classified on a quantitative chemico-mineralogical basis according to the system of Cross, Iddings, Pirsson, and Washington,* and the chemical results have also been plotted as diagrams according to the system devised by Iddings,† and these diagrams have been combined in a multiple diagram (Plate IX).

* "Quantitative Classification of Igneous Rocks." Chicago, 1903.

† Chem. Comp. of Igneous Rocks expressed by Means of Diagrams, U.S. Geol. Surv., 1903.

The chemical classification is as follows :—

Trachytoid Phonolite, Logan's Point.	Trachytoid Phonolite, Signal Hill.	Nephelinitoid Phonolite.	Basalt No. 1, Main Flow.	Basalt No. 3, Dyke.
Norm.	Norm.	Norm.	Norm.	Norm.
or 36·70	or 27·80	or 30·58	or 10·56	or 11·68
ab 23·06	ab 36·15	ab 22·01	ab 19·91	ab 4·72
ne 8·52	an 4·73	ne 24·42	an 22·24	an 25·02
so 5·81	ne 2·84	ac 5·54	ne 10·79	ne 5·11
ac 14·32	so 3·88	di 11·23	di 14·97	di 21·16
di 6·44	di 11·96	ma 4·41	ol 9·44	ol 23·41
ol 2·50	ol 0·31	il 0·61	ma 8·82	ma 7·66
ma 0·70	ma 10·67	..	il 0·61	il 0·91
il 0·76	il 0·76	..	..	..
..	ap 1·01	..	..	..
Magmatic name.	Magmatic name.	Magmatic name.	Magmatic name.	Magmatic name.
Class II, Dosalane	Class II, Dosalane	Class II, Dosalane	Class II, Dosalane	Class III, Salfemane
Order 6, Norgare	Order 5, Germanare	Order 6, Norgare	Order 6, Norgare	Order 5, Gallare
Rang 1, Laurdalase	Rang 1, Umptekase	Rang 1, Laurdalase	Rang 3, Salemase	Rang 4, Auvergnase
Subrang 3, Judithose	Subr. 4, Umptekose	Subr. 4, Laurdalose	Subr. 4, Salemose	Subrang 2, ——

The " norm " is seen to correspond roughly to the " mode," or actual mineral composition.

It is interesting to compare the actual proportions of feldspar to feldspathoid in the three types of phonolite : (1) In the Logan's Point phonolite, where feldspar and nepheline each constitute about one-third of the rock, silica is relatively high and alumina low, while alkalies are high ; (2) in the nephelinitoid phonolite, where nepheline constitutes the greater portion of the rock, silica is lower, alumina is higher, and alkalies are about the same ;

(3) in the Signal Hill phonolite, where nepheline is rare and feldspar of various types abundant, silica is nearly the same as in the nephelinitoid type, alumina is low, and alkalies are also low.

EXPLANATION OF PLATES VIII–XI.

Plate VIII.

Geological map of Signal Hill, with sections along lines AA, BB, CC, on map.

Plate IX.

Fig. 1. Map showing locality.
Fig. 2. Graphic representation of the chemical composition of the rocks (after Iddings).

Plate X.

Fig. 1. Logan's Point phonolite; × 200. Shows association of cossyrite and ægirine-augite.
Fig. 2. Signal Hill trachytoid phonolite; × 45. Crossed nicols. Shows large crystal of anorthoclase.
Fig. 3. Signal Hill trachytoid phonolite; × 45. Shows a large crystal of amphibole partly resorbed.
Fig. 4. Nephelinitoid phonolite; × 45. Shows the groundmass consisting chiefly of nepheline with mossy ægirine.

Plate XI.

Fig. *a*. Logan's Point phonolite overlying basalt No. 5 on Main North Road, near Normanby.
Fig. *b*. Dyke of basalt No. 3, intruded in basalt No. 1.

Art. XXII.—*Further Notes on New Zealand Starfishes.*

By H. Farquhar.

Communicated by H. B. Kirk, Professor of Biology, Victoria College.

[*Read before the Wellington Philosophical Society, 7th October, 1908.*]

Stegnaster inflatus, Hutton. Plate XII.

This species has not been figured before; the figure now given is from an example found at Island Bay by Mr. Stuckey, headmaster of the Island Bay State School, and photographed by Mr. A. Hamilton, in which R = 63 mm., and r = 52 mm.

The species is interesting as being the type of Sladen's genus *Stegnaster*. In his monograph Sladen says, "I have also added in the following list another genus, *Stegnaster* (n. gen.), which seems to me necessary. The type of *Stegnaster* is the starfish described by Hutton under the name *Pteraster inflatus*, and subsequently placed under *Palmipes* by Perrier. I consider that the disposition of the papulæ, the membraneous investment of the abactinal area (with the absence of the characteristic tufts of spines and the presence of granules), and the simple character of the armature of the adambulacral plates, are sufficient to warrant the generic separation of this form from *Palmipes*. I also refer to the same genus *Asterina wessli*, though not without some hesitation, as the examples I have seen of that species appear to be immature forms."*

* "Challenger" Reports, vol. xxx, p. 375.

I have not been able to discover that the association of *A. wessli*, a West Indian species, with *Stegnaster* has been confirmed, or that any other species of this genus have been found.

Asterina neozelanica, Perrier.

The type specimen of this species is in the Paris Museum; it was described by E. Perrier in the "Archives de Zoologie Experimentale et Generale," vol. v, p. 33 (1876), from a specimen which he found among a number of examples of our common littoral form *Asterina regularis*. I have collected a considerable quantity of *A. regularis* in the neighbourhood of Wellington, but I have not found a specimen of *A. neozelanica*. (I write the name "*neozelanica*" in accordance with the rule suggested by Von Martens, and adopted by New Zealand naturalists—see Trans. N.Z. Inst., vol. xxi, p. 238—that specific names should be one word only.) As Perrier's description may not be accessible to New Zealand observers I transcribe it here, so that specimens may be identified when found:—

"Corps de forme pêntagonale, à côtés légerèment échancrés.

"R = 20 mill., $r = 13$, R = $\frac{3}{2}$ r environ.

"Plaques de la face dorsale entièrement couvertes de petits tubercules mousses. serres contre les autres et formant pour chaque plaque un groupe tantôt distinct circulaires, tantôt plus ou moins allongé. Des groupes allongés sont généralement concaves vers le centre du disque et séparés les uns des autres par un au plusieurs groupes arrondis. Dans les groupes allongés les petits piquants mousses ou tubercules forment au moins trois ou quatres rangées. Ces groupes de tubercules ne dessinent pas sur le disque de figure de forme particulière. Plaques marginales imbriquées et formant autour du disque une sorte de bordure où la partie apparente constitue une sorte de pavage à éléments rhomboïdause. La plaque madréporique arrondie est située à 3 millimètres du centre du disque et entourée de groupes de granules plus allongés que les autres. Les sillons qu'elle porte ne sont pas rayonnants autour d'un centre. En somme, sauf le nombre et la disposition des piquants, l'ornementation de la partie dorsale de cette espèce resemble beaucoup à celle de l'*Asterina gunnii* (*A. regularis*).

"La face ventrale est au contraire toute différente. Les plaques du sillon ambulacraire portent chacune dans le sillon troits piquants divergents. reunis en une lame un peu oblique relativement à la direction du sillon par un repli des téguments qui n'atteint pas le sommet des piquants. En dehors ces plaques portent en outre une rangée oblique de trois piquants, un peu plus grands que ceux qui existent sur les autres plaques de la face ventrale et qui sont aussi au nombre de trois ou même quatre, surtout au voisinage de la bouche sur chaque plaque. Les piquants sont d'autant plus sérrès les uns contre les autres qu'on se rapproche davantage des bords du disque, où ils sont fréquemment aussi au nombre de quatre sur chaque plaque. Un seul individu de la Nouvelle-Zelande, en très-bon état et conservé dans l'alcool."

Asterias fragilis, Studer.

I have a manuscript copy of Studer's description of this species, kindly furnished to me by the late Andreas Reischek; I am also indebted to him for the above description of Perrier's *Asterina neozelanica*. Studer's description was published in the "Transactions of the Royal Academy of Science," Berlin, 1884; and I give here a translation of it, so that the species may be identified when rediscovered:—

Small, five-rayed, with slender body and five angular arms which branch off from the flat-shaped body through a ring-like furrow. The body is covered with small stumpy spines arranged in rows along the arms; between these lie depressions in which there are numerous papulæ. Ambulacral spines in two rows.

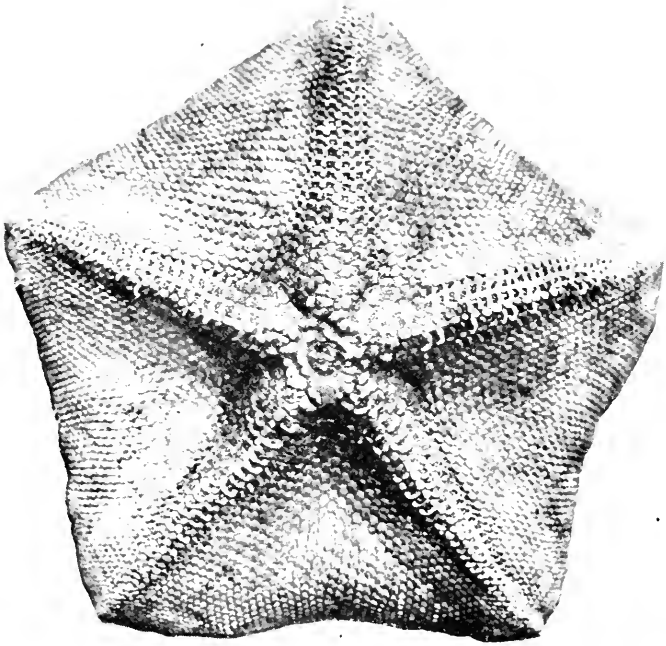
R = $16\frac{1}{2}$, $r = 4$. Width of arm at the proximal end, 8 mm.

The body itself is flat, but bulky, and separated from the rays dorsally by more or less distinct pentagonal wrinkles. At this point the arms very easily separate themselves from the body. At the base they are somewhat contracted, but soon widen out, and then gradually taper away. Each arm has a perfectly flat ventral surface, two straight side surfaces, and a back raised somewhat like the keel of a boat. The ambulacral furrow is broad, and bounded by two rows of small cylindrical spines, the inner row having a third fewer spines than the outer. Outside the furrow there is a row of straight pedicellariæ. On the back there is a row of bluntly pointed spines, three or four together. The perpendicular side surface of the arm is free of spines, and is clothed with a thin and soft skin, which is pierced by a row of papulæ, between which there are straight pedicellariæ. The dorsal skeleton of the arms consists of a thick mass of lime stems and knotted points, which are arranged in three long rows, and are raised. These bear short blunt spines, whilst the depressions lying between bear papulæ. The lime covering of the body is very dense, and is armed with short stumpy spines, lying about here and there without order. Between them there are crossed pedicellariæ and papulæ, the latter in a radius equidistant from the central point, and the circumference of the body forming a circle. The madreporic plate is very small, and contains few furrows. It is nearly covered by a surrounding half-circle of 6 blunt spines, situated close up to the disc-wall. The entire skeleton of the starfish is rigid and inflexible. The peculiar formation of the skeleton of the arm induces me to place this starfish next to *A. sulcifera*. The colour when fresh was pale reddish-orange.

Found east of New Zealand in S.L. 35° 21′ and E.L. 175° 40′, in 597 fathoms depth.

Asterias calamaria, Gray.

In vol. xxx, page 188, of the Transactions I noted that adult specimens of *A. calamaria* in Port Nicholson have 10 or 11 arms of equal length, while "young individuals of this species always have a number of small arms budding out between the larger ones, or a group of small ones on one side of the disc. . . . They appear to have only a small number of arms at first (4 to 7), and the others are budded afterwards." Recently I and my family were spending the summer holidays at Muritai, on the other side of the bay, where a company of Italian fishermen draw their seine nets ashore on fine evenings. There were always a few large examples, 10 in. to 12 in. in diameter, with 10 or 11 equal arms, and often some smaller ones with a less number of unequal arms (the smaller the specimen the less the number of arms), and on one occasion my son Harry found two very young ones among the refuse of the net. These had only 2 arms each, and measured about 1 in. between the tips of the arms. The 2 arms of both examples were the same size and equally developed, and one specimen had one and the other two little tubercles on the side of the disc—the beginnings of other arms just starting to bud out. It therefore appears probable that the young of this species have only 2 arms at first, and the



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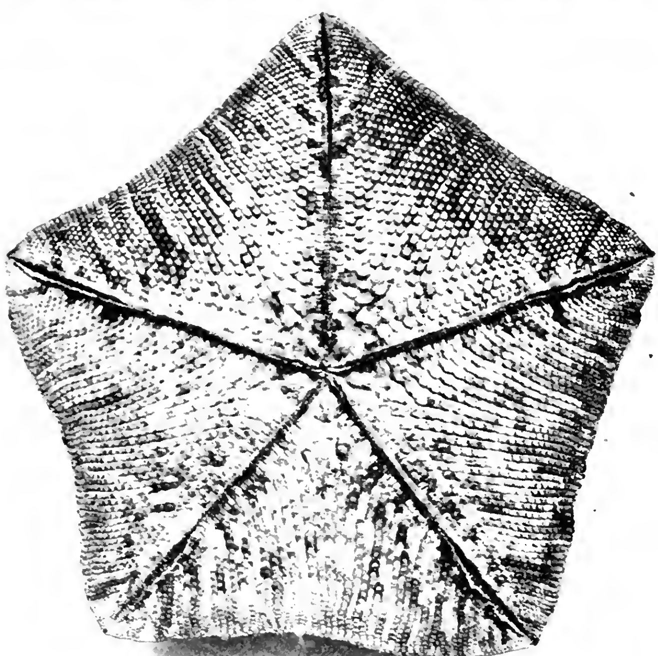

2.

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NEW ZEALAND STARFISH.—Farquhar.

Face p. 128.

number increases with age until 10 or 11—usually 11 in Port Nicholson—are developed.

Species which divide, and those in which the number of arms increases by budding from the disc, usually have more than 1 madreporic plate. *Stichaster insignis* usually has 4, but examples may be found with 1, 2, or 3; *Stichaster polyplax* has from 1 to 4; and *Asterias calamaria* often has 2 or 3.

Asterias calamaria var. **reischeki**, var. n.

I described a variety of *Asterias calamaria* in vol. xxi, page 187, of the Transactions, which occurs freely at Nelson, under stones at low water. Its general facies differs much from that of the form which is common in Port Nicholson. The arms are not stout and rounded at the tips like the Wellington specimens and the Mauritius forms as figured by Loriol, but are more delicate, and taper evenly to a very fine extremity; and the spines are never coarse or truncated, but always fine, long, single, and very finely pointed. These differences are so definite and constant that I am now of opinion that, if not a distinct species, it is at any rate a well-marked variety, and worthy of a distinct name. I therefore dedicate this form to the late Andreas Reischek, who has added largely to our knowledge of the habits and characteristics of the New Zealand birds. It would have been more appropriate had his name been associated with one of our native birds, but, as their history, as regards the finding of new species, is probably closed, this much more humble form may serve, in a measure, to commemorate the man and his work. Reischek's natural-history work in New Zealand extended over about twelve years (1877–89), and the records of his observations, which are published in vols. xiv, xvii, xviii, xix, xx, and xxi of the Transactions, show that he was a keen and good observer. He also wrote "The Story of a Wonderful Dog," an extremely interesting little book, published at the *Star* Office, Auckland, 1889, in which he gives an account of the training of his dog "Caesar," and his experiences in the New Zealand "bush."

Stichaster polyplax, Müller and Troschel.

I stated in vol. xxvii, page 208, of the Transactions that probably subdivision takes place in *S. polyplax*, as in *S. insignis*. The latter species, which has six arms, three of which are usually smaller than the other three, continually undergoes a process of transverse division, each half regenerating the parts that are missing; but I am now convinced that this does not occur in *S. polyplax*. The young examples of *S. polyplax* which I and my son have collected in the neighbourhood of Wellington always have a few—1 to 4—fully developed arms, and a number of smaller ones usually of different lengths, some just budding from the disc; and hence it appears probable that the same process occurs in the development of the arms as in *Asterias calamaria*, with this difference: adult specimens of *A. calamaria* have 10 or 11 arms, while those of *S. polyplax* have only 7 or 8.

EXPLANATION OF PLATE XII.

Fig. 1. *Stegnaster inflatus*: abactinal view; reduced.
Fig. 2. " actinal view; reduced.

Art. XXIII.—*Captain Dumont D'Urville's Visit to Tologa Bay in* 1827.

Translated from the French* by S. Percy Smith, F.R.G.S.

[*Read before the Auckland Institute, 18th November, 1908.*]

In the Transactions for 1907 appeared an account of Captain D'Urville's visit to Tasman's Bay, ending up with the passage of the "Astrolabe" through the French Pass, on the 28th January, 1827. We will now follow the corvette on her passage through Cook Strait and up the east coast of the North Island, New Zealand, to Tologa Bay.

A few notes have been added in brackets [ ] where necessary to identify places, names, &c. The voyage up the coast offers nothing remarkable, and therefore will be summarised in a few sentences.

After safely traversing the French Pass on the 28th January, D'Urville quickly passed through the narrow part of the Strait, with the intention of anchoring in Cloudy Bay, in order to decide whether a suspected passage did or did not exist between Cloudy Bay and Queen Charlotte Sound. But, the wind failing, the ship was brought up off Tory Channel, of which D'Urville says, "At its base [of a hill he describes] a little bay seemed to communicate by a narrow channel, obstructed by rocks, with the Bay of Queen Charlotte, of which the calm waters were perfectly distinguishable from the mast-head. Some great fires were also seen on the left-hand point of the opening. Anxious to see us, it is probable the savages employed that means to attract our attention." [These Natives were probably some of the original Rangitane Tribe, of those parts, for the occupation by Ngati-Toa and Te Ati-Awa Tribes had not as yet eventuated.]

From there D'Urville attempted in vain the following day to enter Cloudy Bay, but was driven by a strong wind on the 29th down to Cape Campbell, from whence he steered for the North Island, intending to explore the coast west of Cape Palliser. "To my great regret the wind did not permit us to gain a deep bay between Cape Poli-wero [the native name as given to D'Urville, but now called Sinclair Head, and situated a few miles west of the entrance to Port Nicholson] and Cape Toura-kira [Turaki-rae, six miles S.E. of Port Nicholson], where are found some isles near the shore, which should offer excellent anchorages." [These isles are Barrett's Reef, at the entrance of Port Nicholson—Maori name, Te Ure-a-Kupe.] Had his efforts not been thus frustrated D'Urville would doubtless have been the first to discover and describe the harbour of the capital of New Zealand. The corvette continued her course, and entered and anchored on the west side of Palliser Bay, where some canoes came off to her, and two Maoris—one named Tehi-Noui [? Te Hi-nui], a chief, and his companion, Koki-Hore [? Kiore]—insisted on remaining on board, being eventually carried on to Tologa Bay. D'Urville saw Lake Wai-rarapa, which he conjectured to be an arm of the sea. The name (as he gives it, Wai-Te rapa) he applied to the range to the west—*i.e.*, Tararua.

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* Voyage de la corvette L'Astrolabe, exécuté par ordre du Roi, pendant les années 1826, 1827, 1828, 1829, sous le commandement de M. J. Dumont D'Urville (Paris, 1833), vol. ii, p. 68 *et seq.*

After attempting to land, but prevented by the surf, the corvette proceeded along the east coast past Cape Palliser, the name of which (Kawakawa) is correctly given as furnished by the two Maoris, and on the 1st February they were off Cape Topolopolo [Te Poroporo], the Cape Turnagain of Cook. "At 10h. 10m. on the 3rd February we rapidly passed at half a league's distance L'ile Stérile of Cook [Bare Island], of which the true name is Moton-Okoura [Motu-o-Kura]. It is an escarped rock, naked, and a mile or more from the land. A *pa* (or fortress) of some size occupies the summit, and ought to be an impregnable position. There were also to be seen several houses on the slopes of the isle, and by aid of the glass we easily distinguished the inhabitants moving about their fortress and occupied in regarding attentively our passing. As at other points of the coast, they had made some great fires to call our attention. A canoe, well armed, came from Motou-Okoura to meet us. It was reported to me that our two Natives had uttered cries of joy on seeing it, and, charmed to be able to offer them the means of escaping from their captivity, I laid to. Already the canoe was but a cable-length from the side, when I announced to them that they were at liberty to seize the occasion to go ashore. What was my surprise to see both, at that proposition, become desolate, cover their faces, and roll on the deck, with all the signs of despair, declaring with energy that they desired positively to remain on board. They then informed me that the people of Motou-Okoura were their enemies, and that if they fell into their power they would be put to death and devoured. They invited us in the most unequivocal manner to fire on and kill them. The late transports of joy of our guests were only proofs, as I soon learnt, of their persuasion that we should exterminate the new-comers, and of their hope of a repast, which, according to their ideas, would become the prize of victory."

After passing Cape Mata-mawi [Matau-a-Maui -Cape Kidnappers of Cook] the corvette sailed some six or seven miles into Hawkes Bay. Referring to Scinde Island, on which is now built part of the town of Napier, and the adjacent country, D'Urville says, "We believed we saw an island of some extent situated close to the coast, which escaped the researches of Cook, but which may well be only a peninsula. There is reason to presume that between it and the mainland there may be good anchorages. In the south-west of Hawkes Bay we were able to see a pleasant landscape, dotted with clumps of trees, and on the edges some large basins of calm water, but which probably do not offer sufficient depth of water for anchorages. [These no doubt were parts of Te Whanga-nui-a-Rotu (Napier Harbour) and the lagoons near Clive.] From three or four plains disposed in amphitheatres the ground gradually rises up to the high mountains of the interior; and in all New Zealand that part is without doubt the richest and most attractive that has been offered to my gaze. This country seems well peopled, as denoted by the numerous columns of smoke arising from many points." [This is the country about Hastings, Clive, Havelock, &c., one of the finest in the Dominion, then inhabited by the powerful Ngati-Kahu-ngungu Tribe.]

After passing Portland Island, off the Mahia Peninsula (which D'Urville calls Tera-Kako, after Cook, but the origin of which is not known), on the 4th February the corvette was off Poverty Bay. Here we shall follow the narrative of the voyage literally:—

[On the 4th February, 1827] we doubled at 2 p.m. the Cape Young Nicks, memorable for having been the first point of New Zealand seen by the illustrious Cook; we passed quickly the opening of the Bay Taone-Roa [? Te One-roa—Poverty Bay], the lands at the bottom of which we could only distinguish indistinctly. At 4 p.m., in 35 fathoms, we made a stoppage at about 4 leagues from Cape Gable [Gable-end Foreland—Pari-nui-te-ra].

We know that this name was given by Cook because of its resemblance to the wall of a house comprised between the two roofs. . . . The coast, which had retained a wild aspect from the Isle Tea-Houra [Portland Island] up to the S.W. point of Taone-Roa [Poverty Bay], beyond that assumed a less severe appearance. The surroundings of Cape Gable are particularly agreeable, and there are sites where culture would make fertile fields. There the columns of smoke again showed in greater number than elsewhere, proof infallible of a more numerous population.

Towards 6 p.m. we approached the Tologa Bay of Cook, and I counted on doubling it before night, when the breeze, which had already decreased, fell entirely, and the corvette remained immovable at three or four miles from the coast. At 7 p.m. we thought we saw a small schooner, which at first ran along the coast, and then all of a sudden put out to sea and disappeared—a manœuvre which I could only account for by supposing that the craft viewed our visit as not quite an agreeable one.

At 8 p.m. two canoes, which we had observed for some time paddling towards us, came alongside without any fear, and as though accustomed to see Europeans. They sold us some pigs, potatoes, and other objects of curiosity in exchange for hatchets, knives, and other trifles. Forty-five days had passed since our departure from New Holland, and all our fresh provisions had been exhausted long since. It may therefore be judged with what pleasure these articles were received, above all when they told us that pigs were plentiful at Tologa, and that they would sell them at the lowest price. Te Rangui-Wai-Hetouma, chief of the New-Zealanders who came to visit us, announced himself as one of the principal *rangatiras* of the district, and wished to send his canoes ashore to procure pigs and potatoes, and to pass the night with us. I was well satisfied with this proof of confidence in us, but, fearing for him the same troubles (sea-sickness) as those of Tera-Witi, I refused, and obliged him, much to his regret, to re-embark in his canoe. I promised, however, that he would find us in the same place in the morning.

Tehi-Noui and Koki-Hore appeared now to have regained their spirits, for a copious feed of dolphin-flesh, and the prospect of another next morning, had quite enchanted them, and in the evening a shark that had been caught completed their delight. Overcome by this abundance, they seemed little disposed to acquiesce in the desire I expressed to leave them here. Koki-Hore particularly did not relish that proposition.

All night there was only a feeble breeze from the west, with superb weather. At 10 p.m. we laid to in 53 fathoms, muddy sand.

5th February.—In the morning, the breeze having changed to the N.N.W., which did not permit us to continue along the coast, I decided to profit by it to make a stoppage at Tologa. At 7.30 a.m. we steered for the bay, and at 11 a.m. the "Astrolabe" dropped her anchor precisely on the same spot where the "Endeavour" had anchored fifty-five years before.

The Natives came out to us at an early hour, but I did not permit many on board. Arrived at the anchorage, we were soon surrounded by canoes full of islanders, who came to traffic with the crew. However turbulent and noisy in their bargaining, they showed much good faith, and we could only felicitate ourselves on the nature of our exchanges. The usual price for a fat pig was a large hatchet; a small one would purchase a young pig.

for indifferent knives, fish-hooks, or other trifles we obtained potatoes in profusion. It may be judged what an ample supply of fresh provisions we obtained for the crew and our tables.

I at once sent MM. Jacquinot and Lottin to the watering-place of Cook to observe the latitude and longitude. At 1 p.m. M. Paris departed to sound the channel. The naturalists and the artist also went ashore to follow their avocations. I remained on board with the other officers to watch the movements of the Natives—a precaution which I judged more necessary here than elsewhere, as much on account of their numbers as their physical force and turbulent disposition.

Already I had nearly drawn upon myself the animosity of one of these redoubtable savages—a thing I was anxious to avoid at any price, above all on account of those persons the nature of whose work obliged them to go ashore. Thus, as I have already said, whilst we were under sail I had kept off all the canoes which approached the ship, and only allowed Wai-Hetouma, who said he was chief *rangatira* of the place, to come on board with another Native whom he had represented as one of his near relatives. It is well to remark that this chief, who appeared to have received all his insignia, to judge by the complete tattooing of his face, was a peaceable man, easy and honest, and that he had applauded my resolution not to let any one on board beyond himself and companion. Most of those who presented themselves obeyed the prohibition against them, although with visible repugnance; but one amongst th m would not obey the sentinel, and only left when trembling with rage at the peremptory order I gave him myself. It was plain to see that from his canoe he menaced me. By his stature and haughty mien and the air of submission of those who surrounded him, it was obvious he was a chief. Moreover, a young woman in his canoe who spoke a mixture of English corrupted and New Zealand did not cease to repeat to me, with an extraordinary volubility, that Shaki,* her master, was a great chief and friend of the English, and that it was very bad of me not to receive him. Of course, I could afford to mock at these menaces against myself; but I have explained the motives which guided me in dealing with these savages, especially the chiefs. Therefore I called Wai-Hetouma, and asked him who was this new-comer, so urgent. He allowed that Shaki was a great chief, and soon I had reason to believe he was superior to Wai-Hetouma in rank, or at least in influence. I then made a sign to Shaki to come on board, and explained amicably to him that I was unaware he was a distinguished *rangatira*, and gave him a few presents, which soon effected a change in his demeanour. From that moment we became the best friends in the world, and he was one of the last to quit the corvette, from which he never budged an instant whilst we were there. This Native, who seemed hardly thirty years of age, was at least 5 ft. 9 in. high; his form was athletic, with a martial air. He told me he had seen many English, and had been the companion-in-arms of Pomare, of Mata-ouwi [Matauri—Bay of Islands], that celebrated conqueror of New Zealand. The name of Shongui-Ika [Hongi-hika] was also known to him, but he said he had never seen him. [Pomare, here referred to, was the celebrated Nga-Puhi chief of that name, who made several warlike expeditions down the East Coast, the principal one in 1823, when possibly Shaki joined him. Pomare was killed on the Waipa River in 1826.]

* We borrow from the English the form *sh* to represent here and in the course of this work a sound intermediate in some sort between that of *j* and *ch* in French.

In spite of my precautions, it was plain how very nearly I had made an implacable enemy of Shaki. On returning ashore he might perhaps have avenged on the officers or the naturalists of the "Astrolabe" what he considered an affront offered to his dignity. This is what often occurs to Europeans, especially among a people so irritable, so vindictive, as those of New Zealand, where the chiefs are all independent, and very jealous of one another. This latter sentiment, which renders the position of Europeans so very uncertain, is carried beyond bounds among the Natives; they all want to profit exclusively in the advantages due to the visits of strangers, and are jealous at seeing their neighbours participate in them. We had a very extraordinary proof during our stay at Houa-Houa [this is the nearest D'Urville gets to Uawa, the proper name of Tologa Bay].

Whenever fresh canoes arrived, the first-comers harassed me with requests to fire on them, and kill those on board; nevertheless, so soon as the latter came alongside, the first-comers immediately entered into conversation with them, and received them as persons well known to them. . . . . I could not refrain from laughing at this singular behaviour, when all of a sudden a general movement, a sort of confused murmur, arose amongst the Natives; they cast unquiet glances overboard, and soon I saw the trouble was occasioned by the arrival of a canoe manned by seven or eight men only, among whom two seemed of superior rank. This time our guests prayed and supplicated me earnestly to shoot the new-comers; they went so far as to demand muskets to shoot them themselves—in a word, they employed all possible means to excite my anger against these strangers. Far from acceding to these sanguinary wishes, I felt more inclined to receive amicably those who were in such repute, and to assure them that they would be well received. They appeared to hesitate for some time, and, together with the evident desire to come on board, a shade of inquietude and suspicion was apparent. In the meantime the conduct of the other islanders towards them totally changed. Convinced that I would not concede to their prayers, they assumed a very respectful manner towards the new-comers. Shaki himself, until now so bold and most urgent that I should fire on them, changed his tone suddenly; he became modest and silent, and so respectful to the two strangers that he offered them some large hatchets which he had only acquired with much trouble, and to which he seemed to attach as much value as to his life. This procedure was followed by all those who had not had time to hide what they had received from us.

The two chiefs finally decided to come on board. I examined attentively their completely tattooed faces and their warlike and fierce attitude. I have never observed these double qualities so pronounced in any New-Zealander before, not even in the terrible Hihi, of Waimate. [Hihi was a well-known Nga-Puhi warrior and a very fleet runner. Much is to be found about him in "Wars of the Northern against the Southern Tribes in the Nineteenth Century."] I commenced to interrogate them, after having made friends with them by means of some presents, when all of a sudden they quitted me abruptly, entered their canoe, and pushed off. Having inquired the reason of this precipitate retreat, I found that the Natives already on board, Shaki at their head, had insinuated to the companions of these two chiefs that my intention was to kill them, and that their lives were not safe on board the ship, wishing at all costs to drive them away. These cunning savages could not imagine a better means than this fiction, and it succeeded. Despite this treachery, and anxious as to the consequences it might have, I rebuked those who had invented the story, and hastened to disabuse the strangers, and asked them to come aboard again. They appeared to place faith in my protestations; but, seeing that they had been deceived, they were exceedingly furious with the Natives on board, and although the latter were three or four times as numerous they defied them by words and the most outrageous gestures, and I saw that they challenged them to go ashore and render account for this insult. Those on board, gloomy and confused, hardly offered any words in reply.

The strangers would not return on board, but demanded some hatchets of me in a tone of authority. I replied calmly that if they would bring some hogs on board they should not want what they desired. On that they moved off without further communication with us. I felt a sincere regret, for it would have been easy to have questioned them and learnt the reason of their superiority over our first guests.

My first thought was that they belonged to a tribe at enmity; but they had presented themselves in too few a number to have dared to defy the others on board as they had done. Beyond that, the latter constantly denied that the former were their enemies; they ended, indeed, by saying, on the contrary, that they were friends and relatives. I observed that my questions in regard to this matter did not please them—generally they eluded them—above all, Shaki, who did all he could to turn the conversation to another subject.

In consequence of what I then learned of the manners and political constitution of these people, the following appears to me the most probable theory: As in all other parts of New Zealand, the Natives of Houa-Houa [Uawa] live in small independent groups, under the direction—or, rather, under the protection—of their own particular chiefs. Without doubt those who first arrived belonged to some feeble tribe, whilst those of the later canoe belonged to one more powerful, commanded perhaps by some redoubtable *ariki* like Shougui [Hongi] at the Bay of Islands, and Poro on the north part of the Ika-na-Mawi [Te Ika-a-Maui]. The first-comers, fearing to see their neighbours take from them, in consequence of their credit and opulence, the treasures of Europe, and wishing to obviate loss, tried to avoid this by at first engaging us to fire on them, and afterwards by persuading them that my intention was to destroy them. Thus may be explained the arrogance of the strangers, as well as the surprising patience with which the others listened to their reproaches and provocations. Among this people, as everywhere, a too-powerful ally is often more feared than an enemy that one might oppose with equal arms.

The only prepared head (*moko mokai*) which we saw here was brought in that canoe, and purchased for a little silver, valued at about the price of a few beads of coloured glass. It had been well prepared and conserved, and had belonged to some distinguished person. It is a pity that it has not been taken to France, for it very well illustrated the fine type of the people, and the design of a complete tattoo.

Here we mad the acquaintance of the *Pihe* [D'Urville had learnt this well-known funeral dirge on his previous visit to the Bay it is printed in Kendall's "Grammar"], though Shaki could only recite some portions, which he repeated uniformly, and often twenty or thirty times following. But Rau-Tangui [Rau-tangi], a very sprightly young woman of twelve or thirteen years, and who was singularly attached to me, recited it almost completely, as it is found in the grammar of the missionaries. Both were agreed in confirming the fact that it is the prayer addressed to the grand *atua* of heaven when the sacred food is offered on the field of battle. [Rather is it a dirge sung over the great dead.]

Young Rau-Tangui appeared to be intimately connected with Shaki, but it was impossible for me to learn whether she was his slave or his sister. Their responses to my questions varied at each instant and left me in incertitude. With the system of adoption prevailing amongst them, it seems possible that both were correct, and that in fact the father of Shaki had espoused one of his prisoners, mother of Rau-Tangui. That little girl was extraordinarily lively; her body was in constant movement, and her imagination was equally active, for we saw her laugh, then cry, and often do both almost at the same moment. Many of her companions offered their favours indiscriminately to the officers and sailors for any kind of trifle: but it is well to be on one's guard, for these ladies, following their constant practice, not content with voluntary tributes given to them, added all they could steal. Thus one of our gallant chevaliers saw his watch disappear all at once, to his great consternation, and subsequently found it in the hands of the honest Shaki, for it is ordinarily to the supreme chief all these objects accrue.

Our two passengers from Tera-Witi [Palliser Bay] had made acquaintance with the inhabitants of Houa-Houa [Uawa], and Tehi-Noui had decided to remain with them. I confirmed him in that resolution, and gave him, at his request, a cartridge of powder, in order to satisfy the *rangatira* under whose protection he pretended to be, and who was to furnish him with a canoe to enable him to return home. As a fact, after muskets (*pou*) [*pu*], more precious than gold or diamonds amongst us, powder is the object most essential in their eyes.

Koki-Hore appeared little satisfied with this determination, preferring to remain on board, but honour prescribed that he should follow his chief.

All the morning it had been nearly calm, and I hoped to pass the night tranquilly at anchor, when at 6 p.m., with a light breeze from the W.N.W., we found that our anchor was dragging. Twenty fathoms of chain that were paid out instantly did not stop us. I concluded that our anchor was foul. We were rapidly approaching the breakers of Moui-Tera (Sporing Isle of Cook), and I could not hope to let go a second anchor, for fear of exposing our cable to become fouled with the chain at the turn of tide. I decided, therefore, to get under sail and out of the bay. At the same moment our two boats came off, and my decision was without doubt the safest.

There remained on board fifteen Natives, of whom five or six were females, who had allowed their canoe to depart, with the intention of passing the night with us. They were at first very much alarmed, and thought we were going to carry them off. I endeavoured to reassure them by explaining the reasons that forced me to quit the anchorage so hastily; then they resumed their confidence and gave us a representation of one of their dances and passed the night in gaiety.

Shaki, Rau-Tangui, and two other *rangatiras* gave me very minutely the names of the different parts of the coast from Cape Gable (Pa-noui-Tera) [Pari-nui-te-ra] up to the East Cape (Wai-Apou). [Wai-apu River is about eight miles south of the cape in reality.] Sporing Island is Moui-Tera, and White Island, on the right of the bay in entering, is Motou-Heka. It is worthy of remark that the names of Tologa and Tegadou are quite unknown to the Natives; but it has long since been averred that Cook, so full of sagacity otherwise, had little aptitude in acquiring the names of

Fig. 1.

Fig. 2.

Fig. 3.

D'URVILLE AT TOLOGA BAY.—Smith.

Face p. 136.

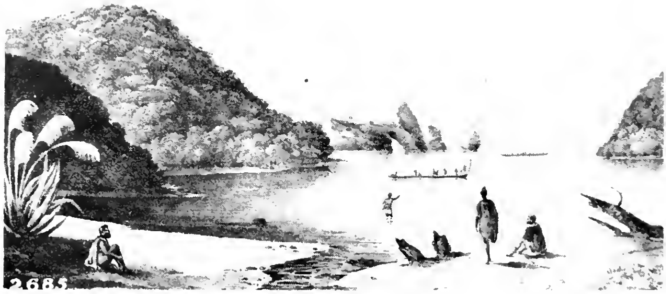

Fig. 1.

Fig. 2.

Fig. 3.

D'URVILLE AT TOLOGA BAY.—Smith.

the peoples he visited, and, above all, in representing them in writing.* The true name of the bay, Tologa, or, at least, of the district which surrounds it, is Houa-Houa [Uawa], and it is that which we have adopted. On the Isle Moui-Tera we were able to view at our ease those singular arches, formed by nature or the effect of the waves, which had already attracted the attention of Cook and his companions.

I sincerely regretted being constrained to quit this place so promptly, for I had promised myself much pleasure in making some excursions. To judge by the account of Cook and his companion Banks [Sir Joseph Banks, F.R.S.], the surrounding country is very picturesque; and, beyond that, the Natives of the district, still practising their original customs, and barely as yet influenced by their intercourse with Europeans, would have been for me a subject of interesting study and observation.

It was here that I obtained the first positive information on the subject of the kiwi, through a mat ornamented with plumes of that bird, and which is one of the first objects of luxury of the Natives. According to them, the kiwi is a bird of the size of a small dindon, but, like the ostrich and the cassowary, deprived of all means of flight. These birds are common in the neighbourhood of Mount Ikou-Rangui [Hiku-rangi]. It is by night, with torches and dogs, they are caught. It is probable that these birds belong to a genera closely allied to the cassowary, and I believe it has already received the name of *Apteryx* by some authors. M. Quoy brought me a leaf of a species of palm which I had already observed in Tasman's Bay. Unluckily, it had neither fruit nor flowers, so I have not been able to recognise to what genus it belongs; all I can say is that I am inclined to believe it is allied to the *Zamia* or *Seaforthia* of Australia. It is the same vegetable without doubt that Cook designates "chou-palmiste" [? cabbage-palm], for there are no true "arequers" [? areca palms] in these parts.

The latitude which results from the observations of MM. Jacquinot and Lottin is found to be 33° 22′ 32″ S., which differs only 8″ from that found by Cook; and the longitude is 176° 5′ 35″ E. [east of Paris].

Although we did not remain long in this anchorage, I do not consider it other than as a good one, so long as there is no appearance of wind from the north to the east; only it is necessary to anchor at a cable's-length or two more to the west, towards the bottom of the bay. I was prevented from doing so by the double desire to make sail easily and to be nearer to succour our people at the observatory if that became necessary.†

6th February, 1827.—A light breeze from the N.W. prevailed all night, and we passed it peaceably, lying-to in 35 fathoms, sandy mud. At 4.5 a.m. I sent the two smaller boats, under the orders of MM. Lottin and Dudemaine,‡ to measure a base in Houa-Houa Bay, the only element still wanted

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* This is perfectly true; it is rare that Cook ever comes near the proper Native names of places, either in New Zealand or other parts inhabited by the Polynesian race; whilst D'Urville is more often right than wrong.

† M. Quoy (the celebrated naturalist) says, in regard to Cook's Cove, Tologa, "That little bay is too open to be much peopled. We were surrounded by a considerable number of canoes, among which were some very fine ones, containing thirty paddlers. Their manner of paddling is to sit, and this gives to these vessels as much elegance as majesty: they have no outriggers, and their bottoms are made of a single tree-trunk." . . .

‡ M. Lottin describes his visit ashore to measure a base, as follows: "The calm which prevailed permitted the two boats to advance rapidly towards the bay. Our passengers attentively studied with curiosity each article in the whaleboat, and explained to each other its use, and their reflections thereon. Our long oars at first attracted their attention, and they followed with the head their regular movements, uttering

by the first of those officers to complete his plan. At the same time I sent ashore twelve of the Natives with whom we were still charged. Amongst that number were Tehi-Noui and Koki-Hore, who here took leave of us, and to whom I gave a quantity of powder—double that which I had promised. In seeing them depart I had sincere wishes for their safe return. If they were destined to reach their own country, I felt sure they would soon forget their *ennui* on board, and that they would recall with pleasure the friendship and good treatment they had received.

There remained on board only Shaki, Rau-Tangui, and two other chiefs, whom I was glad to retain in my power until the return of the two boats. At this time there arrived alongside a great number of canoes laden with provisions, which the Natives disposed of peaceably and with great good faith. They had many pigs, potatoes, and much *Phormium* fibre, all of which we bought at reasonable prices. Towards 11 a.m. the boats returned on board, and I hastened to put to sea to get rid of the Natives, whose cries and babbling with the crew commenced to be excessive. We parted very

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cries to excite the ardour of the sailors, and presently themselves giving a hand with noisy gaiety. They pulled so hard that, fearing to see the oars broken, I requested them to remain as spectators of the operations. One of them, with an expressive pantomime, undertook to demonstrate to us the superiority of their paddles over our oars; these last seemed to them of an inconvenient length, and required several men to move a boat, whilst a single paddle would make a canoe fly, by using the paddle on alternate sides. Another Native observed that each sailor turned his back to the direction in which he was going, which made them all laugh heartily. Their attention was also drawn to other objects. The rudder struck them particularly, and they gravely considered its utility, with frequent marks of approbation. The tiller was confided for a moment to one of them, and the promptitude with which it changed the direction of the boat in its rapid pace ravished them with admiration. I steered for the north point of the bay, a route which made us pass along the reefs that separate Motou-Heka [Motuheka] and extend a mile and a quarter to the N.E. They form a line of rocks near which are to be found 7 to 11 fathoms of water; we passed within a few feet. These reefs are covered with several species of limpets, and I regretted not having time to land. Not having more than a few moments to pass ashore, I took from its case Rochon's micrometer. The brilliant colour of the brass suddenly attracted the attention of the Natives. I placed before the eye-piece a coloured glass, and, holding it to the eye of my neighbour, I succeeded with some trouble in making him see the disc of the sun. He explained at once to his companions that he saw the sun coloured red, without being dazzled. I then replaced it with a green glass—another surprise. Lastly, I moved the crystal prism, and the disc appearing double excited a cry of astonishment. Each one desired to have the eye-piece in his hands, but we approached the land and their curiosity was thus not satisfied. I wished to debark our passengers before a little village. Twenty houses and nine canoes hauled up on the beach denoted a village of about one hundred persons. They came running down to receive us without arms. Some rocks bordering the coast prevented our coming close. They offered to haul the boat on to the shore, which usage is probably considered an honour in this country, for our guests received the proposition with cries of joy. But I had no desire to abandon myself to the discretion of fifty strong and jolly fellows, who were already in the water up to their waists. Seeing that they insisted, I made use of a ruse to get rid of them: I traversed rapidly an inlet somewhat deep, landed the Natives, took the micrometric distances which I wanted, and was in the boat again, to the great disappointment of the crowd, which had been forced to run round the inlet, arriving just in time to see us depart. Some young men defied us by chanting their war-song; but we were by that time at ease, and there was not a single stone on the rocks, which the waves clear off each tide. I fired a shot to inform the second boat that our operations were complete, and it rejoined me on the way to the corvette. M. Dudemaine, who commanded it, had been troubled by the Natives; they, fully armed, surrounded the boat with their canoes, endeavouring to take anything which fell into their hands, and refusing obstinately to sell any of their arms; the muskets, above all, excited their cupidity. The distance from the corvette rendered them daring, and no doubt if the boat had been alone they would have proceeded to some violence."

good friends, though they were much concerned to see that I would not return to Houa-Houa.

I observed that the term "New-Zealander" is already employed in this district: only, in lieu of "Noui-Tireni," as the Natives of the Bay of Islands pronounce it, they say "Noui-Tirangui" [Nui Tirangi], which gives the word more of an indigenous sound. The word *pakeha* serves them to signify all whites, whom they also call "Iouropi" (European). I did not observe that they had any special name for the English. They use *ariki* for a principal chief, and *tohunga* (prophet [*sic*]) appears unknown to them.

We had nothing but feeble breezes from the north to north-east, with calms, which did not allow us to make much way. At about 3 p.m. a large canoe, which had for a long time been approaching us, came alongside. The principal person came on board, and accosted me with an ease and grace which proved that he was accustomed to deal with Europeans. He told me his name was Oroua [Te Rere-horua, in reality], and that he was the principal chief of the *pa* at Toko-Malou [Toko-maru], probably the Tegadou of Cook. This chief conserved the knowledge by tradition of the visit of that navigator to Houa-Houa and Taone-Roa [Te One-roa—Poverty Bay].

I had Oroua to dinner with me, who appeared much flattered with that favour, and comported himself with perfect propriety. At my demand he recited very correctly the last part of the *Pihe*; we spoke much of the different chiefs of the Bay of Islands, and he appeared well acquainted with the wars that divided the northern people. After the repast he conjured me to anchor for at least twenty-four hours near his home. To induce me to do so he offered me gratuitously two fine pigs. I thanked him politely, and bought them for the ship. His canoe contained more than twenty of these animals, but as we had bought at Houa-Houa all that we could accommodate no one wanted to buy there. Notwithstanding, the companions of Oroua were very desirous of selling, so as not to have to take them back, and therefore parted with them in exchange for knives. . . .

[From Toko-maru the "Astrolabe" continued her voyage round the East Cape and to Whangarei without communicating with the shore. At the latter place we propose to take up D'Urville's narrative, and allow him to describe his visit to Wai-te-mata, the present site of Auckland. With regard to the two Natives, Te Hi-nui and Kiore, whom D'Urville landed at Tologa Bay, inquiries instituted in 1896 show that they finally made their way overland to their homes: but they must have run great risk, for at that time the devastating incursions of Waikato, Taupo, and Ngati-Rau-kawa had commenced and the Hawke's Bay country was not a safe one for strangers to travel in.]

EXPLANATION OF PLATES XIII AND XIV.

PLATE XIII.

Fig. 1. Village in Astrolabe Bay, Tasman Bay.
Fig. 2. "L'Astrolabe" in the French Pass, 1827.
Fig. 3. Te Hinui (on the left), Kiore (on the right).

PLATE XIV.

Fig. 1. Cook's Cove and Sporing Islands, Tologa Bay, 1827.
Fig. 2. Captain Cook's watering-place, Cook's Cove, Tologa Bay.
Fig. 3. War-dance on board "L'Astrolabe," Tologa Bay, 1827.

Art. XXIV.—*Description of a New Species of* Epilobium.

By D. Petrie, M.A.

[*Read before the Auckland Institute, 18th November,* 1908.]

Epilobium Cockaynianum, sp. nov.

E. herbaceum flaccidum cæspitosum.

Caules 10–15 cm. longi, erecti v. basi decumbentes, deinde ascendentes, plus minus ramosi, pallidi v. sub-erubescentes, bifariam puberuli, teretes, interdum superne omnino pubescentes.

Folia floralibus exceptis opposita, conferta, 13 mm. longa, 8 mm. lata, tenuia, late ovata v. ovato-elliptica, obtusa, glabra, remote et obscure v. vix denticulata, breviter petiolata; nervo medio haud prominente, nervis secundariis nullis.

Flores 1–3 in ramis singulis, in axillis foliorum superiorum dispositi, circa 6 mm. longi; calycis laciniis lanceolatis, acutis; petalis albis v. roseo-albis, calyce ½ longioribus.

Capsularum pedicelli fructu maturante elongantes, demum 2–4 cm. longi, graciles, rubelli, plus minus puberuli.

Capsula glaberrima, brunnea, 2½–3½ cm. longa; testa glabra.

Hab.: Mounts Hector and Holdsworth, in the Tararua Range, at 3,300 ft. and upwards; very plentiful on Mount Holdsworth.

The present species is most nearly allied to *E. alsinoides*, A. Cunn., and *E. Hectori*, Haussk. It is likely that the Ruahine Range plant referred by Cheeseman to the latter ("Manual New Zealand Flora," p. 177) properly belongs here. *E. Hectori* I believe to be confined to the South Island.

Art. XXV.—*Notice of the Discovery of a Species of* Burmanniaceæ, *a Family New to the New Zealand Flora.*

By T. F. Cheeseman, F.L.S., F.Z.S., Curator of the Auckland Museum.

[*Read before the Auckland Institute, 18th November,* 1908.]

The flora of New Zealand, as regards the flowering-plants, has now been so well explored, and its composition so well ascertained, that much novelty cannot be expected, although isolated discoveries will doubtless be made from time to time. Under these circumstances, the addition of another family of plants to those already known to occur in the Dominion cannot fail to excite considerable interest. No apology is, therefore, required for submitting the following notice of its discovery to the Institute.

In January, 1903, Mr. H. Hill, of Napier, so well known from his numerous papers on the physiography and geology of the central volcanic plateau of the North Island, forwarded to me a single specimen of a plant found by him at Opepe, near Lake Taupo, which from its habit and general appearance I at once provisionally referred to the *Burmanniaceæ*. Positive identification, however, was quite impossible, as the whole of the interior of the flower, including the stamens, upper part of the ovary, and the style and stigma, had been removed through the attacks of some insect. The discovery induced me to make a special journey to Lake Taupo, in which I was accompanied by Mr. Hill; but, although a long search was made in the locality where the first specimen had been obtained, another damaged specimen was all that could be found. In January, 1905, I made another search for the plant at the southern end of Lake Taupo, but entirely without success. In January, 1907, Mr. Hill paid another visit to Opepe, accompanied by Mr. A. Hamilton, of Wellington. On this occasion he was fortunate enough to find a considerable number of specimens in full flower, most of which he very kindly forwarded to me. An examination of these proved that the plant had been correctly referred to the *Burmanniaceæ*, and that it must be included in the subfamily *Thismieæ*, which differs from the rest of the *Burmanniaceæ* in possessing both the inner and outer whorls of stamens, and in the unusually large development of the anther-connective. It further appeared that there was little to separate Mr. Hill's plant from the genus *Bagnisia*, as amended by Engler in "Die Naturlichen Pflanzenfamilien" (vol. ii., part 6, p. 48), where it is made to include both *Bagnisia* and *Geomitra* of Beccari ("Malesia," vol. i, pp. 249–50, tt. 10–12), the only difference of importance being that in *Bagnisia* and *Geomitra* three of the perianth-segments are wanting, or reduced to mere rudiments; whereas in the New Zealand plant they are well developed, being quite half the length of the inner segments. In this respect it agrees with the genus *Thismia*, but differs in the inner perianth-segments being dilated and connivent at the tips, exactly as in *Bagnisia* and *Geomitra*. In the position of the stamens and the structure of the anther it agrees with *Geomitra*; in fact, the anther-connective of *Geomitra episcopalis*, as figured by Beccari, very closely resembles that of the New Zealand plant. If, therefore, Engler is to be followed in merging *Geomitra* with *Bagnisia*, it appears to me that the New Zealand plant should be placed in the latter genus. In a recent number of the "Kew Bulletin" I have therefore applied the name of *Bagnisia Hillii* to the plant. It gives me great pleasure to associate Mr. Hill's name with the species, as some slight recognition of the long-continued interest he has taken in New Zealand botany, and of his unwearied kindness in supplying both Mr. Colenso and myself with specimens of many interesting plants collected during his journeys in the interior of the North Island. The following description will enable the species to be recognised:—

Bagnisia (Geomitra) Hillii, Cheesem. in "Kew Bulletin," 1908, p. 420.

A minute colourless saprophyte, perfectly smooth in all its parts; leaves wanting or reduced to minute scales. Rhizome creeping amongst humus at the base of tall forest-trees, sparingly or copiously branched, 5–10 cm. long, 1–1·5 mm. thick, fleshy, naked. Peduncles springing from the axils of minute fleshy bracts, 1-flowered, erect or curved, 0·5–1·5 cm. long; bracteoles 3–7, alternate, lanceolate or ovate-lanceolate, acute or acuminate, the upper gradually larger, 1–5 mm. long. Flowers solitary, terminal, large for the size of the plant, 1–1·7 cm. long, about 0·7 cm. broad, bright rose-pink when fresh. Perianth campanulate-lanterniform; tube obovate-oblong, distinctly 6–12 costate; outer perianth-segments smaller, free, linear or oblong, at first erect but ultimately spreading, sometimes abruptly recurved. Inner segments almost twice the length of the outer, linear-spathulate to obovate-oblong, connate or connivent at the tips, gaping in the middle, keeled on the back, with the keel produced into a subulate point at the tip. Stamens 6, affixed to the throat of the perianth-tube, shortly exserted, abruptly deflexed within the tube; filaments very short, free; anther-connectives much enlarged and expanded, connate into a membranous tube which is bilamellate at the apex; anther-cells small, distinct, towards the base of the tube formed by the connectives. Ovary inferior, broadly obovoid, 1-celled; placentas 3, free; ovules very numerous; style short, thick; stigma 3-lobed, the lobes broad, almost quadrate, concave, truncate at the tip. Fruit unknown.

Hab.—Primeval woods at Opepe, near Lake Taupo; alt., 2,000 ft.; *H. Hill.* Flowers in January.

Bagnisia Hillii is usually found on the mound of decaying leaves and humus which accumulates at the base of the trunk of the kahikatea pine (*Podocarpus dacrydioides*). On account of its small size it is easily overlooked, even in the flowering season, the flowers being often partially concealed by fallen leaves. Once noticed, however, the bright rose-pink colour of the flowers enables the observer to pick it with ease. Like many of the *Burmanniaceæ*, the flower has a most bizarre appearance. The three inner perianth-segments, widely separated in the middle, but closing together and connivent at the tips, give it somewhat the appearance of a bishop's mitre, or perhaps of a lantern with three elliptical windows or openings. In the bud, or in the newly expanded flower, the three outer segments partly close these openings, but they gradually spread outwards, and ultimately (judging from specimens in formalin) become sharply reflexed. The structure of the anthers is most peculiar, and deserves careful study. As stated in the description, the connectives are enormously enlarged, and are connate into a broad membranous tube, which, owing to the curious manner in which the stamens are deflexed, lies parallel with the inside of the perianth-tube, the tips of the connectives pointing to the base of the flower, and the minute anthers opening into the narrow space between the connective-tube and the wall of the perianth-tube. The connective-tube is split into two delicate lamellæ at the apex, and the outer lamella of each connective is 2-lobed, with a slender bristle arising from the bottom of the sinus. On the commissure of each connective, but on the inner face of the lamella, is a small oblong gland. The inner lamella is very delicate, and has an undulate margin fringed with delicate cilia.

It is difficult to see how pollination is effected, seeing that the minute anthers, which only produce a small quantity of pollen, are hidden away at the back of the connective-tube, in a narrow passage to which access can only be obtained through the small openings between the short filaments, just at the entrance of the flower, or by crawling up behind the connective-tube from the base of the flower. It is significant that many flowers are found partly eaten by insects. Can it be that the conspicuous coloration of the flower and its juicy texture attract minute insects, which, while destroying certain portions of it, pollinate the short stigma at the base of the flower? It is much to be desired that some local observer would work out the fertilisation of the plant in detail.

Considerable attention has been paid to the *Burmanniaceæ* of late years, the American species in particular having been worked up by Warming, and by Urban in his elaborate "Symbolæ Antillanæ." Part 2 of the "Nachtrag" to Engler and Prantl's "Naturlichen Pflanzenfamilien," page 72, contains a brief sketch of a new classification of the family, from which it appears that sixteen genera, with about seventy-five species, are now known. Nothwithstanding the small size of the family, it has a wide distribution in the tropics, its chief development being in Brazil and Malaya. Northwards, it stretches as far as China and Japan in Asia, and Virginia in America. In the Southern Hemisphere the New Zealand species appears to be the only one yet detected outside the tropics.

The subfamily *Thismieæ*, into which *Bagnisia* falls, now contains four genera and about fifteen species. Seven of these are from Brazil; the remainder come from Ceylon, Borneo, and New Guinea. The discovery of an additional species in New Zealand, so far removed from the two centres of distribution of the subfamily, is a decidedly unexpected and somewhat puzzling fact in geographical distribution.

ART. XXVI.—*Some New Zealand Fossil Cephalopods.*

By Professor P. MARSHALL, M.A., D.Sc., F.G.S., University of Otago.

[*Read before the Otago Institute, 10th November, 1908.*]

HOCHSTETTER first discovered the remains of cephalopods in the Jurassic rocks of Kawhia. He described the species of *Ammonite* as *A. novo-zelandicus*. Two species of belemnites were also described.

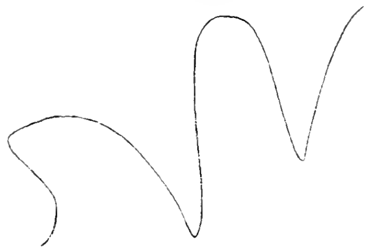
In later years Hector has added several species of belemnites to those named by Hochstetter. The occurrence has been frequently recorded by Cox, McKay, and others in the rocks of the Hokonui Hills and of Kawhia. No descriptions of these have yet been written. The species here described were collected by Mr. R. Browne and the writer in the Hokonui Hills, behind Mandeville, and by Mr. Browne near Te Puti Point, in the Kawhia Harbour. The strata in the former locality have been classed as Permian or Triassic by Hector, and in the latter they have been regarded as Jurassic by all authorities.

Broncoceras mandevillei.

Diameter, 9½ in.; breadth, 3½ in.

Surface ornamented with longitudinal and transverse striæ, giving a knotted appearance to its surface. Deeply involute. Some specimens slightly constricted towards the ventral surface; others flattened. Siphuncle not discernible even in the best-preserved specimens. Siphonal lobe somewhat acute, but less so than the interior lateral lobe.

Rather frequent in the Hokonui Hills. This appears to be the organism called in the Geological Survey reports "Palænautilus."



Part of Suture-line of *Broncoceras mandevillei.*

Part of Suture-line of *Arcestes hokonui.*

Arcestes hokonui, n. sp.

Diameter. $2\frac{3}{4}$ in.: breadth, $1\frac{1}{2}$ in.

Deeply involute, not compressed. Surface smooth, except for distant lines of growth.

Phylloceras kawhiæ, n. sp.

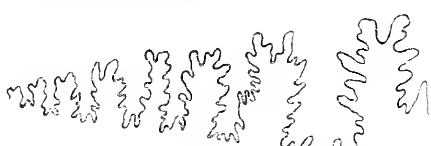
Diameter, $5\frac{1}{2}$ in.; breadth, 2 in.

Deeply involute, somewhat compressed. Shell smooth, except for rather distant lines of growth. No keel.

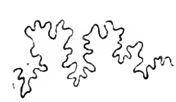
Ægoceras brownei, n. sp.

Diameter, 2 in.; breadth, $\frac{3}{4}$ in.

Surface marked with transverse ridges, which bifurcate near the venter. Form *Anarcestes*-like.



Suture-line of *Phylloceras kawhiæ.*



Suture-line of *Ægoceras brownei.*

Orthoceras brownei, n. sp.

Diameter. $1\frac{1}{2}$ in.: length, not known.

Septa $\frac{1}{3}$ in. apart. Surface smooth. Siphuncle not seen.

Orthoceras otapiriensis, Hector (?).

Diameter, 3 in.; length, not known.

Septa $\frac{3}{4}$ in. apart. Surface smooth. Siphuncle not seen.

This organism appears to be identical with Hector's *Belemnites otapiriensis*, which is described as in all cases of a phragmacone without any guard. He records this form as abundant in the Hokonui Hills, the locality from which this specimen came.

It is remarkable that such genera as *Broncoceras* and *Orthoceras* should be found in strata of such late periods. The former is associated with such a curious assemblage of genera that it is extremely hard to suggest any period to which they could all belong. Among these genera are *Ostræa*,

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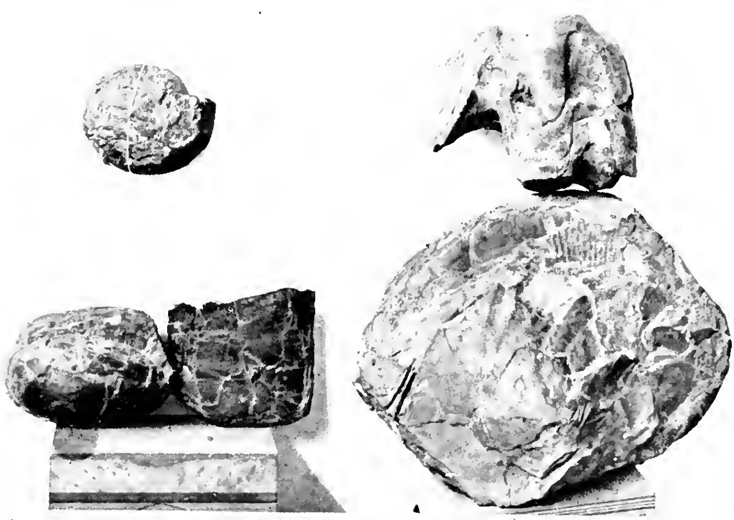

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NEW ZEALAND FOSSIL CEPHALOPODS.—Marshall.

Face p. 111

Gryphæa. Trigonia, Halobia, and *Spiriferina*. Since several of these are not known in strata older than the Jurassic, it is probably right to class these strata as Jurassic, thereby ignoring the presence of the archaic genera here mentioned. This conclusion seems all the more reasonable when the present isolated position of the Dominion is considered. It is quite possible that another period of isolation had terminated at the beginning of the Jurassic period. An old fauna which had lived on during the period of isolation would then be mingled with the invading newer and more vigorous types. Such an explanation might reasonably account for the rapid change in life-forms which has caused Sir James Hector to class a conformable series of rocks as of an age extending from Permian to Jurassic.

ART. XXVII.—*Notes on* Coleoptera *from the Chatham Islands.*

By Major T. BROUN, F.E.S.

[*Read before the Auckland Institute, 18th November, 1908.*]

A COMPLETE list of the *Coleoptera* now proved to occur in these islands is given for reference. It is just possible that some other species may have been described by European authors, but the list includes all that were recorded by the late Captain F. W. Hutton and those whose descriptions follow the list.

Eighteen species appear to be purely endemic at the Chathams; the remaining twenty-three were originally found in New Zealand. All the genera were instituted for the reception of New Zealand species, with the exception of such as are more or less cosmopolitan—eight or nine altogether.

None of the genera and species recently described by me from the Auckland Islands are represented, so far as we are aware at present, at the Chatham Islands, but I feel confident that some, or closely allied forms, will be discovered ultimately.

LIST OF COLEOPTERA FROM THE CHATHAM ISLANDS.

Group ANCHOMENIDÆ.

1. *Anchomenus submetallicus*, White, Man. N.Z. Coleopt., p. 24.
2. .. *chathamensis*, Broun, sp. nov.

Group COLYMBETIDÆ.

3. *Rhantus pulverosus*, Stephens, Man. N.Z. Coleopt., p. 1333.

Group STAPHYLINIDÆ.

4. *Creophilus oculatus*, Fabricius, Man. N.Z. Coleopt., p. 107.

Group HISTERIDÆ.

5. *Sternaulax zealandicus*, Marseul, Man. N.Z. Coleopt., p. 162.

Group Trogositidæ.

6. *Leperina wakefieldi*, Sharp, Man. N.Z. Coleopt., p. 179.

Group Colydiidæ.

7. *Rhitidinotus squamulosus*, Broun, Man. N.Z. Coleopt., p. 204.

Group Hemipeplidæ.

8. *Diagrypnodes wakefieldi*, Waterhouse, Man. N.Z. Coleopt., p. 217.

Group Lucanidæ.

9. *Lissotes capito*, Deyrolle, Trans. Ent. Soc., 1873, p. 339.
10. *Ceratognathus helotoides*, Thomson, Man. N.Z. Coleopt., p. 254.
11. *Mitophyllus reflexus*, Broun, sp. nov.

Group Melolonthidæ.

12. *Odontria zealandica*, White, Man. N.Z. Coleopt., p. 270.

Group Elateridæ.

13. *Thoramus wakefieldi*, Sharp, Man. N.Z. Coleopt., p. 280.
14. ,, *lævithorax*, White, Man. N.Z. Coleopt., p. 282.
15. *Mecastrus convexus*, Sharp, Man. N.Z. Coleopt., p. 293.
16. *Psorochroa granulata*, Broun, Man. N.Z. Coleopt., p. 773.

Group Cleridæ.

17. *Phymatophaea electa*, Pascoe, Man. N.Z. Coleopt., p. 334.

Group Heleidæ.

18. *Cilibe pascoei*, Bates, Man. N.Z. Coleopt., p. 372.
19. ,, *saragoides*, Pascoe.
20. ,, *subcostatus*, Sharp, Ent. Mag., April, 1903.

Group Œdemeridæ.

21. *Sessinia strigipennis*, White, Man. N.Z. Coleopt., p. 420.
22. *Thelyphassa diaphana*, Pascoe, Man. N.Z. Coleopt., p. 422.

Group Otiorhynchidæ.

23. *Cecyropa tychioides*, Pascoe, Man. N.Z. Coleopt., p. 437.
24. *Inophlœus traversi*, Pascoe, Man. N.Z. Coleopt., p. 439.

Group Erirhinidæ.

25. *Stephanorhynchus purus*, Pascoe, Man. N.Z. Coleopt., p. 463.

Group Cryptorhynchidæ.

26. *Psepholax sulcatus*, White, Man. N.Z. Coleopt., p. 479.
27. *Aldonus hylobioides*, White, Man. N.Z. Coleopt., p. 483.
28. ,, *chathamensis*, Sharp, Ent. Mag., April, 1903.
29. *Pseudoreda tibialis*, Broun, Man. N.Z. Coleopt., p. 482.
30. *Acalles fougeri*, Hutton, Trans. N.Z. Inst., 1897, p. 157.

Group Platypidæ.

31. *Platypus apicalis*, White, Man. N.Z. Coleopt., p. 541.

Group Cerambycidæ.

32. *Zorion minutum*, Fabricius, Man. N.Z. Coleopt., p. 584.
33. „ *opacum*, Sharp, Ent. Mag., April, 1903.
34. *Xuthodes punctipennis*, Pascoe, Man. N.Z. Coleopt., p. 580.
35. „ *divergens*, Broun, Man. N.Z. Coleopt., p. 581.

Group Lamiidæ.

36. *Xylotoles costatus*, Pascoe, Man. N.Z. Coleopt., p. 599.
37. „ *traversi*, Pascoe, Man. N.Z. Coleopt., p. 599.
38. „ *schauinslandi*, Sharp, Ent. Mag., April, 1903.
39. „ *abnormalis*, Sharp, Ent. Mag., April, 1903.
40. *Hybolasius trigonellaris*, Hutton, Trans. N.Z. Inst., 1897, p. 158.
41. *Tetrorea cilipes*, White, Man. N.Z. Coleopt., p. 609.

List of Introduced Species.

Aphodius granarius
Lacon marinus
Otiorhynchus sulcatus
Coccinella 11-punctata
} Recorded by the late Captain F. W. Hutton, Trans. N.Z. Inst., 1897, pp. 156–58.

Group Anchomenidæ.

Anchomenus chathamensis, sp. nov.

Suboblong, slightly convex, nitid, piceous; the legs, antennæ, and palpi rufo-piceous; lateral margins of thorax and elytra similarly rufescent.

Head oviform and, including the large eyes, rather broader than front of thorax; irregularly rugose behind the inter-antennal groove, smooth on the back part. Labrum large, entire. Antennæ with the basal 3 joints shining and glabrous, 2nd joint half the length of the 3rd. Thorax one-fourth broader than long, its sides with well-developed margins, moderately rounded, very gradually narrowed behind the middle, posterior angles nearly rectangular but obtuse, the base feebly rounded towards the sides, apex incurved; disc moderately convex, with feebly impressed striæ across it, dorsal furrow indistinct near the base and apex, near the front there is an indistinct transverse impression, basal fossæ large. Scutellum smooth. Elytra oblong, slightly and gradually widened backwards, slightly sinuate but evidently obliquely narrowed towards the apices; shoulders a little curvedly narrowed, yet rather wider than the base of thorax; the suture is somewhat elevated posteriorly, the 4 discoidal striæ on each elytron are well marked but impunctate, the outer ones are finer, 3rd interstices tri-punctate.

Tarsi setose, the anterior spongy underneath, their basal 2 joints moderately dilated and oblong, the 3rd also dilated but shorter and more narrowed near the base, 4th small and cordiform, basal joint of the posterior grooved along the outside. Palpi rather short, terminal articulation sub-cylindric.

Underside shining piceous, last ventral segment very broadly rounded, almost truncate, with a single setigerous puncture near each side at the apex.

♂. Length, $3\frac{3}{4}$ lines; breadth, $1\frac{1}{2}$ lines.

Chatham Islands; February, 1907.

One example, forwarded by Dr. W. B. Benham for identification. It is somewhat similar to *A. lawsoni*, but smaller and more depressed, the sides of the elytra more explanate behind, the thorax relatively larger and less rounded laterally; frontal foveæ indefinite, &c.

Group ÆSALIDÆ.

Mitophyllus reflexus, sp. nov.

Oblong, rather elongate; subdepressed, subopaque, piceo-rufous, margins of thorax and elytra and the legs infuscate red, sparingly clothed with flavescent setæ: antennæ, tarsi, and palpi red.

Head much narrowed behind the large and very prominent eyes, broadly depressed between the greatly elevated antennal tubercles, closely punctate. Mandibles rather small and broad, bifid at apex. Antennæ well developed, basal joint elongate, stout and much curved, 2nd very short, joints 3 and 4 equally elongate, 5th evidently shorter than the preceding one, 6th very short, 7th short and slightly prolonged towards the front; club composed of 3 long lobes, bearing numerous slender outstanding setæ. Thorax transverse, anterior angles obtusely rounded, the posterior rectangular: its sides explanate and obviously reflexed, apex subtruncate, base widely bisinuate; its sides almost evenly rounded, yet a little narrowed towards the front; its surface distinctly and closely punctured, less closely at each side of the middle in front, and having at the base a narrow elongated smooth space. Scutellum large. Elytra oblong, parallel-sided, with a depression inside each shoulder: they are closely and distinctly punctured, and exhibit 3 or 4 feebly impressed longitudinal striæ. Tibiæ elongate, the intermediate curvate and finely asperate, the anterior subserrate externally, with a very small denticle above the middle and not in the least protuberant at the extremity. Tarsi slender and elongate, basal joint of the posterior short, 2–4 decrease in length, all however unusually long, the terminal slender and as long as the preceding 3 united; claws very long and slender.

♂. Length, $4\frac{1}{4}$–5 lines; breadth, $1\frac{1}{2}$–2 lines.

Chatham Islands.

Described from two specimens found by Professor W. B. Benham in February, 1907. They differ in almost every detail from the typical New Zealand species (*M. irroratus*). The very prominent eyes, explanate and reflexed thoracic margins, and strongly elevated antennal tubercles are sufficient for immediate identification.

Cilibe saragoides.

Oblong-oval, moderately convex, subopaque, piceous, elytra more rufescent, tarsi and antennæ pitchy-red.

Head closely punctate. Thorax transverse, its sides broadly concave, with reflexed margins, gradually narrowed towards the anterior angles, which extend beyond the front of the eyes, near the base they are straight, the posterior angles being subacute, directed backwards, and resting on the elytra; base slightly and widely bisinuate, the apex deeply incurved; the disc finely and not closely punctured, more closely and coarsely but not deeply at the sides. Scutellum broadly triangular, with a few minute punctures. Elytra transversely convex, their sides very broadly expanded and reflexed, becoming less so near the middle, still narrower behind, and simple at the extremity, the base is broader than that of the thorax, they are slightly but widely sinuate before the middle femora; the broad grooves are opaque, with irregular punctures, so that the finely punctured interstices, which are slightly shining, appear somewhat costiform; the broad marginal channels are indistinctly sculptured, there is no perceptible granulation; near each side, at the base, there is a broad impression, which, however, may not be a constant character.

The broadly expanded sides distinguish this species.

Length, $5\frac{1}{4}$ lines; breadth, $2\frac{1}{2}$ lines.

Pitt's Island.

My specimen was presented to me over twenty years ago by the late F. P. Pascoe, who, no doubt, had described it under the name I have attached to it; its description, however, I have not seen.

DESCRIPTIONS OF COLEOPTERA FROM THE CHATHAM ISLANDS, BY DR. D. SHARP, COPIED FROM THE "ENTOMOLOGISTS' MAGAZINE" FOR APRIL, 1903.

Group HELEIDÆ.

Cilibe subcostata.

Nigra vel picea, minus depressa, fortiter sculpturata, opaca, elytris evidenter subsulcatis.

Long., $13\frac{1}{2}$ mm.

This is distinguished from all the other species by the peculiar sculpture of the elytra, which, however, is only an exaggeration of what we find in some other forms. The front angles of the thorax are much produced, and the sides are much explanate, their margins a little sinuate; the hind angles much produced backwards and markedly acute; the punctuation at the sides is very dense, on the disc it is scanty, but the surface is not in the least shining. The elytra are rather short, and have a vague costation, the very slightly elevated ribs are separated by coarse punctures; this sculpture sets off and makes evident the ribs.

Professor Schauinsland found a small series of this species. It is nearest allied to *C. pascoei*, Bates, of Pitt's Island, a species which was also met with there by the German traveller. *C. pascoei* is, however, rather more elongate and less convex in form, and with the sculpture of the elytra different, there being merely traces of the longitudinal ribs. Professor Schauinsland's specimens are intensely black, being considerably darker in colour than Mr. Bates's type. I have dissected the sexes of *C. subcostata*, and do not find any external marks to distinguish them.

Group CRYPTORHYNCHIDÆ.

Aldonus chathamensis.

Ferrugineus vel piceus, setis erectis numerosis superne vestitus, haud squamosus, rude sculpturatus; subtus setosus, inter setas squamis perpaucis munitus.

Long., $7\frac{1}{2}$–13 mm.

Distinguished from *A. hylobioides* and all the other species ascribed to the genus by the absence of scales from the surface. The rostrum is longer than it is in *A. hylobioides*; it bears fine erect hairs, but in consequence of the absence of scales its coarse sculpture can be distinctly seen. Thorax very rough, with tubercular sculpture, with fine, short, erect hairs, and with still shorter, very slightly curved, thicker, more pallid setæ, which represent the squamosity that is so remarkable in the other species. The elytra are rather deeply striate, and the striæ have very large punctures, separated only by short intervals one from the other.

Chatham Islands: Professor Schauinsland.

Group Cerambycidæ.

Zorion opacum.

Fusco-testaceum, supra submetallico-nitens, sericeo-subopacum; antennis pedibusque testaceis, his femoribus basi excepta rufo-obscuris, illis fusco-annulatis; elytro singulo ante medium fascia pallida transversa marginem lateralem fere attingente.

Long., 4–5 mm.

This comes very near to *Z. minutum*, but is distinguished by the peculiar pallid suffused colour and the silky dullness of the surface. The thorax, instead of being polished, is dull, and covered with a slight sculpture, a sort of minute wrinkling of the surface. The elytra are rather longer than in the other species.

Chatham Islands; Professor Schauinsland. Three specimens.

The British Museum collection includes a specimen of this species said to be from Otago. This locality I think very doubtful.

Group Lamiidæ.

Xylotoles schauinslandi.

Fusco-rufus, supra viridescens, nitidus, antennis pedibusque rufis; elytris tricostatis, costis at apicem fere dualis, interstitiis irregulariter interruptim costatis.

Long., 10 mm.

This species comes very naturally between *X. traversi* and *X. costatus*. It is not half the size of the latter; but is a little longer than *X. traversi*, more elongate, with the sculpture more developed, and the costation continued near to the tip. Of the forms found on the mainland, it is perhaps nearest to *X. rugicollis*, but it is very different in colour, and the elytra are singly rounded at the tip. The thorax is elongate and subcylindric, and bears 2 transverse channels; otherwise it is very indistinctly sculptured. The scutellum is covered with pallid pubescence. The elytra have each an elevated rib running along the suture, and outside this 3 others, the space between bearing much coarse irregular sculpture; the 3rd costa is itself divided behind the shoulder so as to fork somewhat, and form, in fact, 2 costæ. The ventral segments have each a conspicuous spot of yellow pubescence at the side.

The four specimens found by Professor Schauinsland differ but little, and the British Museum collection has two others.

Chatham Islands; Professor Schauinsland.

Xylotoles abnormalis.

Minutus, brevis, testaceus, pallidus, tomentosus; thorace fortiter transversus; corporis latera longitudinaliter fuscescente.

Long., 5 mm.

This minute Lamiid looks like a *Hybolasius*, but as it is flightless I place it in *Xylotoles*, where it will come near to *X. huttoni*. The front of the head is very low, and the mouth much inflexed. The antennæ have the 3rd and 4th joints very elongate, the 4th a little the shorter, but quite twice as long as the 5th; from this to the end each is slightly shorter than its predecessor. The thorax is scarcely so long as broad, infuscate at the sides and across the middle. The after-body is short, the elytra covered with minute tomentum, which allows, however, numerous small pits to be seen; they are pallid, but at each side there is a large irregular dark patch, which beyond the middle approaches near to the suture. Under-surface infuscate. Femora short and thick, yellow, with dark marks.

Chatham Islands; Professor Schauinsland. Two specimens.

Art. XXVIII.—*Revision of the New Zealand* Cossonidæ, *with Descriptions of New Genera and Species.*

By Major T. Broun, F.E.S.

[*Read before the Auckland Institute, 18th November, 1908.*]

Owing to the difficulties encountered by local entomologists in identifying the numerous species, nearly all small, often without very perceptible distinguishing characteristics, and, as a rule, inconspicuous and uninteresting, I determined to undertake the task of revision. The resolution was easy, the accomplishment just the reverse.

Any naturalist who has really studied these minute creatures will readily acknowledge that the work of rearranging and classifying such a complex assemblage was an undertaking of more than ordinary difficulty.

A distinguished British entomologist, with the best typical collections of insects and books of reference in the world easily accessible, when dealing with about twenty species of a nearly allied group consisting of 108 genera, remarked that "The study of these genera is attended with great difficulties, for they are divided from one another by no strongly marked peculiarities," &c. So, although he stated that these twenty species represented "a considerable number of distinct genera," only two new genera were described, all the other species being referred to the typical genus of the group, and there they have remained for upwards of thirty years. As the members of that group are much larger, and differentiated by more easily seen characters, it is unlikely that our *Cossonidæ* would be more systematically dealt with.

In 1873 no less than 123 genera, including five from New Zealand, were known to occur in various parts of the world. A great many of these are rare, and, as there is nothing very attractive about their general appearance, most collectors during their travels make no special search for them, consequently any New Zealand student will find it nearly impossible to obtain accurately named specimens of more than a dozen of these exotic genera for comparison with our own, so that in attempting to classify and name our indigenous species he must carefully study the Latin descriptions of these 123 genera. Any naturalist who has made the experiment will know what that means.

Pentarthrum may be accepted as the typical genus of our *Cossonidæ*, and to it, by European entomologists as well as by myself, over forty of our endemic species have been ascribed within the past thirty or forty years. These I have, so far as specimens were available, carefully studied, separated into groups or series, and detached first one and then another as representatives of new or distinct genera, until at length I had instituted seventeen new genera for their systematic location, irrespective of thirteen I had previously described. Only fifteen species have been left under the name *Pentarthrum*, and these are divided into three sections, so that the identification of the older species has been much simplified.

Few are aware of the trouble involved in that process. Every specimen in my collection was carefully set out and gummed to strips of cardboard or mica slabs, and after the superficial examination of generic characters had been completed it was necessary to remove each one from its original position, so that the structure and sculpture of the under-surface might be as carefully studied as that of the upper before the description of any genus could be properly prepared. This removal from the cardboard, and the subsequent replacement of the specimens in my cabinet, was a very tedious, delicate, and risky operation, as the least carelessness would result in the damage or loss of the type of some species which may not be found again during my lifetime. Notwithstanding all the care bestowed, I managed to lose one, much to my regret.

On reference to the following list, it will be seen that our *Cossonidæ* now consist of forty-seven genera, comprising 141 species, the descriptions of which are attached hereto.

It must, however, be understood that the object in view was not to monograph the species, although each one has been more or less critically reviewed, and placed, in accordance with my own views, in its proper position. Every genus and its typical species have been fully described by myself, and two or three diagnostic characters of the species attached to each genus have been given as an aid to identification, together with references to the original descriptions. The maximum measurements are given; that of the length invariably includes the rostrum of all properly mounted specimens.

During the progress of the work I found that, for the convenience of colonial entomologists, it would be expedient to adopt some fixed standard for purposes of comparison. *Pentarthrum zealandicum*, var. *canaliculatum*, has been selected, and placed at the head of the list, because it is our typical exponent of the Pentarthrides, and also on account of its being readily procurable in the South as well as the North Island. Its generic description has been renewed and somewhat restricted, the term " more or less elongate," applied to the rostrum in the original diagnosis, having been deleted, so that only such characters as are exhibited by the endemic species itself are given.

Those who have no special knowledge of our *Cossonidæ* should, before attempting to classify and name their collections, carefully study the general form, appearance, and structural details of the insect I have chosen as the standard, the female as well as the male. To do this thoroughly four specimens should be obtained, and one of each sex neatly set out and mounted on cardboard with the antennæ, legs, and tarsi properly displayed, and another of each sex mounted on its back, so that differences of the underside can be examined. *Euophryum* or *Torostoma* may be studied next, noting and comparing the peculiar modifications of the rostrum and elytral margins; then the common pubescent *Sericotrogus*, comparing the form of its head, the position of the coxae, and structure of the lower surface with those of the standard. The training of the faculty of observation thus acquired will be invaluable when the specific names of members of the more complex or rare genera have to be decided by the examination of single examples.

When reading descriptions the inexperienced entomologist should remember that what is termed coarse sculpture, or vestiture, in the case of a minute insect would be considered to be only moderate, or even fine, in one of greater bulk. Mistakes are liable to occur through forgetfulness to make due allowance for such details.

In the descriptive portion of this memoir the habitat of every species, so far as known to me, has been recorded, but, as no reference has been made to modes of life, some brief remarks on this subject may be of interest.

The greater number have been obtained promiscuously by being dislodged from shrubs or branches of trees at times when special notes of their capture could not be recorded, others were found under bark or adhering to the underside of logs, and a few were cut out of solid wood.

Several very curious, though small, genera and species—two of them blind, or nearly so—are only found amongst decaying leaves, on the ground. The genus *Pselactus*, consisting of two species, and the last three attached to *Eutornus*, are inhabitants of the sea-shore. The three species of *Novitas* seem to live almost wholly on *Phormium tenax*, and one of *Phlœophagosoma* was taken out of the seed-vessels of that plant.

Our native palm, *Areca sapida*, has yielded no less than four remarkable genera, but in order to search for and secure these I had to cut down more than one of the palms with my tomahawk, and to break off and carefully examine each frond separately.

The most important genus, from a commercial point of view—*Xenocnema*—occurs in *Agathis* (*Dammara*) *australis*. Its destructive propensities were observed by me over thirty years ago. The paper prepared regarding its ravages will be found in vol. ix. page 366, of the "Transactions of the New Zealand Institute."

LIST OF THE NEW ZEALAND *COSSONIDÆ*.

Fam. COSSONIDÆ.

Group PENTARTHRIDES.

Funiculus 5-articulate.

Pentarthrum, Wollaston, Trans. Ent. Soc., 1873.

Body convex, cylindric or fusiform-cylindric, subnitid, piceous or castaneous, subglabrous.

Head globose below; occiput usually smooth and narrowed anteriorly, thus causing the eyes to appear more prominent behind than they would be otherwise; there is no frontal line of demarcation. Thorax rather longer than broad, triangular-ovate, constricted in front. Scutellum distinct. Elytra subtruncate at base, as wide as thorax, subparallel, or gradually narrowed posteriorly, their margins not incrassate near the extremity; apices singly rounded sometimes.

Femora moderately long, dilated, emarginate below near the extremity. Tibiæ flexuous, expanded towards the apex, with well-developed terminal hooks. Tarsi pseudotetramerous, 3rd joint slightly expanded, cordate, excavate above but not lobate, the terminal equals the preceding 3, with distinct claws.

Metasternum elongate, rather longer than basal 2 segments combined, 2nd ventral segment shorter than the basal, their suture sinuate and very fine or indistinct, both on the same plane as the metasternum; 3rd and 4th abbreviated, with profound sutures. Epipleuræ linear. Coxæ widely separated, the anterior included.

Male.—Rostrum half length of thorax, broad, parallel, subdepressed above, without any basal line of demarcation. Scape medially inserted, attaining back part of eye, straight, stout, gradually incrassate. Funiculus 5-articulate, 2nd joint longer than 3rd, the following 3 closely articulated and subquadrate. Club ovate, not perceptibly annulate.

Female.—Rostrum cylindric, parallel, rather longer and about half the breadth of that of the male, its base on a rather lower level than the forehead. Antennæ more slender, inserted behind the middle. Thorax more triangular, more gradually narrowed anteriorly.

The above characters are derived from specimens in my own collection.

Sect. 1. Rostrum of male longitudinally canaliculate.

Pentarthrum zealandicum, Wollaston. 903. Trans. Ent. Soc. 1873. (Plate XV, fig. 1.)

Subnitid, piceous, legs and elytra piceo-ferruginous or castaneous, the suture and sides of the latter piceous, tarsi and antennæ dark red; very indistinctly, minutely, and sparingly pubescent.

Thorax widest near the base, posterior angles obliquely curvate, disc moderately convex, but with a slight median basal impression, deeply constricted near apex, distinctly and rather closely punctate. Elytra evidently striate-punctate, interstices with fine serial punctures and transversely rugose.

Underside shining, piceous, scantily, minutely, and indistinctly pubescent, finely but not closely punctured, base of prosternum somewhat transversely rugose, metasternum medially sulcate behind, basal ventral segment broadly impressed.

Male.—Rostrum distinctly punctate, canaliculate along the middle, the punctuation continued to the back of the eyes, occiput with a few fine punctures.

Female.—Rostrum slender, reddish, shining, finely and sparingly punctured.

This species varies in size and coloration.

♂. Length, 2 lines; breadth, quite ½ line.

Both Islands.

P. amicum, Broun. 2195. Man. N.Z. Coleopt., p. 1247.

♂. Funiculus more slender than 903, eyes prominent behind, elytral interstices not rugose, thorax rufescent. Sparingly clothed with slender but quite perceptible yellow hairs.

♂. Length, 1½ lines; breadth, ⅜ line.

Paparoa, Howick. Unique.

P. fultoni, Broun. 2189. Man. N.Z. Coleopt., p. 1243.

♂. Rostrum broad, gradually slightly narrowed anteriorly. Scape short. Thorax shorter than 903, sides more strongly rounded. Castaneo-rufous, head and apical portion of elytra piceous.

♂. Length, 1⅜ lines; breadth, ⅜ line.

Taieri, Otago. One of each sex.

P. proximum, Broun. 1627. Man. N.Z. Coleopt., p. 910.

♂. Rostrum very closely punctate, very slightly, hardly appreciably, wider at antennal insertion than elsewhere. Scape rather short. Uniformly piceo-rufous. Pubescence scanty, slender, yellowish, more perceptible than in 2189.

♂. Length, $1\frac{5}{8}$ lines; breadth, quite $\frac{3}{8}$ line.

Tuakau, Auckland. Unique.

Sect. 2. Rostrum of male not canaliculate.

P. brevirostre, Sharp. 911. Man. N.Z. Coleopt., p. 512.

♂. Subopaque, subdepressed, piceous.

Rostrum broad, parallel, closely punctate, interstices coriaceous. The punctuation ceases abruptly behind the eyes, so that the front of the occiput seems depressed. Elytra punctate-striate.

♂. Length, $1\frac{1}{4}$ lines; breadth, $\frac{3}{8}$ line.

Whangarei. Both sexes.

P. ruficorne, Broun. 1304. Man. N.Z. Coleopt., p. 734.

♂. Subopaque, nigro-piceous, antennæ and tarsi dark red.

Thorax longitudinally impressed, and with a fine smooth central line. Antennæ stout, 2nd joint of funiculus hardly any longer than 3rd. Rostrum with rather shallow punctures, minutely coriaceous.

♂. Length, nearly $1\frac{1}{2}$ lines; breadth, $\frac{3}{8}$ line.

Tairua, Auckland. One only.

P. philpotti, Broun. Ann. Mag. Nat. Hist., 6, xv, p. 414.

Rostrum slightly contracted behind, very distinctly punctured. Nigro-piceous, elytra more rufescent, antennæ red.

♂. Length, $1\frac{3}{8}$ lines; breadth, $\frac{3}{8}$ line.

Invercargill. One.

P. melanosternum, Broun. 1548. Man. N.Z. Coleopt., p. 869.

Subopaque, castaneous; the apex of the thorax, the metasternum, and basal 2 ventral segments piceous, with fine numerous suberect yellow setæ. Scape moderately short.

♂. Length, $1\frac{1}{2}$ lines; breadth, $\frac{3}{8}$ line.

Otago. Both sexes.

P. punctirostre, Broun. 1300. Man. N.Z. Coleopt., p. 733.

Rostrum closely and moderately punctured, and bearing some fine yellowish hairs, like those that are distributed over the body. Thorax longitudinally impressed along the middle. Rufo-piceous, moderately nitid.

♂. Length, $1\frac{3}{4}$ lines; breadth, quite $\frac{3}{8}$ line.

Wellington. One of each sex.

P. planicolle, Broun. Description being published at London.

Nitid, piceo-rufous, head and rostrum darker. Scape flexuous and elongate. Thorax subdepressed. Rostrum slightly narrowed towards the base. Club rather narrow and annulate.

♂. Length, $1\frac{1}{2}$ lines; breadth, $\frac{3}{8}$ line.

Southland. One.

P. subsericatum, Wollaston. 905. Man. N.Z. Coleopt., p. 509.

Subopaque, pale rufo-ferruginous, minutely pubescent.

♂. Length, $1\frac{1}{2}$ lines.

Incog. Locality unknown.

Sect. 3. Females: Exact position doubtful

P. assimilatum, Broun. 909. Man. N.Z. Coleopt., p. 511.

Fusiform, rufescent.

Rostrum not slender, slightly narrowed near the base. Eyes only slightly prominent. Club subrotundate.

♀. Length, $1\frac{1}{2}$ lines; breadth, $\frac{3}{8}$ line.

Whangarei. Unique.

P. reductum, Broun. 1298. Man. N.Z. Coleopt., p. 732.

Convex, subopaque, piceous, legs fusco-rufous.

Eyes only slightly prominent. Elytral striæ crenate-punctate.

♀. Length, $1\frac{1}{4}$ lines; breadth, $\frac{3}{8}$ line.

Napier. One.

P. brunneum, Broun. 907. Man. N.Z. Coleopt., p. 510.

Very elongate, fusiform, thorax and elytra of almost equal width at the base and rather closely adapted to each other. Moderately nitid, rostrum and thorax rufescent, elytra pale castaneous.

Thorax subtriangular, only slightly rounded laterally. Eyes not prominent.

Certainly represents a distinct genus.

♀. Length, $1\frac{3}{4}$ lines; breadth, $\frac{3}{8}$ line.

Tairua. One, not in very good order.

P. nubilum, Broun. 2191. Man. N.Z. Coleopt., p. 1244.

Shining, rostrum and thorax dark red, elytra pale castaneous.

Eyes only slightly prominent. Near 903.

♀. Length, $1\frac{3}{8}$ lines; breadth, quite $\frac{3}{8}$ line.

Paparoa, Howick. One.

Touropsis, gen. nov.

Fusiform, only slightly convex, shining; bearing some fine indistinct pubescence, which is most easily seen at the base of the thorax and extremity of the elytra.

Rostrum about a third shorter than thorax, stout, but not broad, subparallel, evidently contracted near the base. Scrobes short, as deep above as below, extending to the upper as well as the lower part of the eyes, thus to a great extent causing the basal contraction of the rostrum. Scape elongate, flexuous, moderately stout, incrassate just at the extremity; it is inserted behind the middle, and reaches to just beyond the back of the eye. Funiculus closely articulated, 2nd joint very slightly longer than the following ones, 3–5 transverse. Club very distinct, rather short and broad, annulate in front. Head globose, the smooth convex occiput very sharply marked off by an abrupt linear depression. Eyes moderately prominent behind. Thorax triangular-ovate, deeply constricted in front. Scutellum small, but distinct. Elytra a little biarcuate at the base, and broader than that of the thorax, gradually narrowed backwards, apices separately obtusely rounded. Legs stout, 3rd tarsal joint not lobed.

The separation of the type of this genus is necessary on account of the peculiar scrobes, the antennal insertion, and form of the rostrum, which do not agree with either sex of *Pentarthrum*. The head and rostrum are more like those of *Toura*, but the structure of the tarsi is quite different. The frontal limitation of the occiput is even more abruptly defined, and the thorax is broader and more oviform.

Touropsis punctatus, Broun. 925. Man. N.Z. Coleopt., p. 518.

Shining, castaneo-rufous, antennæ and tarsi fulvescent.

Rostrum convex, finely and not closely punctured, nearly smooth along the middle. Head distinctly but not closely punctured as far as the back of the eyes; this portion apparently on a higher level than the front of the smooth occiput. Thorax about as broad as it is long, widest behind the middle, well rounded there, much narrowed and deeply constricted in front, hardly perceptibly flattened above, the central linear space nearly smooth, its punctuation distinct but not coarse or close, finer but not smooth in front, having minute coriaceous sculpture there. Elytra punctate-striate, the punctures somewhat transversely angular, the suture and interstices with fine serial punctures.

♂. Length, nearly $1\frac{1}{4}$ lines; breadth, nearly $\frac{3}{8}$ line.

Tairua, Auckland. Unique.

Euophryum, gen. nov.

Body transversely convex, subcylindric, narrowed anteriorly. Rostrum more than half the length of thorax, only moderately broad, somewhat abruptly contracted near its base, so that the scrobes seem deep and wide; the sides, underneath, are swollen for the greater part of their length, and the central carina extends from the mentum and becomes thicker near the eyes. In the female the rostrum is more slender, and, behind the contraction, is a little expanded, so as to become as broad as the front of the eyes. Scape inserted just behind the middle, short, stout, and incrassate towards the extremity; it only reaches the front of the eye. Funiculus longer than the scape, 2nd joint slightly longer than 3rd, 2–5 gradually thickened, 5th transverse. Club ovate, of moderate bulk. Eyes subrotundate, transverse rather than longitudinal, more prominent behind than in front, the smooth occiput being somewhat narrowed anteriorly. Thorax nearly twice as long as broad, ovate-triangular. Scutellum small, but distinct. Elytra cylindric, slightly narrower than thorax, individually strongly rounded at apex, causing a sutural gap there, their margins posteriorly expanded or incrassate. Tarsi narrow, penultimate joint narrow, excavate but not lobate.

The buccal cavity is well marked, and there is a minute dentiform projection of the mentum within it. The anterior coxæ are more approximated than in *Pentarthrum*, with a fine curvate suture between them. The epipleuræ are slightly thickened behind, and the dilatation seen on the upper surface is quite evident on the lower also, but distinct from the epipleura itself.

The characters which distinguish this genus from *Pentarthrum* are the obviously basally contracted rostrum, deep broad scrobes, short scape, incrassate elytral margins, strongly singly rounded apices, and sutural notch, these last two being quite exceptional features amongst the *Cossonidæ*. The underside also differs. The more parallel outline and coarser sculpture will also aid in the identification of the species now detached from *Pentarthrum*.

In the female the antennæ are inserted midway between the middle of the rostrum and the eyes.

Euophryum rufum, Broun. 908. Man. N.Z. Coleopt., p. 510. (Plate XV, fig. 2.)

Subcylindric, slightly nitid, piceo-rufous, seemingly calvous, but with some minute greyish hairs; antennæ and tarsi paler.

Rostrum distinctly and rather closely punctate: the vertex more coarsely. The smooth occiput distinctly marked off immediately behind the eyes. Scape much shorter than funiculus. Thorax with obtuse hind angles, rather gradually narrowed anteriorly, only moderately constricted near the apex and causing a transverse impression there: it is coarsely, rather closely, and on some parts longitudinally confluently punctured, very closely and rugosely at the sides, much more finely at the apex. Elytra quite parallel, longer than but hardly as broad as the thorax: distinctly and rather closely punctate-striate, interstices with fine serial punctures and sometimes a little rugose.

Underside moderately shining, sparingly and minutely pubescent, somewhat irregularly, moderately coarsely, but not very closely punctured. Metasternum slightly flattened and distantly punctured along the middle, with a small angular fovea behind. Basal ventral segment flat, with two slight obtuse elevations behind, separated by a broad groove; 3rd, 4th, and 5th with a transverse series of distinct punctures on each.

Female.—Rostrum more finely punctured than the male.

♂. Length, nearly $1\frac{3}{4}$ lines; breadth, $\frac{3}{8}$ line.

Mount Manaia, Whangarei. Both sexes in my own collection.

E. asperellum, Broun. 1301. Man. N.Z. Coleopt., p. 732.

Nigro-piceous, antennæ and tarsi rufo-piceous, slightly nitid.

Rostrum rather longer than that of 908, eyes evidently more prominent. Thorax longer and more closely punctured, without the least trace of any smooth median line. Elytral striæ crenate-punctate, interstices rugose.

♀. Length, $2\frac{1}{8}$ lines; breadth, $\frac{1}{2}$ line.

Wellington. Unique.

E. sculpturatum, Broun. 1297. Man. N.Z. Coleopt., p. 731.

Rufo-piceous.

Rostrum slightly narrowed from the antennæ towards the extremity; distinctly, very closely, and somewhat rugosely punctured throughout, with a transverse impression midway between the antennæ and extremity. Scape very short. Thorax with an ill-defined smooth median line. Inner extremity of tibiæ with an acute denticle.

♂. Length, $1\frac{3}{4}$ lines; breadth, $\frac{3}{8}$ line.

Parua, Whangarei. Unique.

E. punctatissimum, Broun. 2194. Man. N.Z. Coleopt., p. 1246.

Near 1297.

Rostrum not narrowed anteriorly, rather shorter, more transversely convex, not impressed near the front. Scape even shorter and thicker. Inner angle of anterior tibiæ more acutely projecting, the tibia itself somewhat curved externally, the femora slender near the base but strongly arched above. Eyes very convex. Moderately shining, thorax dark red, elytra obviously paler.

♂. Length, $1\frac{1}{2}$ lines; breadth, $\frac{3}{8}$ line.

Howick. Both sexes.

E. dubitans, Broun. Description being printed at London.

Near 908, ♂.

Rostrum slightly longer, rather more finely and closely punctured. Club distinctly longer, not much broader than 5th joint of funiculus.

♂. Length, nearly 2 lines; breadth, $\frac{3}{8}$ line.

West Plains, Southland.

E. confinum, Broun. 1299. Man. N.Z. Coleopt., p. 732.

Rufo-piceus, pubescence yellowish and scanty but quite easily seen.

Eyes more prominent than those of the female *E. rufum*, the shape a little more fusiform, punctuation of rostrum almost seriate, the interocular area not raised above the level of the front of the occiput as in that species.

♀. Length, $1\frac{5}{8}$ lines; breadth, $\frac{3}{8}$ line.

Wellington. Unique.

E. antennale, Broun. Ann. Mag. Nat. Hist., 6, xv, p. 415.

Pubescence slender, yellowish, quite perceptible.

Body slightly more fusiform than that of 908, scape rather longer, club evidently narrower, punctuation on the middle of thorax more open with larger smooth intervals.

♂. Length, $1\frac{7}{8}$ lines; breadth, $\frac{3}{8}$ line.

Invercargill. Both sexes.

E. crassellum, Broun. Ann. Mag. Nat. Hist., August, 1904, p. 123.

Rufo-piceous, cylindric, minutely pubescent.

Club narrow, but little broader than 5th joint of funiculus. From the female of 2194 it is distinguished by the more robust form, darker colour, more distinctly punctured rostrum, and less rugosely sculptured thorax. *E. poratum* can be separated by the absence in it of interstitial punctures and hairs.

♀. Length, 2 lines; breadth, $\frac{1}{2}$ line.

Picton. Unique.

E. servulum, Broun. 1629. Man. N.Z. Coleopt., p. 911.

Differs from the corresponding sex of 908 by the more shining surface and much finer thoracic sculpture, rather longer and more slender antennæ, less prominent eyes, &c.

♀. Length, $1\frac{1}{2}$ lines; breadth, $\frac{3}{8}$ line.

Taieri, Otago. Unique.

E. porcatum, Sharp. 2198. Man. N.Z. Coleopt., p. 1248.

Subcylindric, piceous, nitid.

Eyes prominent. Thorax coarsely and very closely punctured. Elytra deeply punctate-striate. Its description shows that it is the only species of this genus without interstitial punctures and pubescence. I have not seen it.

Length, nearly 2 lines.

Dunedin, Greymouth, and Picton.

Zenoteratus, gen. nov.

Body cylindrical, transversely convex; pubescence minute, scanty, and inconspicuous. Rostrum short, broad, parallel, and half the width of the head in both sexes. Head almost abruptly enlarged and of almost equal breadth throughout, nearly as long as the rostrum, globose below. Eyes widely distant from each other and from the thorax. Antennæ medially inserted in the male, behind that point in the female. Scape short, attaining the back of the eye. Funiculus 5-articulate, 2nd rather shorter than 1st yet evidently longer than 3rd, 3–5 transverse. Club broad, but compressed, so that it seems hardly broader than the funiculus when examined sideways. Thorax widest near the base, much narrowed towards the front, where it is only moderately constricted. Scutellum small. Elytra parallel, posterior margins expanded, the dilatation, however, is partially concealed by the thickened lateral interstice just above it; they are singly rounded and slightly dehiscent at the extremity. Legs stout; tarsi narrow, 3rd joint not lobate.

When compared with the typical *Pentarthrum*, 903, the large swollen head is very apparent, the eyes are more widely separated, the rostrum is shorter, and in the female much shorter and broader; the scape is shorter. The apical portion of the elytra is manifestly different, and when examined from the side or underneath is seen to extend downwards and to be on an obviously different plane from the last three ventral segments, appearing more like one of the *Brenthidæ*. The anterior coxæ are more widely separated.

Zenoteratus macrocephalus, Broun. 1549. Man. N.Z. Coleopt., p. 869. (Plate XV, fig. 3.)

Piceous or nigrescent, legs and antennæ piceo-rufous.

Rostrum moderately finely and closely punctured, with a slight broad longitudinal impression behind, bearing yellow setæ in front. Head convex, not closely punctate, the occiput more finely and remotely. Thorax nearly a third longer than broad, appearing somewhat swollen behind, the disc moderately finely and not closely punctured, the linear median space and apical margin nearly smooth. Elytra punctate-striate, interstices with distinct serial punctures, in some aspects appearing a little rugose.

Underside as shining as the upper surface and bearing slender but distinct yellowish hairs, moderately punctate. Metasternum elongate, flattened behind, with a median sulcus. Basal ventral segment slightly impressed, its sinuate apical suture fine, 3–5 on a lower level than the basal two.

Female.—Rostrum scarcely longer and only a little narrower than in the male, rather more finely sculptured.

♂. Length, $1\frac{3}{4}$ lines; breadth, $\frac{3}{8}$ line.

Taieri, Mount Arthur, Waikato. Both sexes.

Z. diversus, Broun. 2190. Man. N.Z. Coleopt., p. 1244.

Shining, ferruginous, club fulvescent.

Thorax with an indistinctly raised smooth central line, and with an impression in front of the scutellum similar to that seen in *Z. macrocephalus*. Elytra biarcuate at base, punctate-striate, the 3rd and 4th striæ indistinct near the middle, suture and interstices with fine serial punctures, interstices not rugose, more or less elevated behind.

♀. Length, $1\frac{3}{4}$ lines; breadth, $\frac{3}{8}$ line.

Clevedon, Hunua Range. Unique.

Z. cephalotes, Sharp. 2197. Man. N.Z. Coleopt., p. 1247.

Subcylindric, piceous, nitid.

Thorax closely and finely punctate. Elytra very deeply striated, coarsely and closely punctured, the punctures confluent, the interstices narrow, indistinctly seriately punctate.

♀. Length, nearly $1\frac{3}{4}$ lines; breadth, $\frac{3}{8}$ line.

Picton. Evidently closely allied to 1519. I have not seen it.

Torostoma, gen. nov.

Robust, subcylindric, narrowed anteriorly, transversely convex, sparingly and indistinctly pubescent.

Rostrum twice as long as broad, parallel or just perceptibly narrowed anteriorly, on the same plane or slope as the head, which, at the sides, is slightly constricted immediately behind the eyes. The scrobes are deep and oblique towards the lower part of the eyes. Scape medially inserted, of moderate length, attaining to just behind the centre of the eye. Funiculus with the 2nd joint nearly as long as the 1st, 3–5 transverse. Club moderate, oviform. Eyes prominent, more so behind than in front. Thorax longer than broad, curvedly narrowed towards the frontal constriction. Scutellum small. Elytra parallel, of the same width as the thorax; posterior margins rather widely dilated and appearing each as two curves; underneath the dilatation is broad and distinctly sculptured from the 3rd ventral segment to the extremity, and on an evidently higher level than the terminal 3 segments.

The margins of the buccal cavity are thick, and, in line with the cuneiform mentum, terminate as tubercular projections. The rostrum is broadly concave underneath, with thick borders. The metasternum is elongate, depressed behind, and grooved along the centre. The basal 2 abdominal segments are on a higher plane than the following 3; the first is medially depressed. Femora strongly inflated; tibiæ much curved, with well-developed hooks; 3rd tarsal joint simple.

The characters of the underside as detailed above, in conjunction with the peculiarly dilated elytral margins, distinguish this genus in an unmistakable manner from *Pentarthrum* and its allies.

Torostoma apicale, Broun. 906. Man. N.Z. Coleopt., p. 509. (Plate XV, fig. 4.)

Nigro-piceous, moderately nitid, legs piceous, antennæ and tarsi dark red; sparingly and indistinctly pubescent.

Rostrum moderately finely and closely punctured, the interocular sculpture nearly similar, occiput with many minute punctures. Antennæ pubescent. Thorax convex, moderately closely and in proportion to the large size of the insect not at all coarsely punctured, the apex more finely. Elytra cylindrical, moderately striate, the punctures not very coarse and subcrenate, the suture and interstices with fine distant serial punctures, and more or less transversely rugose; the reflexed posterior dilatation on each assumes the form of two curves, the terminal one the larger.

Underside shining, nigrescent, sparsely clothed with fine short greyish hairs. Prosternum usually somewhat convex and rather finely but closely punctate in front, nearly smooth, or with some transverse rugæ behind the intercoxal suture. Metasternum more distinctly punctured near the sides than on the middle, the sides broadly impressed. Abdomen moderately finely, the 5th segment closely, punctate.

Female.—Rostrum more slender, very finely punctate, antennæ inserted behind the middle, basal ventral segment simple.

♂. Length, $2\frac{3}{4}$ lines; breadth, nearly $\frac{3}{4}$ line.

Whangarei and Hunua Range. Both sexes.

Toura, gen. nov.

Body fusiform-cylindric. Rostrum of nearly the same length as thorax, nearly twice as long as that of 903, much more slender, evidently arcuate; very slightly, just perceptibly, broader in front than behind; a little dilated medially underneath; nearly as stout but quite parallel in the female. Scrobes elongate. Scape somewhat curved, moderately incrassate apically, inserted distinctly before the middle, but only reaching the front of the eye. Funiculus rather elongate, 2nd joint nearly as long as the 1st, joints 3-5 somewhat laxly articulated. Club indistinctly annulate, moderate. Eyes rotundate, moderately prominent. The smooth occiput marked off in line with the back of the eyes. Thorax triangularly ovate, constricted in front. Scutellum distinct. Elytra slightly biarcuate at the base and rather broader than that of the thorax, subfusiform. Legs elongate and rather slender; tibiæ only a little expanded towards the extremity; 3rd joint of the tarsi expanded and moderately bilobed.

Prosternum elongate, intercoxal suture strongly curved. Basal 2 ventral segments as long as the metasternum. Rostrum bisulcate and tricarinate underneath.

The nearly similar rostrum of both sexes, its upper curvature and unusual length, the antennal insertion, different scrobes, curved scape, slender legs, expanded and lobate 3rd tarsal joint, and more approximated front coxæ are sufficient for generic separation of Wollaston's *Pentarthrum longirostre*, which I adopt as the type of *Toura*. In the female the antennæ are implanted before the middle, just the reverse of what is the case in *Pentarthrum*. It bears some resemblance to *Phlœophagosoma*.

Toura longirostre, Wollaston. 904. Man. N.Z. Coleopt., p. 508. (Plate XV, fig. 5.)

Nitid, piceous or nigro-piceous, legs and antennæ pitchy-red.

Rostrum rather finely and closely punctate, the interocular sculpture similar, the occiput smooth. Thorax rather abruptly contracted near the apex, finely punctured there; disc convex, moderately coarsely punctured, its sides moderately rounded. Elytra not perfectly parallel, slightly narrowed backwards; punctate-striate, sutural striæ deep, the suture and interstices with fine serial punctures and slightly transversely rugose.

Underside a little glossy, nigrescent, with some minute hairs, moderately coarsely punctate. Basal ventral segment broadly depressed, the terminal one with a large transverse oviform depression which is densely and minutely sculptured.

♂. Length, 2 lines; breadth, nearly ½ line.

Parua, Whangarei. Both sexes.

T. fulva, Broun. 2188. Man. N.Z. Coleopt., p. 1243.

Shining, fulvescent, club fuscous, tarsi yellowish.

Smaller than 904. Rostrum very finely punctate. Thorax rather small, narrower than the elytra, more cylindrical, their sides very slightly and regularly rounded from the truncate base to the apical contraction, the disc more finely but less closely punctured. Elytra subparallel before the middle, gradually narrowed posteriorly, each slightly rounded at the base, their striæ and punctures finer.

♀. Length, $1\frac{3}{8}$ lines; breadth, $\frac{3}{8}$ line.

Paparoa, near Howick. One.

T. morosa, Broun. 1749. Man. N.Z. Coleopt., p. 969.

Rostrum rather longer than that of 904, slightly incrassate medially, the point of antennal insertion. Occiput not delimited in front. Thorax more curvedly narrowed near the base, its sides more strongly rounded. Humeral angles subrectangular. Nigrescent, each puncture with a minute greyish seta. Perhaps represents a distinct genus. Male *incog.*

♀. Length, $2\frac{1}{4}$ lines; breadth, $\frac{1}{2}$ line.

Howick (one), Mount Egmont (one). Both during 1884.

Merisma, gen. nov.

Subdepressed, elongate, minutely pubescent.

Rostrum almost as long as thorax, evidently but gradually narrowed towards the middle, its frontal portion as broad as the head, the basal narrower; in the female it is slender, parallel, and arched. Scrobes straight and elongate above, widened and nearly convergent underneath. Scape medially inserted, slightly curved, gradually thickened, barely attaining the front of the eye. Funiculus as long as the scape, 2nd joint nearly as long as the 1st, 3–5 subquadrate, each narrowed towards the base. Club rather narrow, oblong-oval, finely annulate, not much shorter than the funiculus. Eyes distant from the thorax and each other, only moderately prominent. The head, at each side, has two slight constrictions, the smaller immediately behind the eye; the other, about equidistant from the eye and thorax, limits the smooth occiput from the sculptured part, which extends nearly half-way from the eye to the thoracic margin. Thorax longer than broad, much narrowed and constricted in front, moderately rounded laterally. Scutellum distinct. Elytra slightly biarcuate at the base, which is rather broader than that of the thorax; they are elongate and taper towards the extremity. Legs relatively rather short; inner extremity of the tibiæ with a minute calcar; 3rd tarsal joint moderately expanded, cleft nearly to its base, and consequently strongly bilobed.

Underside plane. The rostrum with a central carina, which seems to project into the buccal cavity. Basal 2 ventral segments combined rather longer than the metasternum and broadly impressed, with their fine sinuous suture quite distinct, the 5th with a rounded depression occupying half of its area.

Female.—Antennal insertion just behind the middle.

The depressed elongated body, peculiar head and rostrum, strongly lobate penultimate tarsal joint, and much more approximated anterior coxæ amply justify the creation of *Merisma* for the reception of Wollaston's *Pentarthrum sharpianum.*

Merisma sharpiana, Wollaston. 926. (Plate XV, fig. 7.)

Elytra rufescent, thorax and rostrum somewhat piceous, moderately shining.

Rostrum slightly transversely convex, rather finely punctate in front, more closely and somewhat rugosely behind, the rather coarser punctuation of the head extending backwards for half the distance between the eyes and thorax; there is usually a slight longitudinal impression on the vertex: the occiput is not quite smooth, having some fine punctures, and being, like the rostrum and thorax, more or less densely and minutely sculptured. Thorax moderately closely and finely punctured, with a smooth median line. Elytra punctate-striate, the striæ rather shallow, broad towards the extremity, suture and interstices with minute serial punctures, the 2nd from the suture somewhat elevated and abruptly bent outwards at the extremity.

Underside dark rufous, shining, nearly glabrous, the slender pubescence most easily detected on the terminal ventral segment; the punctuation nowhere close, rather fine, slightly coarser on the prosternum. Metasternum with a short linear impression behind, not sulcate along the middle.

Female.—Rostrum arched above, moderately slender.

♂. Length, $2\frac{1}{2}$ lines; breadth, $\frac{1}{2}$ line.

Tairua and Hunua Range.

Wollaston's description I have not seen.

M. aurantiaca, Broun. 2192. Man. N.Z. Coleopt., p. 1245.

Fulvescent, slightly nitid, apparently calvous.

Near 926; the rostrum not as broad; scape rather more curvate; the thorax, behind the middle, not broader than the base of the elytra; scutellum transversal; elytra less striate; the tarsi shorter, their penultimate joint less expanded.

♂. Length, $1\frac{3}{4}$ lines; breadth, $\frac{3}{8}$ line.

Tairua, Auckland. Unique.

Tanysoma, gen. nov.

Body slightly convex, narrow, subparallel, sparingly clothed with slender but distinct brassy hairs.

Male.—Rostrum quite half the length of thorax, evidently but not abruptly narrowed behind the middle, stout, its frontal portion nearly as broad as the head. Scape inserted between the middle and apex, reaching the front of the eye, a little curved, its apical half subclavate. Funiculus rather laxly articulated, joints 2–4 narrowed towards the base, 5th submoniliform and transverse, 2nd longer than 3rd. Club oblong-oval. Head moderately narrowed anteriorly, but with a distinct sculptured plica or swelling which at each side extends just beyond the back of the eye. Eyes small, quite lateral, slightly prominent. Thorax triangularly ovate, constricted in front. Scutellum small. Elytra elongate, parallel as far as the hind thighs, slightly narrower than thorax. Legs rather elongate and slender; tarsi densely pilose underneath, their 3rd joint cleft almost to its base, with strongly developed and divergent lobes. Underside with short distinct yellowish hairs, moderately finely but distinctly punctured, the intervals densely and minutely sculptured. The prosternum elongate, the coxæ much less separated than in *Pentarthrum*, with a distinct suture between them. Mesosternal suture well marked. Metasternum shorter than the abdomen, medially sulcate. Basal 2 ventral segments broadly depressed medially, their suture sinuate and distinct.

Female.—Rostrum more slender, on a lower level than the vertex, porrect; widest at the apex, gradually narrowed towards the middle, slightly dilated at or just before the middle, where the antennæ are placed, its basal half distinctly medially narrowed, almost abruptly contracted underneath. Head without any visible post-ocular plication. Metasternal groove abbreviated. Abdominal depression shallow, the last 3 segments red, as in the other sex.

Differs from *Euophryum* in being without any dilatation below the rostrum, in its longer scape being inserted nearer the apex, by the presence of the plica behind each eye, by the absence of any incrassation of the elytral margins, and by the well-developed and divergent lobes of the penultimate tarsal joint.

Tanysoma angusta, Broun. 1626. Man. N.Z. Coleopt., p. 910.

Subopaque, piceo-rufous, the funicle and tarsi paler.

Rostrum quite opaque, with relatively coarse, close, shallow, rugose punctuation, which is continued to behind the eyes, the apical portion with fewer and much finer punctures; the whole derm dull with dense minute sculpture: the occiput finely punctate. Thorax evidently longer than broad, posterior angles curvedly narrowed, its sides only slightly rounded, gradually narrowed anteriorly and constricted near the apex; disc slightly flattened, distinctly but not coarsely or closely punctured, more coarsely and rugosely near the frontal constriction. Elytra moderately punctate-striate, intermediate striæ shallow, interstices and suture with serial punctures and appearing rugose.

Female.—Rostrum red, only slightly shining, its sculpture very much finer, the thorax with the linear median space nearly smooth.

♂. Length, $1\frac{3}{4}$ lines; breadth, $\frac{3}{8}$ line.

Otago: Mount Maungatua and Dunedin. One pair.

Stenotoura, gen. nov.

Body subdepressed, very elongate and narrow, moderately shining, sparsely and minutely pubescent.

Rostrum quite as long as thorax, arched above, slender, subparallel. Scape inserted before the middle, elongate and slender, slightly thickened apically, flexuous, barely attaining the front of the eye. Funiculus elongate and slender, loosely articulated, 2nd joint longer than 3rd. Club ovate, elongate. Eyes not prominent, moderately distant. Occiput short, more or less distinctly marked off nearly midway between the eyes and thorax. Thorax triangular-ovate, only moderately constricted in front. Scutellum distinct. Elytra very elongate and parallel, narrowed posteriorly, nearly thrice the length of the thorax. Legs moderate, tibial hooks rather small; 3rd articulation of the tarsi a little dilated, with short lobes.

Toura differs in many details of structure. *Agrilochilus* may be at once distinguished by its opaque and densely pubescent surface. *Stenotoura* should be located between these genera.

Stenotoura exilis, Broun. 2193. Man. N.Z. Coleopt., p. 1245. (Plate XV, fig. 6.)

Nitid, dark red or ferruginous, antennæ and tarsi paler.

Rostrum very slightly, hardly perceptibly, narrowed behind, its punctuation moderately fine and close, somewhat longitudinally disposed, nearly smooth in front, a little convex but not at all carinate along the middle; the vertex punctate to beyond the eyes; the occiput with a few fine punctures. Thorax slightly wider behind the middle than elsewhere, basal margin a little incrassate; disc unimpressed, distinctly but not closely punctured, more finely and closely in front. Elytra feebly striate but with distinct punctures, the intervals nearly as large as the punctures, interstices with indistinct distant serial punctures, closer along the suture.

Underside flat, shining, ferruginous, minutely and scantily pubescent, finely yet distinctly and rather sparingly punctate. Anterior coxæ distinctly but not at all widely separated, little more than half as much as those of 903. Metasternum as long as the basal 2 segments, medially grooved behind, these 2 segments finely and remotely punctured, the intervening suture distinct and medially curved.

Length, 1⅜ lines; breadth, ¼ line.

Tairua and Howick. One of each sex.

S. lateritia, Broun. 924. Man. N.Z. Coleopt., p. 518.

Shining, pale ferruginous, apparently glabrous.

Near ♀ 2193, differing therefrom in having the scape more curvate, joints 3–5 of the funiculus more moniliform, disc of thorax slightly flattened, elytra less striate and the punctures on the interstices obsolete.

♀. Length, 1½ lines; breadth, quite ¼ line.

Tairua. Unique.

S. prolixa, sp. nov.

Subdepressed, very elongate and angustate, glabrous, slightly nitid, rufous, elytra paler.

Rostrum longer than thorax, arched, slender, parallel, nearly smooth and shining near the middle, finely and distantly punctured in front, more distinctly behind and to beyond the back of the eyes, and minutely coriaceous there. Scape medially inserted, flexuous; 2nd joint of the funiculus evidently longer than broad, 3–5 obconical, club oblong-oval, not annulate. Eyes slightly prominent. Thorax longer than broad, its sides gently rounded, a good deal narrowed anteriorly; disc nearly plane, moderately finely but not closely punctured, intervals, especially near the sides, densely and minutely sculptured. Scutellum small. Elytra slightly bisinuate at the base, as wide as thorax there, subparallel or very gradually narrowed backwards; moderately finely striate-punctate, striate behind, interstices with minute serial punctures, and on some parts with minute irregular aciculate impressions, the sutural 2 striæ on each rather deep near the apices. Legs rather short, the 2 hind pairs particularly.

More elongated than *S. exilis*, the rostrum evidently longer, the antennal insertion a little further back, the derm more or less coriaceous instead of being smooth.

♀. Length, 1¾ lines; breadth, nearly ⅜ line.

Totara, Southland. A single female sent several years ago by Mr. A. Philpott, of Invercargill.

Eutassa, gen. nov.

Body stout, subdepressed or only slightly convex, obviously pubescent.

Rostrum a third shorter than the thorax, slightly arched in front, slightly narrowed behind the antennal insertion, before the middle, moderately stout. Scape moderately elongate, gradually incrassate, attaining the front of the eye. Funiculus as long as the scape, 2nd joint nearly as long as the basal one but more slender, 3–5 obconical, laxly articulated. Club oval, large, indistinctly annulate. Thorax constricted in front, up to that point quite oviform. Scutellum small but distinct. Elytra slightly narrowed posteriorly, the base slightly curved towards the scutellum, and as wide as the middle of the thorax. Legs rather elongate, the inner angle of the tibiæ acutely mucronate, their hooks rather slender. Tarsi elongate, penultimate joint divided nearly to its base, the lobes elongate and divergent, the terminal with minute claws.

Female.—Rostrum of similar form, rather narrower and more finely sculptured. Underside shining, black, the terminal 3 segments rufescent; pubescence brassy, fine but distinct; evidently, but not coarsely or closely, punctate; the sutures between the front and intermediate coxæ straight, that between the basal 2 segments sinuate. Rostrum distinctly tricarinate. Metasternum and basal 2 segments of nearly equal length, the former medially grooved behind, abdomen simple.

The rostrum is as stout as that of *Sericotrogus*, but longer, narrowed posteriorly, and with the antennal insertion nearer the extremity. The head is shorter, and, like the eyes, more resembles *Pentarthrum*. Thorax broader, and constricted in front. The elytra are gradually attenuated posteriorly, instead of being narrowed towards the base, as in *Sericotrogus*, and the tarsal lobes are more elongate and divergent.

Eutassa comatum, Broun. 1748. Man. N.Z. Coleopt., p. 968.

Rostrum and thorax dark red and moderately shining, elytra somewhat fulvescent and glossy, legs and antennæ infuscate red, the club and tarsi slightly paler; the vestiture yellow, slender but conspicuous, legs finely pubescent, thoracic disc nearly bare.

Rostrum and head distinctly and closely but not coarsely punctured, the former more finely in front. Thorax widest just behind the middle, well rounded; disc obsoletely impressed behind, its punctuation not close, rather fine, closer and finer in front, apex nearly smooth. Elytra with somewhat indefinite sculpture, subpunctate-striate near the suture, the punctures elsewhere seriate, interstices with serial punctures and rugulose, the 3rd slightly elevated behind, the apices singly rounded; on each, between the shoulder and the middle, there is a broad shallow impression.

♂. Length, $1\frac{3}{4}$ lines; breadth, quite $\frac{3}{8}$ line.

Howick. One pair only.

E. fuscicollis, sp. nov.

Subdepressed; except the middle of the thorax, clothed with distinct yellow hairs; thorax fuscous, elytra and rostrum slightly infuscate pitchy-red, antennæ and tarsi rufescent.

Rostrum subopaque, distinctly, rugosely, and very closely punctured; the punctuation continued to the slight swelling behind the eyes, pubescent there; occiput curvedly narrowed anteriorly, very minutely and densely sculptured, and with a few fine punctures. Thorax longer than broad, its sides well rounded, a good deal narrowed and contracted in front; disc unimpressed, its punctuation moderately fine, very scanty between the middle and each side, close and rugose at the sides, closer and finer near the smooth apical margin. Elytra elongate, subparallel to beyond the middle, narrowed posteriorly, the base slightly curved towards the scutellum, apices individually rounded, each slightly longitudinally impressed before the middle; they are striate-punctate; the suture and interstices have fine serial punctures and appear rugose, the 2nd from the suture thickened, somewhat elevated, and sharply bent outwards at the extremity.

Underside with distinct and moderately close punctures and yellow pubescence, basal ventral segment broadly depressed, metasternum sulcate behind, rostrum tricarinate.

More robust than *E. comatum*; rostrum rather longer, broader, more densely sculptured, and subasperate; the thoracic punctuation different; antennæ stouter and implanted nearer the middle.

Obs.—The individually rounded apices of the elytra should form part of the generic diagnosis, as it is a distinctive character amongst the *Cossonidæ.*

♂. Length, $2\frac{1}{8}$ lines; breadth, nearly $\frac{1}{2}$ line.

Waitakerei Range, Auckland. Unique.

Adel, gen. nov.

Body stout, moderately elongate, narrowed anteriorly, slightly convex; clothed with numerous rather short and slender suberect setæ, similar to those on *Entium aberrans.*

Rostrum quite half the length of thorax, not quite as broad as the head, slightly wider near the front than it is elsewhere, a little dilated at the point of antennal insertion, distinctly contracted near its base, moderately stout, and bearing erect setæ in front and others horizontal along each side of the anterior half. Scrobes short, expanded towards the front of the eyes. Scape medially inserted, moderately elongate, very gradually thickened, attaining the back of the eye. Funiculus 5-articulate, 2nd joint but little shorter than the 1st, joints 3–5 subquadrate, all narrowed towards the base. Club oblong-oval. Head moderately globose, gradually narrowed anteriorly, the outline scarcely at all interrupted, the punctuation ceasing in line with the back of the eyes, which are flattened and nearly as far from the thorax as they are from each other. Thorax but little longer than broad, widest behind the middle, well rounded there, much narrowed and constricted in front, its base truncate. Elytra rather wider than the broadest part of the thorax, the base widely incurved towards the suture, only slightly curvedly narrowed near the extremity. Legs moderately stout, tibial hooks distinct, 3rd tarsal joint a little expanded, concave in front, with very short indefinite lobes.

Prosternum deeply incurved in front, the coxæ widely separated. Mesosternal suture broadly curved between the coxæ. Metasternum hardly as long as the basal 2 segments combined, slightly convex, feebly sulcate behind. Basal ventral segment not much longer than the 2nd, slightly transversely impressed behind, its frontal suture nearly truncate between the coxæ, the 2nd with the fine frontal suture medially curved, the terminal rather short.

The form of the head bears some resemblance to that of *Agastegnus.* The body is rather less convex than in *Pentarthrum*, and the hind-body is relatively broader throughout, whilst the rostrum and eyes are essentially different. It should be placed between *Eutassa* and *Agastegnus.* The scutellum is distinct.

Adel crenatus, Broun. 1431. Man. N.Z. Coleopt., p. 804.

Shining, dark red, antennæ and tarsi paler.

Rostrum finely, almost seriately, punctured, so as to appear slightly longitudinally rugose. Thorax broadly but not deeply impressed along the middle; distinctly and evenly, but not closely, punctured; the intervals smooth; apical margin submetallic. Elytra with crenate-punctate striæ, interstices with fine serial punctures.

Underside shining piceous, minutely setigerous, the punctuation distinct, not close, and rather evenly distributed, the 2nd segment, however, more finely punctured.

Length, $1\frac{3}{8}$ lines; breadth, $\frac{3}{8}$ line.

Waitakerei Range. Unique.

Rhinanisus, Broun. Man. N.Z. Coleopt., p. 805.

Subdepressed, moderately broad, finely pubescent.

Rostrum more than half the length of thorax, contracted behind the middle in both sexes, broad in the male, cylindrical, but never slender in the female. Head rather broader in the male; the nearly smooth occiput does not extend, even in the female, as far as the eyes, there being a punctate space behind these, which are only moderately prominent. Scape stout, rather short, gradually thickened, inserted just before the middle in both sexes, it attains the front of the eye. Funiculus 5-articulate, 2nd joint hardly longer than the 3rd. Club large, ovate, annulate near the extremity. Thorax triangularly ovate in the female, broader and more rounded near the base in the male, constricted near the front. Scutellum small. Elytra elongate, parallel, equalling the thorax in width, apical margins simple. Tarsi pubescent underneath, 3rd joint slightly dilated, excavate above and sublobate, the female less so.

Underside plane, rostrum deeply grooved behind.

The species composing this genus are only about half the bulk of *Pentarthrum*; the antennal insertion, form of the rostrum, subdepressed body, and less widely separated coxæ distinguish them from that genus. *Rhinanisus* differs from *Euophryum* in the much less prominent eyes, longer scape, simple elytral margins, more lobate 3rd tarsal joint, less robust body, and different rostrum.

Rhinanisus fulvicornis, Broun. 912. Man. N.Z. Coleopt., p. 512. (Plate XV, fig. 9.)

Shining, dark red, vertex piceous, antennæ fulvescent; pubescence scanty, fine, yellowish, and quite perceptible.

Rostrum rather deeply incurved between the middle and base, the frontal portion almost as broad as the head, more finely and less closely punctured than the basal. Head closely and, in proportion to the small size of the insect, moderately coarsely punctured to behind the eyes; this sculpture, in conjunction with the dark colour, render these organs indistinct; occiput shining but not perfectly smooth, narrowed in front. Thorax longer than broad, widest and a good deal rounded near the base; disc somewhat flattened but not impressed longitudinally, subfoveate near the middle of the base, moderately distinctly but not closely punctured. Elytra punctate-striate, the striæ, however, not at all deep; interstices with indistinct serial punctures, and in some aspects appearing rugose.

Female.—Rostrum slightly longer, narrower, more shining, and finely sculptured; the thorax more gradually narrowed anteriorly.

♂. Length, 1 line; breadth, nearly ¼ line.

Whangarei. One of each sex.

R. parvicornis, Sharp. 913. Man. N.Z. Coleopt., p. 513.

Subdepressed, moderately nitid, ferruginous, strongly punctate.

Thorax slightly constricted. Elytra strongly striate-punctate, interstices finely punctured, with very short indistinct setæ. Rostrum opaque and thick in the male; longer, more slender, and shining in the female.

Length, 1 line.

Auckland.

R. contiguus, Broun. 923. Man. N.Z. Coleopt., p. 517.

Near 912, ♂. Rostrum rather longer, more opaque, slightly longitudinally impressed between the antennæ and base. Thorax narrower, indistinctly impressed medially.

♂. Length, $1\frac{1}{8}$ lines; breadth, $\frac{1}{4}$ line.

Whangarei. Unique.

R. sagax, Broun. 1750. Man. N.Z. Coleopt., p. 969.

Nitid, castaneo-rufous, vertex darker.

Club large. Thorax deeply constricted in front, broadly impressed along the middle. Elytra broader than thorax. Pubescence distinct yellowish.

♂. Length, $1\frac{1}{4}$ lines; breadth, nearly $\frac{3}{8}$ line.

Mount Egmont. Unique.

R. cheesemani, Broun. 2201. Man. N.Z. Coleopt., p. 1249.

Shining, castaneo-rufous, pubescence extremely slender but rather elongate.

Thorax not deeply impressed, frontal constriction deep. Rostrum slightly arched. Resembles the preceding, *R. sagax.*

♂. Length, $1\frac{1}{4}$ lines; breadth, nearly $\frac{3}{8}$ line.

Mount Arthur. Both sexes.

R. lewisi, Broun. Description being published at London.

Elongate, rather slender, nitid, ferruginous, pubescence inconspicuous.

Thorax distinctly medially depressed. Elytra plane, 3rd interstices distinctly elevated and bent near apices. Paler than the preceding species; base of elytra more or less infuscate.

♂. Length, $1\frac{1}{4}$ lines; breadth, $\frac{1}{4}$ line.

Broken River, Canterbury. Both sexes; several specimens.

R. elongatus, Broun. Description being published at London.

Narrow and elongate, subopaque, piceo-rufous, antennæ and tarsi rufo-testaceous, with minute greyish setæ.

Eyes not easily discernible, owing to the sculpture of the head.

♀. Length, $1\frac{3}{8}$ lines; breadth, quite $\frac{1}{4}$ line.

Ashburton. One of each sex; mutilated.

R. subconvexus, Broun. Description being published at London.

Nitid, rufous, pubescence scanty and slender.

Rather smaller and paler than *elongatus*, less depressed than *R. gracilis*. Scape rather short. Thorax not closely punctate. Elytra slightly convex.

♂. Length, $1\frac{1}{8}$ lines; breadth, $\frac{1}{4}$ line.

Otara, Southland. Unique.

R. suturalis, Broun. Description being published at London.

Rufo-piceous, legs and antennæ fusco-rufous.

Elytra distinctly striate-punctate, the suture slightly elevated. Antennæ rather elongate. Club narrow and somewhat flavescent.

Length, $1\frac{1}{4}$ lines; breadth, $\frac{1}{4}$ line.

Totara, Southland. One.

R. confertus, Sharp. 2199. Man. N.Z. Coleopt., p. 1248.

Narrow, subdepressed, nigrescent; the head, rostrum, antennæ, and legs rufous; shoulders fusco-rufous.

Rostrum elongate, cylindric. Elytra deeply striate, the striæ very closely punctured.

Somewhat similar to *R. parvicornis.* I have not seen it.

Length, $2\frac{3}{4}$ mm.

Picton.

R. constrictus, Sharp. 2200. Man. N.Z. Coleopt., p. 1249.

Narrow, subdepressed, fulvo-rufous.

Thorax longitudinally depressed on the middle, and with a slight smooth space on the middle. Elytra flat, coarsely punctate-seriate, interstices impunctate.

May be placed near *R. parvicornis.* I have not seen it.

Length, $2\frac{1}{4}$–3 mm.

Greymouth.

R. sulcirostris, sp. nov.

Elongate, subdepressed, dark rufous, elytra a little paler, club fulvescent; pubescence scanty, fine, and yellowish.

Rostrum broad in front, distinctly narrowed behind the middle, the punctuation rather shallow but moderately coarse and rugose behind the middle, in front with some slender longitudinal rugæ and some fine punctures; a broad furrow extends from near the apex towards the forehead; the coarse punctuation of the head is prolonged about half-way between the eyes and the thorax. Antennæ stout; 2nd joint of the funiculus very slightly longer than the 3rd; club elongate-oval, rather narrow. Thorax moderately constricted in front; if this portion were detached the remainder would be quite ovate; disc subdepressed, moderately but not closely punctured. Elytra subparallel, the base slightly yet quite appreciably incurved medially, and about as broad there as the widest part of the thorax, behind the middle; they are distinctly striate-punctate; near the suture, however, on each there are two striæ; interstitial punctures distant and indistinct. Tibiæ with a slender mucro at the inner extremity.

In some respects like *R. contiguus.* The rostal furrow, narrow club, and incurved elytral base, taken together, distinguish this species from all the others.

♂. Length, $1\frac{1}{8}$ lines; breadth, $\frac{1}{4}$ line.

Mount Egmont. One, minus a leg.

Camptoscapus, Broun. Ann. Mag. Nat. Hist., November, 1893.

Subdepressed, with some minute greyish hairs.

Rostrum more than half the length of thorax, moderately stout, very slightly arched, subparallel, or gradually narrowed towards the eyes in both sexes; in the female rather more slender, with the antennal insertion behind the middle. Eyes moderately prominent, distinctly separated from the thorax by the short smooth occiput. Antennæ moderately stout and elongate, inserted medially. Scape not at all short, incrassate but not abruptly clavate near the apex; this thick portion is bent backwards, the basal slightly in the opposite direction, in both sexes. Funiculus 5-articulate, 2nd joint nearly as long as the basal, 3–5 transverse. Club ovate, finely annulate. Thorax triangular-ovate, constricted in front. Scutellum distinct. Elytra as wide as thorax, nearly parallel, gradually narrowed backwards. Legs moderately long and stout; tibiæ slightly expanded towards the extremity. Tarsi slender, penultimate joint hardly at all dilated, excavate above but not lobate.

In the Japanese *Tychiodes* the scape is short and flexuous, an uncommon character apparently, but it and its immediate allies differ from *Camptoscapus* in other respects. From its New Zealand congeners it is readily separated by the peculiar form of the scape. The eyes are comparatively large, and, though rotundate, extend much downwards.

Camptoscapus sanguineus, Broun. Ann. Mag. Nat. Hist., November, 1893.

Nitid, piceo-rufus, the vertex and elytra suffused with piceous; pubescence scanty, slender, and cinereous, most easily seen on the posterior declivity.

Rostrum slightly narrowed behind the middle, moderately finely yet distinctly punctured, rather coarser behind, and abruptly terminating in line with the back of the eyes. Thorax with obtusely rounded posterior angles, its sides moderately rounded and narrowed towards the frontal constriction; disc almost flat, moderately finely, distinctly, but not closely punctured, more finely in front, the middle of apex smooth. Elytra at the base about the same width as the middle of thorax, subparallel, very gently narrowed posteriorly, their striæ regular, moderately deeply and distinctly punctured, interstices with fine serial punctures. Tibiæ but little dilated, not triangular, the front pair with yellow pubescence along the inner face and near the extremity; claws very small.

♂. Length, quite $1\frac{1}{4}$ lines; breadth, nearly $\frac{3}{8}$ line.

Mount Pirongia. Unique.

C. planiusculus, Broun. 910. Man. N.Z. Coleopt., p. 511.

Subdepressed, moderately shining, ferruginous, the fine short greyish hairs easily perceptible near the extremity of the rostrum and hind-body.

Rostrum moderately distinctly punctured, longitudinally rugose, more finely and closely near the apex, the punctuation rather coarse on the vertex and continued to just beyond the back of the eyes, the constriction or frontal narrowing of the finely punctate occiput does not reach the eyes, which are moderately large. Club evidently pubescent, apparently triarticulate. Thorax longer than broad, distinctly rounded laterally, widest near the middle, abruptly narrowed near the front, closely and finely punctate there, but with the middle of the apex smooth; dorsum subdepressed, distinctly but not closely punctured, more closely near the sides, the basal margin slightly thickened. Scutellum smooth. Elytra biarcuate at base, distinctly punctate-striate, interstices with serial punctures and rugulose, 3rd elevated and bent outwards at the extremity, femora slender near the base, clavate beyond.

♂. Length, $1\frac{5}{8}$ lines; breadth, $\frac{3}{8}$ line.

Whangarei. One only.

C. conicollis, Broun. 1306. Man. N.Z. Coleopt., p. 735.

Elongate, subdepressed, dark red.

Rostrum subparallel, shining, finely punctate; occiput nearly smooth. Scape quite the length of funiculus. Thorax more triangular than 910;

frontal constriction less deep and a little further from the apex; the disc rather more closely and distinctly punctate. Elytral striæ rather deeper, interstitial punctures more distinct.

♀. Length, $1\frac{5}{8}$ lines; breadth, $\frac{3}{8}$ line.

Wellington. Unique.

Macroscytalus, Broun. Man. N.Z. Coleopt., p. 736.

Body rather broad, subdepressed, minutely and scantily pubescent.

Rostrum more than half the length of thorax, moderately stout, narrowed behind the middle in both sexes. Occiput sharply limited at the sides close to the eyes; the punctuation of the head ceases abruptly in line with these organs. Scape stout, medially inserted, subclavate near the extremity, it attains the front of the eye. Funiculus short, 2nd joint nearly as long as the short basal one, 3–5 compact, transverse. Club oblong-oval, acuminate, as long as or longer than the funiculus, distinctly pubescent. Eyes large, slightly prominent, subtruncate behind, widely separated. Thorax rather short and broad, its sides strongly rounded; the moderate frontal constriction at each side extends obliquely towards the median discoidal linear impression. Scutellum small but distinct. Elytra rather short, subparallel or very slightly curved laterally, rather broader than the base of the thorax. Legs moderately stout; hooks of the tibiæ well developed, inner extremity with a sharp calcar; tarsi moderate, penultimate joint excavate but not lobed.

This genus should follow *Rhinanisus*. The rather broad subdepressed body and remarkably large antennal club, apart from other details, are characteristic.

Macroscytalus laticollis, Broun. 1308. Man. N.Z. Coleopt., p. 737. (Plate XV, fig. 10.)

Body moderately shining, dark red, head and thorax somewhat piceous, club nigrescent.

Rostrum for two-thirds of its length nearly as broad as the head, closely and finely punctured in front, more distinctly behind, and as far as the eyes and with a linear impression from the middle backwards. There is a slender interocular fovea. Thorax hardly any longer than it is broad, impressed along the middle, most obviously near the base, and with 2 oblique frontal impressions, the surface moderately closely and rather finely punctured. Elytra with indistinctly curvate sides, punctate-striate, interstices with numerous distinct serial punctures.

Underside plane. Mesosternum not abbreviated. Basal 2 ventral segments broadly impressed, and equalling the metasternum in length; the latter finely grooved. Coxæ small, widely separated.

♂. Length, $1\frac{1}{4}$ lines; breadth, $\frac{3}{8}$ line.

Parua, Whangarei. One of each sex.

M. depressus, Broun. 1433. Man. N.Z. Coleopt., p. 807.

Shining, castaneo-rufous, the interocular area, front of thorax, and the club somewhat piceous.

Rostrum finely punctured and shining. Interocular fovea small. Thorax with a shallow median impression at the base only. Elytra broadly impressed before the middle. Club much longer than the funiculus.

♂. Length, $1\frac{1}{8}$ lines; breadth, $\frac{1}{4}$ line.

Parua. Unique.

M. russulus, Broun. 1309. Man. N.Z. Coleopt., p. 737.

Castaneo-rufous, shining, antennæ slender, club pale fuscous.

Rostrum subcylindric, slightly narrowed behind, finely punctate and shining. Interocular fovea very distinct. Apex of thorax shining, but finely punctured, disc not flattened, with a small basal impression. Elytra very slightly rounded, unimpressed, rather broad.

♀. Length, $1\frac{1}{8}$ lines; breadth, $\frac{3}{8}$ line.

Tairua. Unique.

M. remotus, Sharp. 914. Man. N.Z. Coleopt., p. 513.

Rufo-piceous, club nigrescent.

Thorax medially impressed near the base. Interocular fovea indistinct.

♂. Length, $1\frac{1}{8}$ lines; breadth, quite $\frac{1}{4}$ line.

Tairua. One pair.

M. frontalis, Broun. Ann. Mag. Nat. Hist., November, 1893.

Shining, rostrum and thorax rufous, elytra and legs rufo-castaneous, club dull black.

Thorax shining and only feebly constricted in front. Interocular fovea indistinct. Elytra indefinitely impressed before the middle.

♀. Length, $1\frac{1}{8}$ lines; breadth, nearly $\frac{3}{8}$ line.

Hunua Range. One.

M. badius, Broun. 920. Man. N.Z. Coleopt., p. 516.

Broad, testaceous or slightly infuscate.

Thorax short and broad, unimpressed, abruptly narrowed in front.

♂. Length, $1\frac{1}{8}$ lines; breadth, nearly $\frac{3}{8}$ line.

Whangarei. One pair.

M. crenatus, sp. nov.

Subdepressed, moderately nitid, rufo-piceous, the frontal half of rostrum and the humeral area rufescent, antennæ clear red and shining, club nigrescent and densely pubescent.

Rostrum evidently narrowed behind the point of antennal insertion, before the middle, broadly sulcate from thence to the back of the eyes, distinctly yet finely punctate, more finely and distantly in front; occiput nearly smooth and shining. Thorax hardly longer than broad, considerably narrowed and constricted in front, widest behind the middle, strongly curvate there, the basal margin minutely prominent at the sides; disc flat, with a more or less evident smooth median line reaching the constriction but distant from the base, its punctuation moderately fine and close. Elytra rather wider than thorax at the base, very gradually narrowed posteriorly, moderately crenate-striate, interstices with fine serial punctures, and somewhat rugose. Legs closely punctured, 3rd tarsal joint a little expanded but not lobate. Pubescence scanty, greyish, visible only on the posterior part of the elytra.

Female.—Rostrum more slender, shining, finely and sparingly punctured, distinctly narrowed behind the middle.

The rostral canal and crenate-punctate elytral striæ will enable this species to be recognised. 1308 and 914 most nearly resemble it.

♂. Length, $1\frac{3}{8}$ lines; breadth, $\frac{3}{8}$ line.

Hunua Range and Woodhill. One at each.

Bæorhopalus, Broun. Man. N.Z. Coleopt., p. 806.

Subdepressed, rather broad, almost elongate-oval, glossy, glabrous.

Female.—Rostrum moderately arched, shorter than thorax, stout but not broad, slightly dilated medially, the point of antennal insertion moderately narrowed near the base. Head globose underneath, not elongated, gradually curvedly narrowed to the same width as the rostrum, the outline not interrupted by any prominence of the eyes, which are rather small and nearly flat; the occiput not distinctly marked off from the eyes or vertex. Scape stout, much thickened near the extremity, medially inserted, and attaining the front of the eye. Funiculus compactly articulated, 2nd joint not perceptibly longer than 3rd. Club oblong-oval. Thorax strongly rounded laterally, constricted in front. Scutellum distinct. Elytra indistinctly curved at the sides, gradually narrowed behind, their base a little wider than that of the thorax. Legs moderate, 3rd tarsal joint not lobate.

Male.—Underside glabrous, nearly plane, shining, castaneo-rufous, very finely and distantly punctured. Basal 2 ventral segments as long as the metasternum, broadly depressed along the middle, the metasternum grooved behind, prosternum quite truncate in front. The mesosternal suture and that between the basal 2 segments fine and nearly straight. 5th segment with a small impression at each side.

The natural position of this genus is, without doubt, next to *Macroscytalus*, which, though similar in form, is distinguished by the altogether different head, less slender rostrum, larger and more prominent eyes, larger club, &c. The coxæ are less widely separated than in *Pentarthrum*.

Unfortunately, this and three or four closely allied genera are seldom met with; all their species are rare.

Bæorhopalus glabrus, Broun. 1305. Man. N.Z. Coleopt., p. 735.

Glossy, rufous, elytra chestnut-red.

Rostrum with fine almost seriate punctures, the interocular sculpture nearly similar, with a slender fovea. Thorax nearly flat, as broad as it is long, widest just behind the middle, its sides strongly rounded, narrowed towards the constriction, very finely and distantly punctured, with a slight impression before the scutellum. Elytra rather flat, finely punctate-striate, interstices moderately broad, with fine serial punctures.

The male specimen is mounted on its back.

♀. Length, $1\frac{3}{8}$ lines; breadth, $\frac{3}{8}$ line.

Parua, Whangarei. Two examples.

Selocomis, gen. nov.

Subdepressed, subfusiform, rather thickly clothed with decumbent conspicuous yellow hairs.

Rostrum nearly the length of the thorax, quite half the width of the head, slightly narrowed near the base, not marked off from the forehead, abruptly truncate or shaved off at its apex. Scrobes oblique. Scape inserted behind the middle, attaining the centre of the eye, elongate, gradually incrassate. Funiculus laxly articulated, rather short, 2nd joint distinctly longer than 3rd, joints 3–5 transverse, 5th almost cup-shaped. Club compact, opaque, densely pubescent, very elongate, fully the length of the whole funiculus. Head short, narrowed anteriorly, globose underneath, the occiput short. Eyes subdepressed in front, slightly prominent behind, large, transversal. Thorax but little longer than broad, widest behind the middle, well rounded there, curvedly narrowed towards the abrupt frontal contraction. Scutellum distinct. Elytra rather broader than the thorax, parallel to beyond the hind thighs, curvedly narrowed behind, slightly transversely bi-impressed above. Legs stout, only moderately elongate; tibiæ uncinate, and acute at the inner extremity. Tarsi moderately narrow, 3rd joint slightly dilated, concave in front, entire below, not lobate. Coxæ widely separated. Rostrum, underneath, with two sharply defined grooves, and therefore appearing tricarinate. Metasternum rather longer than the basal 2 ventral segments taken together, distinctly medially sulcate. Mesosternal suture straight. Basal 2 segments slightly convex, their suture distinct and a little sinuate, the 1st transversely impressed behind.

Underside glossy, piceous, the last 3 abdominal segments rufescent, with distinct rather evenly distributed punctures, almost quite glabrous, having only a few minute hairs on the terminal segment, and therefore in marked contrast to the upper surface.

Exactly intermediate between *Macroscytalus* and *Agastegnus*, having the disproportionally long club of the former and the facies of the latter, from which, nevertheless, it differs in having shorter and thicker legs, more prominent eyes, stouter and differently inserted antennæ, different rostrum, &c. From *Macroscytalus* it is readily distinguishable by a glance at its conspicuous vestiture.

Selocomis æneopiceus, Broun. 915. Man. N.Z. Coleopt., p. 513.

Fusco-rufous, slightly bronzed; femora piceous; rostrum, antennæ, and tarsi rufous; slightly shining.

Rostrum parallel for more than half of its length, moderately closely and finely punctured, more distantly and finely in front. Head pilose, distinctly but not closely punctured. Thorax broadly impressed medially, with a slightly raised smooth central line, distinctly but not closely punctured, the apical margin nearly smooth. Elytra slightly broadly impressed before and behind the middle, their striæ somewhat indefinite, but with the punctures on the suture and interstices unusually close and distinct, the 3rd thickened, elevated, and bent at the extremity, and causing an apparent depression beyond each of them.

Length, $1\frac{3}{4}$ lines; breadth, nearly $\frac{1}{2}$ line.

Mount Manaia, Whangarei. One only.

Glyphoramphus, Broun. Man. N.Z. Coleopt., p. 970.

Body subdepressed, sparingly clothed with slender yellow hairs.

Rostrum shorter than the thorax, not quite as broad as the head, just perceptibly medially incurved, quite vertical in front, deeply concave between the antennæ. Head moderately globose; occiput short, slightly narrowed in front. Eyes moderately large and prominent, rotundate, widely separated. Scape inserted near the apex, attaining the eye, slightly flexuous, moderately elongate, slender near the base, subclavate for half its length. Funiculus rather slender, 2nd joint nearly as long as but more slender than the 1st, joints 3–5 laxly articulated, 5th very short. Club nearly oblong-oval, large, indistinctly annulate. Thorax about as broad as it is long, its sides strongly rounded, base truncate, deeply constricted in front. Scutellum distinct but small. Elytra subparallel, gradually narrowed behind, apices slightly rounded singly, the base evidently broader than that of the thorax. Legs stout and elongate; femora swollen and obtusely angulate below; tibiæ moderately and gradually expanded, their hooks rather small but quite distinct, with a slender spiniform process at the inner extremity. Tarsi moderately narrow, terminal joint as long as the basal 3 combined, 3rd moderately expanded and subbilobed, claws small.

The form most nearly resembles that of *Baorhopalus*, the thorax particularly. The rostrum is thick vertically, and the scape unusually incrassate towards the extremity. There is no approximate genus amongst the Pentarthrides.

Glyphoramphus rarus, Broun. 1735. Man. N.Z. Coleopt., p. 971.

Nitid, piceo-rufous tinged with castaneous, antennæ pale ferruginous.

Head and rostrum densely and very minutely sculptured; the punctures on the head are rather fine, but not close, and gradually become finer and fewer towards the front of the rostrum. Thorax distinctly longitudinally impressed, moderately finely and not closely punctate, the apex raised and nearly smooth. Elytra slightly broadly impressed before and behind the middle, regularly and moderately finely striate-punctate, striate behind; interstices finely seriate punctate and rugose, the 3rd and the suture elevated and sharply bent at the extremity.

♂. Length, $1\frac{1}{4}$ lines; breadth, $\frac{3}{8}$ line.

Mount Egmont. Unique.

Belka, gen. nov.

Body fusiform, moderately convex, evidently clothed with decumbent elongate yellow pubescence.

Rostrum rather shorter than thorax, subparallel, slightly narrowed near the base, cylindric, half the width of the head, and bearing many fine but elongate setæ along its sides; these are most easily seen from underneath. Scrobes prolonged to the inner and lower part of the eyes, their upper margins sharply defined there. Scape inserted behind the middle, attaining the centre of the eye, elongate, only moderately slender. Funiculus rather stouter than the scape, 2nd joint longer than 3rd, joints 3–5 become shorter. Club ovate. Head rather short, occiput strongly globose underneath, slightly narrowed but not perceptibly marked off in front. Eyes slightly prominent, moderately small, almost transversely oval. Thorax longer than broad, widest behind the middle, well rounded there, a good deal narrowed and constricted in front. Scutellum small. Elytra broader than thorax at the base, subparallel, narrowed behind, base slightly biarcuate, apices not distinctly rounded separately. Legs stout, femora subclavate; tibiæ uncinate; penultimate tarsal joint slightly dilated, concave above, entire below, terminal rather thick, with small claws.

It would be absurd to leave the type of this genus with *Pentarthrum*. The rostrum is like that of the female *Pentarthrum* (903) in length, but is slightly stouter, and quite perceptibly narrowed near the base. The eyes are distinctly smaller and more transversal. The scutellum is smaller. The scape cannot reach the back of the eye. The metasternum is shorter, with a very short groove behind. The basal 2 ventral segments are unimpressed, but their suture is well marked and sinuate. The rostrum underneath has 2 sharply impressed grooves. The more robust body and legs, different antennal insertion, and entirely different vestiture, &c., distinguish it from *Attarus*, near which it should be placed.

Female.—Rostrum rather longer, but not appreciably more slender. Thorax different, widest near the base, gradually narrowed from that point: posterior angles quite oblique. Apt to be mistaken for a distinct species.

Belka spadicea, Broun. 1628. Man. N.Z. Coleopt., p. 911.

Subopaque, rostrum and elytra slightly nitid, fusco-castaneous, legs of a chocolate colour, antennæ and tarsi piceo-rufous, pubescence more abundant on the elytra than on the thorax. In the male the elytra are somewhat rufescent.

Rostrum moderately finely and not closely punctured throughout. Head pubescent, moderately punctate; occiput not quite smooth. Scape glabrous, the funiculus finely and sparingly setose. Club densely and finely pubescent, slightly annulate. Thorax with a smooth median line, moderately finely and not closely punctured, disc convex, frontal constriction deep. Elytra as broad as the widest part of thorax, their striæ rather shallow, crenate-punctate, the punctuation becoming indistinct behind, interstices rugose and seriate-punctate.

Underside rufo-piceous, slightly nitid, the whole derm densely and minutely sculptured, the setæ greyish and slender but numerous, the punctuation moderately coarse but not close.

♂. Length, $1\frac{5}{8}$ lines; breadth, $\frac{3}{8}$ line.

Dunedin. One of each sex.

Attarus, gen. nov.

Elongate, fusiform-cylindric, slightly transversely convex, a little shining, sparingly clothed with slender but quite perceptible pubescence.

Rostrum porrect, a little arched in front, rather shorter than thorax, slightly narrowed behind, in front more than half the width of the head. Scrobes linear, directed obliquely towards the lower and inner part of the eyes. Scape elongate, only moderately stout, inserted at or before the middle, and attaining the front of the eye. Funiculus elongate, basal joint large, 2nd not distinctly longer than 3rd, 4th and 5th short. Club ovate, stout, not articulated. Head rather short, moderately globose, the occiput curvedly narrowed towards the eyes, but not constricted or marked off in front. Eyes rotundate, only slightly prominent, lateral. Thorax longer than broad, widest behind the middle, well rounded there, a good deal narrowed and constricted near the front, base truncate. Scutellum minute. Elytra subtruncate at the base, as broad as the widest part of the thorax, gradually narrowed posteriorly, their apices individually rounded. Legs relatively rather slender; tibiæ straight and hardly at all expanded, uncinate; tarsi stout, the terminal joint quite the length of the basal 3 united, 3rd a little expanded, widely concave in front, not distinctly lobate, apparently entire underneath.

Prosternum incurved in front, the coxæ more approximated than in *Pentarthrum*. The metasternum elongate, nearly as long as the abdomen, finely medially sulcate, 2nd ventral segment shorter than 1st, their suture distinct and undulate.

The structure of the antennæ and tarsi, irrespective of other characteristics, is enough to prevent the association of the type of this genus with *Eucossonus*. It cannot be referred to *Agastegnus*, which is composed of depressed, long-legged insects. *Sericotrogus* has an entirely different head, &c., and the other *Pentarthrum* allies also exhibit disparities.

Attarus tristis, sp. nov.

Angustate, dark piceo-rufous, legs rather lighter, antennæ fulvescent; slightly nitid, pubescence greyish-yellow.

Rostrum shining, rufescent, distantly and finely punctured in front, nearly smooth along the middle, the punctuation becoming coarse, somewhat elongate and rugose on the vertex; the occiput also with some distant punctures. Eyes much less prominent than in *Pentarthrum*. Thorax unimpressed; very coarsely, closely, and rugosely punctured at the sides; the disc less coarsely and closely, on the middle especially, more closely in front: the apical margin, however, is smooth, and of a somewhat metallic reddish-coppery hue. Elytra a good deal narrowed at the posterior declivity, the apical margins rufescent and evidently rounded singly; they are regularly and distinctly but not coarsely striate-punctate, quite striate behind, the suture and interstices finely seriate-punctate and slightly rugose. Legs with minute yellowish setæ, most conspicuous along the inner face of the front tibiæ.

Length, $1\frac{3}{8}$ lines; breadth, $\frac{3}{8}$ line.

Paparoa, Howick. Unique.

A. castus, Broun. 1307. Man. N.Z. Coleopt., p. 736.

This species must be detached from *Pentarthrum*. The rostrum is rather longer than that of *A. tristis*, similarly sculptured and narrowed behind, but along each side it bears several slender outstanding yet not very elongate setæ. Occiput smoother and more convex, and therefore more distinctly marked off from the close interocular punctuation. Disc of thorax very slightly and indistinctly flattened; the slender yellow hairs on its sides are quite easily seen. Scutellum small and seemingly bent downwards in front, instead of being horizontal. Elytra with more distinct and closer interstitial punctures; those in the striæ are more quadrate, and are separated by short intervals only; the yellow hairs are more numerous.

Length, $1\frac{1}{4}$ lines; breadth, $\frac{3}{8}$ line.

Whangarei. One.

A. vestitus, Broun. 916. Man. N.Z. Coleopt., p. 514.

Body dark piceo-rufous, tarsi and antennæ red, club fulvescent; pubescence distinct, yellow, rather elongate and slender.

Rostrum rather broad, incurved behind the middle; rather coarsely, relatively, punctured and longitudinally rugose, the punctures not as close on the head; the occiput also with a few punctures. Thorax with the median line smooth, coarsely and rugosely punctured, more closely at the sides than on the disc, very closely near the smooth coppery front margin. Elytra subpunctate-striate, quite striate behind and at the base; the suture and interstices finely seriately punctate and slightly rugose.

Underside shining, rufo-piceous, with minute setæ along the middle of the breast, but on the abdomen and along the sides the setæ are more elongate and obvious; the punctuation on the sides, the front of the prosternum, and on the basal 2 ventral segments is coarser than along the middle of the sternum; base of prosternum transversely rugose and punctate.

Prosternum truncate in front. Rostrum medially grooved underneath, the groove with sharply defined borders. Buccal cavity large. Metasternum elongate, rather shorter than the abdomen, medially sulcate. Basal ventral segment broadly impressed. 2nd shorter. their suture undulate. the 5th with elongate pubescence.

The rostrum is broader. the eyes more prominent. and the antennæ shorter and stouter than in the preceding two species. The scutellum is sunken. and does not seem to penetrate between the elytra.

The description is given in detail in case the discovery of more specimens should make it expedient to treat this species as the representative of a distinct genus. There can be no doubt as to its being a male.

♂. Length. 1½ lines; breadth. ⅜ line.

Parua Forest, Whangarei. Unique.

Agastegnus, Broun. Man. N.Z. Coleopt., p. 805.

Body slender. pubescence conspicuous.

Rostrum rather shorter than thorax. somewhat arched. moderately stout. rather gradually narrowed towards the base. Head globose below. curvedly narrowed anteriorly. the contour not interrupted by the sub-depressed eyes. the usually dark colour and punctuation also tend to render the eyes inconspicuous; the occiput is short. and not at all distinctly marked off in front. Antennæ elongate. Scape slender. gradually thickened. curvate or flexuous. inserted before the middle. in the female at the middle. and attaining the back of the eye. Funiculus laxly articulated, 2nd joint sometimes nearly as long as the basal one. 3–5 submoniliform. Club moderately large. subovate. Thorax triangularly ovate. moderately constricted in front. Scutellum small. Elytra broader than the base of the thorax. parallel or gently narrowed backwards. apices slightly rounded individually. Legs elongate and slender; tarsi narrow. 3rd joint not perceptibly lobed. terminal longer than the basal 3 conjointly. with small claws.

Prosternum deeply incurved in front. Metasternum longer than the basal 2 segments.

From *Pentarthrum. Rhinanisus.* and cognate forms this genus is differentiated by the conspicuous vestiture. long slender legs, &c.. and from *Sericotrogus* by the form of the head and more widely separated anterior coxæ. &c.

Agastegnus ruficollis, Broun. 1432. Man. N.Z. Coleopt., p. 806.

Variegate. moderately shining. pubescence slender. decumbent. yellow. distinct; rostrum and thorax rufescent; the head. club. and parts of elytra piceous; tibiæ more rufescent than the pitchy femora; antennæ pale red.

Rostrum moderately punctured. more finely and less closely in front. Thorax rather longer than broad. widest behind the middle. where it is rounded. more but gradually narrowed anteriorly than at the base. slightly constricted in front; disc broadly impressed along the middle. moderately coarsely punctured almost to the apex. Elytra rather broader than the thorax. feebly broadly impressed before the middle. with rather shallow but distinctly punctured striæ. interstices with minute serial punctures. the 2nd beyond the suture distinctly elevated and bent outwards near the apex.

Female.—Rostrum slightly more slender, parallel. less arched above. Thorax rather narrower. less constricted in front. its disc unimpressed.

♂. Length. 1 line; breadth. ¼ line.

Waitakerei Range.

A. gratus, Broun. 922. Man. N.Z. Coleopt., p. 517.

Concolorous, testaceous, rostrum slightly rufescent.

Thorax broadly but slightly impressed behind the middle. Elytra near the middle.

♀. Length, 1 line; breadth, ¼ line.

Parua, Whangarei. Unique.

A. longipes, Broun. 930. Man. N.Z. Coleopt., p. 522. (Plate XVI, fig. 1.)

Piceous; the thorax, rostrum, and antennæ rufescent; the dark head and club opaque.

Thorax broadly impressed. Elytra with slightly rounded shoulders, scutellar region depressed, slightly transversely impressed before the middle.

♂. Length, 1⅛ lines; breadth, quite ¼ line.

Whangarei. Both sexes.

A. simulans, Sharp. 933. Man. N.Z. Coleopt., p. 523.

Slender, obscure rufous, antennæ testaceous, club piceous.

Thorax indistinctly impressed behind the middle, opaque, closely and strongly punctured. Elytral striæ not deep but strongly punctured. Underside nigrescent.

Length, 1¾ mm.

Auckland.

A. coloratus, Broun. 1630. Man. N.Z. Coleopt., p. 911.

Rostrum, antennæ, and thorax rufescent; elytra fusco-testaceous, with irregular dark marks; legs of a chocolate hue; head and club piceous.

Rostrum as long as thorax, narrowed behind the middle. Eyes slightly prominent. Elytra with deep striæ. Thorax impressed along the middle, and with a smooth central line, which does not attain the base.

An aberrant species.

♂. Length, 1⅜ lines; breadth, ⅜ line.

Tuakau, Auckland. Unique.

A. femoralis, Broun. 1751. Man. N.Z. Coleopt., p. 970.

Shining, rostrum and thorax dark red, elytra castaneo-rufous, antennæ concolorous, club pale red.

Thorax rather finely punctured, impressed behind the middle, almost foveiform at the base. Elytra broadly impressed before the middle. Femora medially inflated. Pubescence unusually scanty.

♀. Length, 1⅜ lines; breadth, ⅜ line.

Mount Egmont. Three.

A. nitidirostris, Broun. 2202. Man. N.Z. Coleopt., p. 1250.

Æneo-piceous, antennæ shining red, club piceous, legs almost chocolate; rather thickly covered with pale-yellow long slender hairs.

Thorax slightly flattened. Elytra impressed before and behind the middle.

♂. Length, 1¼ lines; breadth, ⅜ line.

Mount Egmont. Unique.

A. distinctus, Broun. 2421. Man. N.Z. Coleopt., p. 1388.

Shining, rufous, elytra castaneo-rufous, the legs and club fusco-rufous.

Thorax evidently impressed behind the middle, finely punctured, intervals densely and minutely sculptured. Elytra broadly impressed before and behind the middle. Pubescence bright yellow, rather scanty.

♀. Length, nearly 1¼ lines; breadth, quite ¼ line.

Moeraki. One only.

A. sericatus, Broun. 1752. Man. N.Z. Coleopt., p. 970.

Castaneo-rufous, legs infuscate, the head and club piceous; pubescence yellow, not at all scanty.

Thorax broadly impressed from the base to beyond the middle, moderately coarsely and closely punctured relatively. Elytra paler than thorax, their sides, however, somewhat infuscate, the base biarcuate, slightly transversely impressed before and behind the middle.

♂. Length, 1⅛ lines; breadth, quite ¼ line.

Paparoa, near Howick. Unique.

A. rufescens, Broun. Ann. Mag. Nat. Hist., January, 1907.

Shining, infuscate red, elytra paler, rostrum red; pubescence bright yellow.

Thorax longitudinally but not deeply impressed. Elytra widest behind the posterior femora, gradually narrowed towards the base, indistinctly impressed before the middle. Antennæ very elongate. Scape distinctly flexuous.

Length, 1¼ lines; breadth, quite ¼ line.

Dunedin. One.

A. bi-impressus, sp. nov.

Subdepressed, elongate, only slightly nitid; rostrum, thorax, and antennæ piceo-rufous; head, club, and elytra piceous, these last more rufescent near the base; knees and tarsi paler; club quite opaque, densely and minutely pubescent; clothed with silky yellow hairs, most conspicuous on the thorax.

Rostrum rather slender, gradually narrowed towards its base, its punctuation nearly seriate, finer in front than behind. Thorax evidently longer than broad, its sides moderately rounded, abruptly contracted near the apex, which is sparingly punctured; disc with a broad shallow impression, distinctly and rather closely but not coarsely punctured. Scutellum small. Elytra subtruncate and evidently broader than thorax at the base, gradually narrowed posteriorly, broadly impressed before and behind the middle; their sculpture indefinite, striate-punctate, substriate at the base, the 3rd and 4th striæ moderately distinct, the suture and interstices with serial punctures, the 2nd and the suture somewhat thickened and elevated near the extremity. Scape curvate, inserted immediately before the middle; 2nd joint of funiculus longer than 3rd, joints 3–5 moniliform. Club oblong-oval.

The nearest species is *A. ruficollis*, which, however, has less expanded penultimate tarsal joints, and only one impression across the elytra.

Length, 1¼ line; breadth, quite ¼ line.

Waiorongomai, Mount Te Aroha. Unique.

Sericotrogus, Wollaston. Man. N.Z. Coleopt., p. 521.

Body elongate, subparallel, moderately convex, distinctly pubescent.

Rostrum shorter than the thorax, parallel, moderately broad in both sexes, slightly arched in front. Scape inserted just before the middle and attaining the middle of the eye, straight, thickened apically. Funiculus

5-articulate, 2nd joint longer than 3rd, 3–5 laxly articulated. Club ovate, abruptly broader than the funiculus. Head exserted, slightly narrowed anteriorly, abruptly wider than yet not quite twice the width of the rostrum. Eyes moderately prominent, situated in front. Thorax elongate, suboviform, not distinctly constricted in front. Scutellum distinct. Elytra slightly and gradually narrowed towards the base, apices simple. Legs moderately elongate; 3rd tarsal joint bilobed.

Differs from *Pentarthrum* in its more fusiform outline, longer and unconstricted head, relatively longer and narrower rostrum, differently formed thorax, and bilobed penultimate tarsal joint. The more approximated anterior *coxæ* will at once lead to its identification. The form of the head, the thick parallel rostrum, shorter legs, and much less separated front coxæ, apart from other structural details, distinguish it from *Agastegnus*.

Sericotrogus subænescens, Wollaston. 929. Man. N.Z. Coleopt., p. 521. (Plate XV, fig. 12.)

Elongate, subæneo-piceous, moderately nitid; vestiture fine but distinct, greyish or brassy; tarsi and antennæ dark red.

Male.—Rostrum moderately and closely punctured, somewhat rugosely, more finely towards the extremity. Thorax longer than broad, more gradually narrowed in front than behind, its punctuation, like that of the head, moderately close and distinct, but with the central line or space nearly smooth. Elytra punctuate-striate, the grooves rather shallow, interstices with fine distant punctures.

Underside shining, usually alutaceous or nigrescent, minutely pubescent, more or less coarsely punctate. Metasternum equalling the basal 2 segments in length, 1st segment longitudinally impressed. Rostrum with a broad basal carina, which becomes furcate in front.

Length, $1\frac{1}{2}$ lines; breadth, $\frac{3}{8}$ line.

Auckland, Wellington, and other localities.

S. ovicollis, Broun. 931. Man. N.Z. Coleopt., p. 522.

Near 929, shining, piceous, antennæ and tarsi dark red, nearly glabrous. Rostrum longer, slightly incrassate in front. Thorax more convex in the middle, so as to appear more depressed in front and across its base, more distinctly punctured. Elytra slightly more oviform; 3rd tarsal joint rather more expanded. Club oblong-oval, longer and distinctly narrower.

♂. Length, $1\frac{1}{2}$ lines; breadth, $\frac{3}{8}$ line.

Whangarei. One.

S. stramineus, Broun. 932. Man. N.Z. Coleopt., p. 523.

Flavescent, slightly rufescent sometimes; the pubescence scanty, slender and elongate, quite grey. The punctuation of the thorax more shallow; the serial punctures on the interstices of the elytra indistinct.

Length, $1\frac{1}{4}$ lines; breadth, nearly $\frac{3}{8}$ line.

Tairua. Two.

Gaurocryphus, gen. nov.

Elongate, fusiform-cylindric, subdepressed, vestiture elongate and very conspicuous.

Rostrum slightly arched, rather thicker than that of *Sericotrogus*, slightly narrowed behind the middle; rather more slender in the female, but much less so than in the same sex of *Pentarthrum*. Scape slightly flexuous, incrassate at the extremity, inserted just before the middle, and attaining the front of the eye. Funiculus 5-articulate, 2nd joint slightly longer than 3rd, joints 3–5 subquadrate. Club oblong-oval. Head rather short, globose underneath, slightly constricted just behind the very prominent eyes. Thorax triangular-ovate, evidently constricted in front. Scutellum small. Elytra incurved at base, slightly rounded singly at the apices, parallel-sided, rather broader than thorax at the base. Legs moderate, 3rd tarsal joint small, excavate but not distinctly lobed.

Underside shining, rufo-piceous, sparingly and minutely pubescent, coarsely punctate, terminal segment less distinctly. Anterior coxæ less distant than in *Pentarthrum*, further apart than those of *Sericotrogus*. Mesosternal suture distinct, truncate between the coxæ. Metasternum moderately elongate, medially sulcate. Basal ventral segment broadly impressed in the middle, sloping downwards towards the 2nd, the intervening suture subtruncate and well marked, the terminal bent upwards yet hardly reaching the level of the epipleuræ, with a round median impression; it is rufescent.

The type of this genus cannot remain in *Sericotrogus*, on account of the unlobed tarsi, more widely separated coxæ, different head, &c. The superb vestiture, more convex and prominent eyes, and the slight sexual differentiation of the rostrum show that it cannot be located in *Pentarthrum*. A new genus therefore is instituted for its reception.

Gaurocryphus auricomus, Broun. 1302. Man. N.Z. Coleopt., p. 733. (Plate XV, fig. 13.)

Piceo-rufous, moderately shining; with the exception of the apical half of the rostrum, thickly covered with decumbent, elongate, beautiful yellow hairs; in the female some of the elytral pubescence is greyish.

Rostrum distinctly longitudinally rugosely punctate almost to the extremity; vertex also moderately coarsely punctured, the short occiput finely. The eyes are distinctly convex. Thorax with moderately rounded sides, gradually narrowed from the middle towards the frontal constriction, which is only slight in the female; disc slightly convex, moderately coarsely and closely punctured almost to the apical margin. Elytra punctate-striate, the grooves, however, rather shallow; interstices and suture with serial punctures, the pubescence, however, renders the sculpture somewhat indefinite.

Female.—Rostrum rather longer, quite stout, slightly but widely narrowed behind the middle and again a little expanded towards the eyes. Antennæ medially inserted.

♂. Length, $1\frac{1}{4}$ lines; breadth, nearly $\frac{3}{8}$ line.

Tairua (one female). Waitakerei Range (one male).

Eucossonus, Broun. Man. N.Z. Coleopt., p. 870.

Elongate, subdepressed, the whole surface dull, with dense minute sculpture, and clothed with distinct yellow hairs or setæ.

Rostrum rather shorter than thorax, the basal half narrower than the frontal, arched above; more slender in the female. Scrobes narrow near the apex, expanded, and reaching the eyes. Head short, occiput much narrowed and constricted in front. Eyes moderately convex, subtruncate behind, and extending considerably downwards. Scape slender, elongate and flexuous, inserted before the middle, and almost reaching the thorax. Funiculus elongate, laxly articulated, the basal 2 joints of about equal length, joints 3–5 submoniliform. Club oblong-oval. Thorax longer than broad, deeply constricted near the front, so that the apex seems dilated, the portion behind the constriction quite oviform, rather flat and medially broadly canaliculate, its base bisinuate. Scutellum small. Elytra longer and rather broader than thorax, base biarcuate. Legs rather long and slender, penultimate joint of the tarsi with strongly developed lobes.

Underside nigrescent, subopaque, with some minute setæ; the punctuation moderately coarse, but not deep; the intervals densely and minutely sculptured. Rostrum medially carinate. Prosternum elongate, deeply impressed near the front. Mesosternum much abbreviated, so that the intermediate coxæ are nearly in contact with the prosternum. Metasternum elongate, medially sulcate behind. Basal ventral segment with an almost transverse impression behind, the shorter 2nd with a more shallow impression.

Structurally different from *Sericotrogus* in almost all respects. The form of the head and rostrum, and the frontal dilatation of the thorax, owing to the unusually deep constriction, is remarkable. The scrobes are expanded towards, and terminate in front of, the eyes; in *Sericotrogus* they are directed obliquely downwards to below the eyes. The anterior coxæ are more widely separated, but less so than in *Pentarthrum*. In specimens mounted on cardboard the head is sometimes retracted, and appears peculiarly pinched in behind the eyes; when more carefully set out the refuscent globose occiput is fully exposed.

Eucossonus comptus, Broun. 1550. Man. N.Z. Coleopt., p. 870. (Plate XV, fig. 16.)

Subopaque, fusco-rufous, sometimes darker, antennæ and tarsi ferruginous; the yellow hairs are rather elongate and decumbent on the thorax, finer on the head, rostrum, and elytra; on these they usually form lines or series, on the 2nd and 4th interstices particularly.

Rostrum finely subcarinate along the middle of the frontal half, its punctuation moderately coarse, close, and rugose. Thorax broadly depressed along the middle, with coarse shallow punctures. Elytra with somewhat ill-defined sculpture, apparently with shallow punctures in the striæ; interstices slightly asperate or rugose, the 2nd from the suture somewhat elevated; the setæ suberect. Legs finely setose; 3rd and 4th joints of the funiculus longer than broad.

Female.—Rostrum gradually and slightly narrowed backwards, slightly nitid, moderately coarsely and closely punctured behind, much more sparingly and finely in front.

♂. Length, 1⅝ lines; breadth, ⅜ line.

Waitakerei Range. Both sexes.

E. elegans, Broun. 2419. Man. N.Z. Coleopt., p. 1386.

Female.—Differs from 1550 in having the rostrum slightly dilated at the point of antennal insertion, behind the middle. Elytra striate-punctate.

Length, 1½ lines; breadth, ⅜ line.

Moeraki. One.

E. gracilis, Broun. 2420. Man. N.Z. Coleopt., p. 1387.

Rather narrow.

Rostrum more slender than that of 1550, more sparingly and finely punctate. Thorax not depressed along the middle, simply flattened there. Elytra rather wider near the hind thighs. Legs more slender and scape rather shorter than in *E. elegans*.

♂. Length, 1⅜ lines; breadth, quite ¼ line.

Moeraki. One.

E. setiger, Sharp. 934. Man. N.Z. Coleopt., p. 523.

Slender, narrow, very opaque, with depressed setæ.

Thorax without the obvious depression along the middle as in 1550, its punctuation obsolete. Elytra punctate-striate, but not very distinctly so. Scrobes small and indistinct.

Length, $2\frac{1}{2}$ mm.

Tairua.

E. rostralis, sp. nov.

Elongate, subdepressed, opaque, fusco-rufous, thorax rufo-piceous, antennæ and tarsi clear dark red, clothed with slender yellow conspicuous setæ.

Rostrum shorter than thorax, arched, nearly parallel, dull pitchy-red, the basal portion and the head with moderate shallow punctures and rugose, its frontal portion with finer indistinct punctures, nowhere quite smooth. Scape flexuous, medially inserted, and reaching beyond the back of the eye. Joints 3–5 of funiculus moniliform. Thorax broadly but not deeply impressed along the middle, the punctuation there quite distinct and rather close, finer in front. Scutellum small, rounded, with a distinct central puncture. Elytra indistinctly punctate-striate, interstices minutely sculptured and rugose.

On comparison with each of the described species I find that the rostrum is different. The thoracic punctures are quite definite.

Length, $1\frac{5}{8}$ lines; breadth, quite $\frac{3}{8}$ line.

Otago. One.

Agrilochilus, Broun. Man. N.Z. Coleopt., p. 520.

Body linear, narrowed anteriorly, depressed, opaque, closely sculptured, apparently minutely asperate, rather thickly covered with short slender setæ.

Rostrum as long as thorax, arched, moderately slender, subparallel, very gradually and slightly narrowed towards the extremity. Scrobes elongate, and extending towards the lower part of the eyes. Scape moderately stout and elongate, a little curved, inserted between the middle and the apex, and attaining the eye. Funiculus very slender, its basal joint, however, evidently thicker and longer than the following ones, 2nd longer than 3rd, narrowed behind, joints 3–5 laxly articulated and bead-like. Club broadly ovate. Head abruptly broader than the rostrum, porrect but not elongate. Eyes situated in front, not convex above, more so below, where their greatest bulk is. Thorax gradually narrowed towards the front, only slightly constricted there, feebly bisinuate at the base. Scutellum small. Elytra very elongate and parallel, base biarcuate towards the suture, with simple apices. Female antennæ medially inserted. Legs of moderate length and thickness; tibiæ with rather small hooks. Tarsi slender, 3rd joint with short lobes.

Underside flat, distinctly and closely but not at all deeply punctured, finely setose. Prosternum angularly impressed in front, the coxæ distinctly yet only slightly separated. Mesosternum moderate, the coxal cavities large and obliquely prolonged forwards. Metasternum very elongate yet shorter than the abdomen, the posterior coxæ hardly any further apart than the middle pair. Basal 2 ventral segments with one continuous broad depression along the middle, the terminal with a small fovea.

Abundantly distinct from all our New Zealand genera, as the first part of its description, of itself, clearly demonstrates.

Agrilochilus prolixus, Broun. 928. Man. N.Z. Coleopt., p. 521. (Plate XV, fig. 14.)

Obscure fusco-rufous, but when thoroughly cleaned and freed from sappy matter appearing slightly nitid; tarsi and antennæ ferruginous: the setæ greyish-yellow.

Rostrum with indistinct punctuation, minutely asperate or rugose, finely setose. The occiput very short and distinctly marked off from the sculptured vertex, which extends behind the eyes. Scape dull, funiculus shining and finely setose. Thorax with indefinite sculpture, apparently closely punctate, the apex reddish. Elytra closely striate-punctate and asperate.

♂. Length, 1⅜ lines; breadth, ¼ line.

Parua and Waitakerei Range. Both sexes.

Dioedimorpha, Broun. Man. N.Z. Coleopt., p. 805.

Subdepressed, very elongate, sparsely and very minutely, quite indistinctly, setose, and therefore appearing glabrous and moderately nitid.

Rostrum nearly as long as thorax, strongly curvedly dilated at the extremity, where it is quite as broad as the head; it is again, but only moderately, dilated behind the middle, at the point of antennal insertion. Mandibles prominent. Head subconical, longer than broad, the occiput short and evidently narrower than the sculptured part of the head. Scrobes short and abruptly directed downwards. Eyes not prominent, remote from thorax. Scape stout and gradually incrassate, inserted between the middle and the base, extending back to beyond the eye. Funiculus 5-articulate, joints 2–5 of nearly equal length. Club ovate. Thorax rather longer than broad, subconical, very slightly constricted in front. Scutellum distinct. Elytra twice as long as the thorax, and of almost the same width throughout. Legs relatively short and stout; penultimate tarsal joint excavate in front, but not distinctly lobed.

Underside moderately finely punctured, with some minute setæ. The coxæ more widely separated than in *Agrilochilus*. Metasternum very elongate, medially sulcate. Basal 2 ventral segments elongate. Rostrum with a distinct smooth median carina underneath.

Female.—Rostrum longer and more slender, antennæ inserted near the base.

This genus was instituted for the reception of Dr. Sharp's *Pentarthrum wollastonianum* and *P. debile*. The remarkable head and rostrum are sufficient for generic separation and identification.

Dioedimorpha wollastoniana, Sharp. 917. Man. N.Z. Coleopt., p. 514. (Plate XV, fig. 8.)

Piceous, sometimes more rufescent, antennæ and tarsi rufous, club paler.

Head and rostrum moderately closely and finely punctured, the occiput nearly smooth. Thorax a little wider behind the middle than it is elsewhere, gradually narrowed anteriorly, its sculpture very similar to that of the head, the middle of the apex smooth. Elytra finely striate-punctate, interstices with fine serial punctures and appearing transversely rugose.

This species is common on *Rhopalostylis* (*Areca*) *sapida*, and the individuals exhibit a considerable amount of variation not only as regards bulk, but also in the development of the head and rostrum. The typical specimen is a fully developed male.

♂. Length, 2⅝ lines; breadth, ⅜ line.

Whangarei and Waitakerei Range. Both sexes.

D. debile, Sharp. 918. Man. N.Z. Coleopt., p. 515.

Ferruginous, moderately shining, minutely setose. Differs from 917 in being more slender.

Rostrum relatively longer, but of similar shape. Antennæ inserted medially. Thorax relatively more coarsely punctured. Elytra less rugose, more distinctly punctate, but not quite punctate-striate, and tapering towards the extremity instead of being parallel.

♂. Length, $1\frac{3}{8}$ lines; breadth, $\frac{1}{4}$ line.

Parua and Howick.

Arecocryptus, Broun. Man. N.Z. Coleopt., p. 525.

Body elongate, subdepressed, vestiture setiform, slender but conspicuous.

Rostrum evidently longer than thorax, moderately slender, a little dilated towards the base and apex, slightly arched; underneath, between the middle and base, there is a conspicuous spiniform process, which is furcate at its apex and directed slightly backwards, and on the lower part of the head there is another spine directed forwards. The scrobes begin at the apex, and are prolonged backwards to the lower and front part of the eyes. Scape very elongate, moderately stout, slightly incrassate at the extremity, inserted at the apex, and attaining the eye. Funiculus rather longer than the scape, very slender; basal 2 joints very elongate, 2nd quite as long as but more slender than the basal one, 3rd also elongate but shorter than the preceding one, 5th shorter than 4th, both, however, longer than broad. Club oblong-oval, annulate. Head remarkably short, the nearly smooth occiput narrowed anteriorly, so that the eyes seem very convex and prominent. Thorax longer than broad, subovate, constricted in front, base slightly bisinuate. Scutellum small but distinct. Elytra not twice the length of thorax and rather wider and slightly biarcuate at the base, gradually narrowed posteriorly. Legs moderately long and slender, tibial hooks small. Tarsi with spongelike pubescence underneath, 2nd joint broad, the 3rd still broader, with strongly developed lobes, the terminal very slender and elongate, with long curved claws.

Underside nearly plane, distinctly and moderately closely punctate, with some fine slender pubescence. Coxæ moderately separated. Metasternum as long as the 2 basal ventral segments, the suture between these segments sinuous.

Female.—Rostrum more slender and arched, antennæ inserted before the middle, scape more slender and flexuous, without spines on the head and rostrum.

This is the most remarkable genus of the *Cossonidæ*. The rostral and interocular spines underneath, the long rostrum, outstanding eyes, apically inserted antennæ, and widely expanded lobate penultimate tarsal joint form a combination without precedent.

The more appropriate name *Arecocryptus* has been substituted for *Canthorhynchus*. The insect lives concealed near the base of the fronds of *Rhopalostylis* (*Areca*) *sapida*.

Arecocryptus bellus, Broun. 936. Man. N.Z. Coleopt., p. 526. (Plate XV, fig. 15.)

Subopaque, fusco-rufous, funiculus red, vestiture pale yellow.

Rostrum subcarinate along the middle, longitudinally rugose-punctate, the coarse punctuation ceasing abruptly behind the eyes, and with an angular fovea there. Thorax widest near the middle, rounded there, closely and moderately coarsely punctured: disc very slightly depressed, with an indistinct central line. Elytra subpunctate-striate, interstices rugose or slightly asperate.

Female.—Rostrum slender, finely and almost seriately punctate.

♂. Length, $2\frac{3}{4}$ lines: breadth, nearly $\frac{1}{2}$ line.

Parua and Hunua Range. Both sexes.

Entium, Sharp. Man. N.Z. Coleopt., p. 519.

Subcylindric, with slender suberect hairs.

Rostrum stout, shorter than thorax, subcylindrical, slightly narrowed anteriorly. Head moderate, gradually narrowed to the width of the rostrum; the outline, however, is slightly interrupted by the small longitudinally oval eyes. Scape medially inserted, of moderate length, gradually thickened. Funiculus 5-articulate, 2nd joint distinctly longer than 3rd, 3–5 small. Thorax subcylindric. Scutellum small but distinct. Elytra elongate, rather broader than thorax, distinctly so at the base. Legs slender, tibiæ linear, apical hooks very small. Tarsi small, their 3rd joint with short slender lobes.

Anterior coxæ nearly contiguous. Metasternum and basal 2 ventral segments nearly equally elongate.

The small size, suberect pubescence, small longitudinally oval eyes, almost unconstricted thorax, and approximated front coxæ are its most salient characters.

Entium aberrans, Sharp. 927. Man. N.Z. Coleopt., p. 520.

Narrow, slender, subconvex, moderately nitid, piceo-rufous.

Rostrum finely punctate, minutely and densely sculptured, scantily and minutely pubescent. Thorax a little longer than broad, its sides slightly rounded, relatively moderately coarsely punctate, more distantly along the middle. Elytra not striate, but with regular series of relatively coarse punctures, which become indistinct near the apex; interstices simple.

Underside rufescent, finely and sparingly punctured, with some slender setæ: basal ventral segment broadly impressed.

Length, $\frac{7}{8}$ line; breadth, $\frac{1}{4}$ line.

Parua and Howick. Rare.

Mesoxenophasis, Wollaston. Man. N.Z. Coleopt., p. 524.

Minute, fusiform, narrow, nitid, glabrous.

Head subglobose. Rostrum nearly as long as thorax, only moderately thick, subparallel, slightly and gradually narrowed towards the base. Eyes small, not prominent, placed somewhat on the upper surface. Scape inserted near the apex, moderately stout and elongate, gradually incrassate. Funiculus 5-articulate, 2nd joint slightly longer than 3rd. Club rather large, oblong-oval. Thorax oviform, obsoletely constricted in front, base slightly incurved. Scutellum small but distinct. Elytra fusiform, convex, base truncate. Legs rather long and stout, 3rd tarsal joint expanded and deeply bilobed.

Metasternum rather short. Basal 2 ventral segments suffused.

The distinct scutellum distinguishes this genus from *Microtribus*. There are no obvious sexual distinctions.

Mesoxenophasis brouni, Wollaston. 935. Man. N.Z. Coleopt., p. 525. (Plate XVI, fig. 2.)

Nitid, rufous or pale castaneous, antennæ red, club darker.

Rostrum sparingly but distinctly punctured. Head convex, with a minute interocular fovea. Thorax moderately and almost regularly rounded laterally, convex, its whole surface subopaque with minute dense sculpture, and with fine distant punctures. Elytra convex, moderately coarsely striate-punctate.

Underside sparingly punctate, the abdomen very finely, almost obsoletely.

Length, $1\frac{1}{4}$ lines; breadth, quite $\frac{1}{4}$ line.

Tairua and Hunua Range. Rare.

Proconus, Broun. Man. N.Z. Coleopt., p. 807.

Body depressed; minutely, indistinctly, and sparingly pubescent.

Rostrum as long and, in front, as broad as the head, evidently contracted behind the middle, minutely dilated just before the antennal insertion, broadly and subangularly depressed in front, and with a short smooth cariniform elevation in the middle of the cavity, at the apex, which is finely but distinctly setose. Occiput smooth, hardly perceptibly constricted or marked off from the punctate portion of the head, which extends halfway between the eyes and thorax. Eyes rotundate, only very slightly prominent, widely separated above and distant from the thorax. Scape short and stout, considerably thickened at the extremity, medially inserted, reaching the front of the eye. Funiculus longer than the scape, joints 2–5 gradually incrassate. Club distinct, ovate. Thorax broad, widest behind the middle, narrowed anteriorly, moderately constricted in front. Scutellum distinct. Elytra nearly as wide as the broadest part of the thorax, subparallel, very gradually narrowed posteriorly. Legs stout, 3rd tarsal joint short and without distinct lobes.

Intermediate between *Rhinanisus* and *Heteropsis*. Distinguishable at once by the short, broad, peculiar rostrum.

Proconus asperirostris, Broun. 921. Man. N.Z. Coleopt., p. 516. (Plate XV, fig. 11.)

Body moderately nitid, rufo-piceous, legs pitchy-red, depressed portion of rostrum red, antennæ paler.

Rostrum slightly asperate, more closely but not quite as coarsely punctured as the vertex, the frontal depression nearly smooth, a little transversely impressed near the base. Thorax longer than broad, strongly rounded near the base; disc very slightly impressed or flattened, with a smooth line along the middle, its punctuation moderately close and distinct, the intervals very minutely sculptured. Elytra moderately punctate-striate, the striæ rather shallow, the apex less distinctly sculptured; interstices and suture with fine serial punctures.

♂. Length, $1\frac{3}{8}$ lines; breadth, nearly $\frac{3}{8}$ line.

Whangarei and Helensville. Three. Female *incog.*

P. crassipes, Broun. 1631. Man. N.Z. Coleopt., p. 912.

Shining, pale rufo-castaneous. Much smaller than 921, frontal impression of the rostrum nearly similar, the thorax without any smooth median line.

♂. Length, $1\frac{1}{8}$ lines; breadth, $\frac{1}{4}$ line.

Helensville. Unique.

Heteropsis, Wollaston. Man. N.Z. Coleopt., p. 529.

Body small, narrow, subdepressed, subparallel, shining, glabrous.

Rostrum broad, rather longer than the short head, incurved behind the middle. Occiput marked off in front by a linear impression. Eyes obsolete. Scape inserted near the apex, short and stout, rather abruptly thickened near the extremity. Funiculus 5-articulate, 2nd joint not longer than 3rd. Club ovate. Thorax elongate, ovate-triangular, slightly constricted in front. Scutellum small. Elytra slightly narrower than thorax, parallel. Legs short and stout; tarsi short, 3rd joint narrow, not lobate.

Metasternum elongate. Basal ventral segment indistinctly longitudinally concave.

Differs from *Proconus* by its more cylindrical almost convex body, different rostrum, small size, and more especially by its obsolete eyes; this last character places it near *Amaurorrhinus*, which occurs in the Madeira and Canary Islands and southern Europe; its scutellum, however, is obsolete.

Heteropsis lawsoni, Wollaston. 940. Man. N.Z. Coleopt., p. 529.

Shining, piceo-castaneous, rufous in my specimen.

Head and rostrum finely punctate, marked off from each other by a fine line. Thorax distinctly punctured, more closely near the sides and behind the nearly smooth apex. Elytra lightly punctate-striate, interstices with minute serial punctures.

Underside moderately coarsely punctate.

Length, 1-1¼ lines; breadth, ¼ line.

Auckland. One.

Novitas, Broun. Man. N.Z. Coleopt., p. 527.

Body small, moderately elongate and convex, medially narrowed, glabrous, or with extremely slender pubescence.

Rostrum arched, as long as thorax, moderately stout in proportion to the small size of the insect, very gradually and slightly narrowed towards the extremity; in the female very slender and parallel. Head globose, usually immersed almost to the eyes, narrowed to the width of the rostrum. Eyes with coarse facets, comparatively large but not at all convex. Scape much curved, elongate and slender, but subclavate at the extremity, inserted distinctly before the middle and attaining the eye. Funiculus very elongate, 2nd joint as long as the 1st but more slender, 3rd oviform, 4th and 5th moniliform. Club oblong-oval. Thorax longer than broad, oviform, not constricted in front. Scutellum obsolete or altogether absent. Elytra widest behind the middle, gradually narrowed towards the slightly incurved base, which, however, is rather broader than that of the thorax. Legs long and stout, femora thick but not clavate, tibiæ rather short, not perceptibly uncinate. Tarsi with spongelike soles, basal joint small, 2nd and 3rd expanded and strongly transverse, the latter with short broad lobes and with slender projecting setæ.

Prosternum incurved in front, coxæ only moderately separated. Mesosternum moderately elongate. Metasternum remarkably short, much shorter than the basal ventral segment, so that the 2 hind pairs of legs are more approximated than the intermediate and anterior. Basal segment longitudinally impressed, its apical suture very fine, the 2nd, at the sides, almost as long as the 1st.

The minute size of the body, long arched rostrum, abbreviated metasternum, enormously expanded intermediate tarsal joints, apparently unarmed tibiæ, and obsolete scutellum, independently of other characters, remove this from all the genera known to me. The species live on *Phormium tenax.*

Novitas rufum, Broun. 938. Man. N.Z. Coleopt., p. 528.

Rufous, only slightly nitid, rostrum and thorax subopaque, antennæ and tarsi pale red.

Rostrum closely and minutely asperate, distinctly thicker at the base than in the following species, and with less slender antennæ. Thorax densely and minutely sculptured; distinctly, moderately finely, but not closely punctured. Elytra moderately finely punctate-striate, the outer striæ indistinct, all more or less effaced at the extremity, apices very slightly dehiscent, the interstices with minute sculpture like that of the thorax.

♂. Length, $\frac{3}{4}$ line; breadth, nearly $\frac{1}{4}$ line.

Parua. Unique.

N. nigrans, Broun. 939. Man. N.Z. Coleopt., p. 528.

Subopaque, piceo-niger, apical half of rostrum piceo-rufous, tibiæ, tarsi, and antennæ ferruginuous.

Rostrum closely and minutely asperate, but nearly smooth in front. Thorax rather longer than that of 938, more cylindrical, yet oviform; the derm similarly densely minutely sculptured; its punctures fewer, coarser, and quite distinct. Elytra rather coarsely striate-punctate near the base, almost obliterated behind the middle, with a sutural stria on each extending to the summit of the posterior declivity; the apical sculpture indistinct.

It is from this species that the generic characters were derived.

♂. Length, $\frac{7}{8}$ line; breadth, $\frac{1}{4}$ line.

Parua (one); afterwards both sexes on the Hunua Range.

N. dispar, Broun. 2204. Man. N.Z. Coleopt., p. 1251. (Plate XVI, fig. 4.)

Fusco-niger or piceous; apex of thorax and elytra and terminal 3 ventral segments somewhat castaneous; rostrum shining, slender, and rufescent.

Thorax with a sort of silky opacity, unusually broad in front, without perceptible punctures but appearing as if densely minutely granulate, it bears some slender brassy hairs; in the female it is of the normal shape, narrowed in front. Elytra slightly nitid, striate-punctate as far as the middle.

Female.—Antennæ inserted behind the middle.

♀. Length, $\frac{7}{8}$ line; breadth, $\frac{1}{4}$ line.

Tiritiri Island. Four specimens.

Unas, gen. nov.

Body subcylindric, transversely convex, apparently nude, with minute almost invisible pubescence only; shining, nigrescent, coarsely sculptured.

Rostrum arched, broad, subparallel, only very slightly narrowed towards the extremity, rather shorter than the thorax, not marked off from the forehead. Scrobes oblique. Head globose, its sides slightly narrowed behind the eyes. Scape medially inserted, very short and stout, still thicker at the extremity. Funiculus compact, basal joint moderately large, joints 2–5 transverse. Club but little broader than the 5th joint of the funiculus, oblong-oval, annulate. Eyes prominent, small, rotundate, less distant from the thorax than from each other. Thorax hardly longer than broad, a little wider behind the middle than elsewhere, only moderately rounded there, more narrowed in front than behind, abruptly contracted near the apex. Scutellum very small but quite visible. Elytra subparallel, curvedly narrowed behind. Legs stout, of moderate length, tibiæ uncinate, the anterior most distinctly. Tarsi rather short, 2nd joint transverse, 3rd moderately dilated, deeply excavate, but with short lobes only, the terminal as long as the basal 3 combined, with short claws.

Prosternum truncate in front; the coxæ almost contiguous, separated by the linear process only. The intermediate pair further apart, but not at all distant; the mesosternal suture strongly curved. Metasternum rather short, not as long as the basal 2 segments of the abdomen, with a triangular impression behind, the median sulcus very slender and indefinite. Basal segment very little longer than the 2nd, indefinitely limited behind, broadly but not deeply impressed. Rostrum tricarinate underneath. Tarsi with thickly setose soles.

Micrtribus, so far as the sternal structure and contiguity of the coxæ are concerned, approaches this genus, but the general contour and sculpture, the rostrum, tarsi, and antennæ exhibit striking disparities, and, moreover, the scutellum, like that of its four allies pertaining to St. Helena and Caffraria, is absent or obsolete. *Unas*, therefore, should precede that section, and be assigned a position by itself.

Unas piceus, Broun. 919. Man. N.Z. Coleopt., p. 515.

Nigro-piceous, legs and antennæ piceo-rufous, moderately nitid, with a few minute indistinct setæ.

Rostrum slightly rugosely and finely punctate, less closely along the middle. Head with distinct punctures, the occiput smooth near the sides. Thorax moderately closely and coarsely punctured, very closely at the sides, finely in front, basal margin depressed. Elytra cylindrical, punctate-striate, the intermediate striæ indistinct, the sculpture rather finer near the apices, the suture and interstices with fine serial punctures but not rugose.

Underside shining pitchy-black, with some minute setæ; rather coarsely but not closely punctured, the 3rd and 4th ventral segments with a transverse series of punctures on each, the 5th closely and finely punctured, front of prosternum coarsely and transversely rugose.

♂. Length, $1\frac{3}{8}$ lines; breadth, $\frac{3}{8}$ line.

Mount Manaia, Whangarei. Unique.

Trachyglyphus, gen. nov.

Body transversely convex, subcylindric, narrowed anteriorly, somewhat roughly sculptured, quite opaque; bearing erect short slender setæ, which on the elytra are disposed principally along the interstices.

Rostrum more than half the length of the thorax, broad, nearly the width of the head, gradually and slightly narrowed anteriorly, nearly flat above, slightly arched, not marked off from the forehead; underneath, longitudinally bisulcate. Scrobes expanded towards the eyes. Head moderately globose, short, without any frontal stricture. Eyes small but very convex and prominent, widely distant from each other. Scape very short, much thickened near the extremity, inserted just before the middle, hardly reaching the eye. Funiculus 5-articulate, basal joint stout, 2nd not distinctly longer than 3rd, the last 3 transversal. Club ovate, not visibly annulate. Thorax at the base as broad as the elytra, gradually narrowed towards the front, where it is abruptly constricted, posterior angles oblique, it is longer than broad. Scutellum obsolete. Elytra parallel, narrowed near the extremity, slightly biarcuate at the base. Legs moderate, stout, tibiæ uncinate. Tarsi rather narrow, penultimate joint narrow, not at all lobate, the terminal as long as the basal 3 combined, claws distinct.

Prosternum slightly incurved and deeply constricted in front, the coxæ distant, yet less widely so than in *Pentarthrum.* Metasternum elongate but shorter than the abdomen, distinctly medially sulcate. Basal ventral segment longitudinally concave, not double the length of the 2nd, the apical closely and finely punctate.

After carefully studying the generic diagnoses of the Pentarthrides I fail to find any genus like *Trachyglyphus.* Its allies occur in the Malay Archipelago, Japan, St. Helena, and Europe. In the New Zealand list it must be placed near *Microtribus,* from which, however, it is altogether different. In form it more resembles *Inosomus.*

The eyes are unusually convex and prominent, the scape much abbreviated and incrassate, the scutellum is invisible, and the rostrum is, proportionally, broader than that of *Pentarthrum.*

Trachyglyphus rugirostris, Broun. 1303. Man. N.Z. Coleopt., p. 734.

Opaque, piceous, legs of an obscure chocolate hue, antennæ dark red.

Rostrum longer than broad, rather coarsely punctured and longitudinally rugose, more finely in front, the whole of the head similarly punctured. Thorax widest near the base, its sides only slightly curved but gradually narrowed anteriorly; its whole surface closely, rugosely,, and coarsely punctured, the intervals narrow; each puncture has a small seta, the setæ on the sides more perceptible. Elytra dull, the suture slightly rufescent; punctate-striate, subcrenate, the suture and interstices unusually closely and distinctly seriate-punctate and rugose.

Underside subopaque, piceous; the head rufo-castaneous, and, including the legs, bearing suberect slender brassy setæ; the whole derm densely and minutely sculptured, rather coarsely but not closely punctured.

♂. Length, $1\frac{1}{4}$ lines; breadth, $\frac{3}{8}$ line.

Tairua, Auckland. Unique.

Microtribus, Wollaston. Man. N.Z. Coleopt., p. 527.

Body fusiform, subnitid, nearly glabrous, the base of the thorax and elytra with a few slender hairs.

Head convex. Rostrum rather long, of about the same length as the thorax, moderately slender, parallel. Eyes small, longitudinally oval, placed somewhat on the upper surface, only slightly prominent. Thorax hardly longer than broad, oviform, slightly constricted in front, convex. Scutellum obsolete. Elytra fusiform, base truncate. Antennæ moderately elongate, implanted before the middle. Scape stout, slightly flexuous. Funiculus 5-articulate, laxly jointed, 2nd longer than 3rd, 4th and 5th moniliform. Club large, ovate. Legs stout and moderately long, tibial hooks small. Tarsi with their 3rd joint expanded and bilobed.

Metasternum in the middle hardly as long as the basal ventral segment, both broadly impressed or concave. Anterior coxæ nearly contiguous. These last characters alone remove this genus from *Pentarthrum* and its near allies, whilst the obsolete scutellum necessitates its location in the 3rd section of the Pentarthrides, along with four African and Atlantic genera.

Microtribus huttoni, Wollaston. 937. Man. N.Z. Coleopt., p. 527. (Plate XVI, fig. 3.)

Nigro-piceous, subnitid, antennæ and tarsi piceo-rufous.

Rostrum distinctly, moderately finely, but not closely punctured, slightly narrowed behind. Head with a fine interocular impression. Thorax moderately coarsely but not closely punctured, the intervals minutely sculptured; there is usually a linear nearly smooth space along the middle. Elytra rather finely substriate-punctate, the sutural 2 on each most distinct, the others more or less obsolete, interstices with minute punctures and more or less rugose, the sculpture more indefinite behind.

Underside shining, the metasternum and basal ventral segment coarsely, 2nd segment more finely, punctate.

Length, $1\frac{1}{2}$ lines; breadth, $\frac{3}{8}$ line.

Both Islands. Apparently rare.

M. pictonensis, Sharp. 2203. Man. N.Z. Coleopt., p. 1250.

Subcylindric, fusco-piceous. Rostrum short, rather thicker than in 937, closely punctate, and dull. Antennæ very short and thick, inserted behind the middle, the club small and slender. Thorax closely and strongly punctured, rounded at the sides and much narrowed in front, where it is only very obscurely constricted. Scutellum minute. Elytra with series of coarse punctures at the base, but becoming more obsolete towards the extremity, interstices sparingly seriately punctate.

Length, 3 mm.

Picton.

I have not seen this species, but the presence of the scutellum and the different antennal insertion prove that it is not a true *Microtribus*.

Idus, Broun. Man. N.Z. Coleopt., p. 1493.

Minute, convex, medially contracted, nearly glabrous.

Rostrum arched, quite as long as the thorax, nearly parallel, moderately stout. Scape strongly flexuous, apex incrassate, inserted distinctly before the middle, moderately elongate. Funiculus 5-articulate, laxly articulated, joints 3–5 almost equal. Club abruptly marked off, ovate, evidently annulate. Head deeply immersed, globose. Thorax subcylindrical, its sides a little rounded, not constricted in front. Elytra subovate, convex, rather short, widest behind the posterior femora, narrowed to about the same breadth as the thorax at the base.

Femora long and stout, not dilated underneath. Tibiæ rather straight, the anterior oblique at the extremity, on the inside, beyond the middle, distinctly ciliate, not visibly uncinate; the others with a spinule at each angle. Tarsi narrow and elongate, their penultimate joint equally narrow, simple, the terminal elongate.

Prosternum elongate, widely emarginate in front, the coxæ contiguous. Intermediate coxæ slightly, the posterior moderately, separated. Metasternum much abbreviated, so that the hind and middle coxæ nearly touch each other. Basal 2 abdominal segments depressed and elongate, their suture fine and sinuous, the 1st the larger.

Scutellum absent. Eyes obsolete. These two important characters would seem to indicate that the position of this genus should be in proximity to the Australian *Halorhynchus*, and *Pentatemnus*, from the Canary Islands; both of these, however, according to their descriptions, are materially different, whilst the absence of the tibial hooks, in conjunction with other characteristics, necessitate the formation of a separate section to follow that occupied by *Halorhynchus*.

Idus cæcus, Broun. 2576. Man. N.Z. Coleopt., p. 1494.

Glossy, red, legs paler, antennæ and tarsi yellowish, with a few minute setæ.

Rostrum smooth, its front face apparently shaved off or obtusely truncate. Thorax longer than broad, very slightly wider behind the middle than it is elsewhere, depressed at the base, with rather fine but distinct moderately distant punctures, each of which bears a very minute seta. Elytra with 4 discoidal striæ on each, these with only 8 or 10 coarse punctures, the sutural grooves broader than the others, the posterior declivity more finely sculptured: interstices indistinctly punctate, with a few inconspicuous slender pallid hairs.

Abdomen elongate, the basal 2 segments distantly but distinctly punctured: in each puncture there is a depressed comparatively coarse pale seta; there are none on the 5th.

♂. Length, $\frac{7}{8}$ line; breadth, quite $\frac{1}{4}$ line.

Mount Pirongia. Unique, unfortunately.

Protogonum, gen. nov.

Body robust, moderately elongate, sparingly clothed with minute slender indistinct setæ.

Rostrum nearly as long as and in front not much narrower than the thorax, curvedly narrowed to about half that width behind: the frontal portion is angularly dilated at each side, the apex oblique towards the middle and with a slight emargination there. Scrobes oblique, extending from just behind the lateral dilatations to the lower part of the eyes. Mandibles prominent, bifid at the extremity. Head moderately globose underneath, its sculptured portion extending nearly midway between the eyes and the thoracic margin. Eyes rotundate, moderately prominent, nearly as distant from the thorax as they are from each other. Scape stout, gradually incrassate, slightly flexuous, inserted just before the middle, and attaining the front of the eye. Funiculus with slender setæ, the basal 2 joints of almost equal length, 3–5 transverse. Club oblong-oval. Thorax about as broad as it is long, abruptly contracted in front, quite oviform behind the constriction, base feebly bisinuate. Scutellum distinct. Elytra as broad as the thorax, subparallel, biarcuate at the base, gradually narrowed behind, with simple apices. Legs moderately stout and elongate. Femora slender at the base, clavate beyond. Anterior tibiæ distinctly uncinate, mucronate at the inner extremity; the external hooks of the other pairs are curved forwards instead of backwards, and the inner extremity of each projects as an angular process. Tarsi finely setose underneath, 3rd joint deeply excavate, but hardly at all expanded, so that the lobes are narrow.

Prosternum truncate in front, its basal portion on a higher level than the middle. Anterior and intermediate coxæ almost equally separated, but much more approximated than in *Pentarthrum*. Mesosternal suture very distinct, and strongly curved between the coxæ. Metasternum equal to the basal 2 segments in length, medially sulcate, and with an angular impression behind. Basal 2 ventral segments concave along the middle, their suture very fine and sinuous, 3rd and 4th rather flatter and longer than usual; 5th with a large circular impression, closely and finely punctate and distinctly pubescent.

Mr. J. H. Lewis kindly placed at my disposal his unique specimen of the type of this genus, Sharp's *Pentarthrum helmsianum*. Among the fourteen exotic genera of the section of Pentarthrides in which *Pentarthrum* is placed, not one can be found to correspond with *Protogonum* in structure or facies. I need not specify the differences between this genus and *Pentarthrum*, as they have scarcely any part of their structure alike. The anterior portion of the rostrum to a slight extent resembles that of the Malayan *Megacerus*, one of the *Brenthidæ*.

Protogonum helmsianum, Sharp. 2196. Man. N.Z. Coleopt., p. 1247. (Plate XVI, fig. 8.)

Nitid, black, tarsi and funiculus piceous, club opaque, densely and minutely pubescent.

Rostrum finely longitudinally rugose and punctate in front, nearly smooth at the apex, the punctuation more distinct and almost seriate behind and continued for some distance beyond the eyes; occiput smooth. Thorax moderately convex, deeply constricted in front, with a slight foveiform impression at each side near the apex, its surface moderately closely, distinctly, and evenly punctured. Scutellum with a slight median transverse impression. Elytra distinctly but not coarsely striate-punctate, quite striate behind, the sutural striæ rather broad near the base; interstices with fine serial punctures, and, in my specimen, quite shining.

Underside black, moderately nitid, sparingly minutely setigerous. Metasternum evenly but not closely or coarsely punctured, with a fovea near each side at the middle, the basal ventral segments more finely and closely punctured. The buccal cavity is not deep, and the rigid palpi are quite discernible.

♂. Length, $2\frac{3}{4}$ lines; breadth, $\frac{5}{8}$ line.

Greymouth.

Obs.—This genus is placed at the end of the Pentarthrides, as I had not seen it until after the revision had been completed.

Group Cossonides.

Funiculus 7-articulate.

Phlœophagosoma, Wollaston. Man. N.Z. Coleopt., p. 529.

Body fusiform or elongate subovate-cylindricum, moderately shining, glabrous.

Rostrum as long or nearly as long as thorax, moderately stout, parallel, rarely slightly dilated medially or basally. Eyes moderate, lateral. Thorax usually elongate, ovate-triangular, slightly constricted in front. Scutellum rather small, but distinct. Elytra elongate, the base wider than that of the thorax, subparallel, gradually narrowed posteriorly. Scape moderately elongate, stout, medially inserted, reaching beyond the back of the eye; 2nd joint of the funiculus sometimes longer than the 3rd. Club large, indistinctly annulate. Legs stout, inner angle of the tibiæ produced, with a spinule there. Tarsi with their 3rd joint slightly dilated, rarely subbilobed, claws small.

Metasternum rather long, sharply sulcate medially behind. Anterior coxæ widely separated.

Allied to *Rhyncolus*, but differing therefrom in having the rostrum more slender and elongate, more medially inserted and thinner antennæ, with a more abrupt and larger club, and less prominent eyes. From *Phlœophagus* it differs in having a larger scutellum, more elongated prothorax and metasternum, and the 2nd joint of the funiculus and tarsi more abbreviated. The species are usually larger, less ovate and convex, their rostrum proportionally more lengthened, and the anterior 4 coxæ wider apart.

The species occur in Japan, Malaya, India, New Zealand, &c.

Phlœophagosoma corvinum, Wollaston. 941. Man. N.Z. Coleopt., p. 530.

Parallel-fusiform, subcylindrical, rather convex, nitid, black.

Rostrum rather long, parallel, sparingly and minutely punctate. Eyes small, moderately prominent. Thorax triangular-ovate, very slightly constricted in front, moderately finely but not closely punctured, more openly along the middle. Elytra subcylindric, narrowed posteriorly, quite as broad as the broadest part of the thorax, behind the middle, evidently punctate-striate, subcrenate-punctate: interstices moderately convex, subrugulose, sparingly and minutely punctate, the sculpture much less distinct on the posterior declivity. Underside lightly and distantly punctate. Antennæ rather slender, rufo-piceous, club subobscure.

Length, $2\frac{1}{3}$ lines; breadth, $\frac{5}{8}$ line.

Tairua.

P. thoracicum, Wollaston. 943. Man. N.Z. Coleopt., p. 531.

Nitid, nigro-piceous, elytra piceous.

Rostrum subarcuate, moderately densely punctate. Thorax moderately coarsely and closely punctate. Elytra truncate at base.

Like 941; thorax larger, a trifle more distantly punctured, elytra more deeply punctate-striate and less biarcuate at the base.

Length, $2-2\frac{1}{4}$ lines; breadth, $\frac{5}{8}$ line.

Parua.

P. dilutum, Wollaston. 944. Man. N.Z. Coleopt., p. 531.

Piceous, elytra piceo-castaneous.

Like 941; rather smaller and narrower. Its rostrum, in proportion to its size, a trifle broader, and obsoletely impressed transversely between the eyes, causing it to appear obscurely subdivided from the forehead; and its scape is more elongated, and extends beyond the apex of the rostrum.

Length, $1\frac{3}{4}-2\frac{1}{4}$ lines; breadth, $\frac{1}{2}$ line.

Tairua and Parua.

P. pedatum, Wollaston. 945. Man. N.Z. Coleopt., p. 532.

Like the preceding species; just appreciably less fusiform or more parallel, the vertex with a more distinctly impressed linear fovea, and the 3rd tarsal joint very much wider and deeply bilobed.

Length, $2\frac{1}{2}$ lines; breadth, $\frac{5}{8}$ line.

Auckland and Mokohinau Island.

P. rugipenne, Broun. 1310. Man. N.Z. Coleopt., p. 738.

Nude, shining, piceo-niger, legs and antennæ rufo-piceous, anterior tibiæ along the inside distinctly clothed with fine brassy setæ.

Rostrum parallel, moderately arched, finely but not closely punctured almost as far as the thoracic margin, rather more finely near the apex, the fovea behind the eyes minute. Thorax longer than broad, widest behind the middle; the sides, however, only very gently rounded; frontal constriction distinct; with a smooth central line, distinctly, rather finely, but not at all closely punctured. Elytra evidently striate and crenate-punctate, interstices rugose and, like the suture, with serial punctures; the base distinctly biarcuate. Tarsi simple, their terminal joint rather long and slender.

The antennæ are inserted before the middle. This will lead to its recognition.

Length, $2\frac{3}{4}$ lines; breadth, $\frac{5}{8}$ line.

Mount Manaia, Whangarei.

P. abdominale, Broun. 1311. Man. N.Z. Coleopt., p. 738.

Shining, black, glabrous, legs and antennæ piceo-rufous.

Rostrum slightly dilated behind the middle, distinctly arched or convex there, but not impressed behind, with two minute rufescent projections, and fine pale setæ at the apex; finely but not closely punctured; occiput finely and distantly punctured, the interocular fovea minute. Eyes rather large, subtruncate behind, not prominent. Antennæ inserted behind the middle. Thorax slightly longer than broad, a good deal rounded behind the middle and narrowed but not deeply constricted in front, its sculpture similar to that of 1310. Scutellum transverse. Elytra subtruncate at the base, which is slightly wider than that of the thorax; they are not cylindric, being gradually but quite perceptibly attenuated posteriorly; punctate-striate, the intermediate striæ indistinct, interstices and suture with fine serial punctures but not rugose. Tarsi simple.

The antennal insertion, broad scutellum, larger, depressed, and differently formed eyes are features which will enable it to be identified.

Obs.—Whilst the various members of this genus were under review I noticed that the extreme apex, or clypeus, was more or less rufescent, and angularly emarginate in the middle, as is certainly the case in this species.

Length, $2\frac{1}{2}$ lines; breadth, $\frac{5}{8}$ line.

Mount Manaia. Unique.

Eutornus, Wollaston. Man. N.Z. Coleopt., p. 534.

Allied to the Malayan *Conarthrus*, the body more fusiform and lightly sculptured, more rufescent, &c.

♂. Rostrum broad, hardly as long as the head nor as broad as it is, subparallel. Scrobes deep, oblique, passing abruptly to the lower surface in front of the eyes. Head globose, quite as long as broad, subparallel, the occiput not perceptibly marked off from the head. Eyes widely separated from each other and distant from the thorax, quite prominent, rotundate, moderately large. Scape medially inserted, reaching backwards to beyond the eye, stout, gradually incrassate, and distinctly flexuous. Funiculus closely articulated, the basal joint largest, joints 2–7 almost equally transverse. Club large, ovate, or oblong-oval. Thorax subcylindrical, its sides a little rounded, moderately narrowed and constricted in front. Scutellum very small. Elytra broader than thorax, subparallel, gradually narrowed posteriorly. Legs of moderate length and thickness, tibial hooks well developed. Tarsi finely setose underneath, 2nd joint of the anterior oblong or quadrate, 3rd not expanded, excavate in front, but not lobate, terminal rather slender and hardly the length of the basal three combined.

Underside shining, nigrescent, moderately finely and distantly punctate. Prosternum truncate in front, the coxæ only moderately separated; the intermediate and posterior coxæ almost equally and widely separated. Metasternum as long as the basal 2 ventral segments, medially sulcate; 2nd segment shorter and more finely sculptured than the 1st; both unimpressed.

The above description has been drawn up from specimens of *Eutornus dubius*, and will, I hope, prove more satisfactory to New Zealand students than the original one, which necessitates a careful comparison with Japanese and Malayan genera, which he may never see. The species occur in Ceylon and the Malay Archipelago.

The short broad head and rostrum, and strongly flexuous scape, will enable this genus to be separated from *Phlœophagosoma*.

Eutornus dubius, Wollaston. 948. Man. N.Z. Coleopt., p. 534.

Elongate, fusiform, rather nitid, piceo-niger, elytra rufo-piceous.

Head broader than the rostrum, with a linear interocular impression, moderately punctured, more distantly behind the eyes, nearly smooth behind. Thorax not twice as long as broad, rather wider near the base than it is elsewhere, but only slightly rounded at the sides, gradually narrowed anteriorly; moderately coarsely but not closely punctured. Elytra truncate at base, striate-punctate, interstices with fine serial punctures and in some aspects appearing rugose. Antennæ rufo-piceous.

♂. Length, $1\frac{2}{3}$ lines; breadth, nearly $\frac{1}{2}$ line.

Auckland, Parua, &c.

E. vicinus, Broun. 949. Man. N.Z. Coleopt., p. 535.

Shining, piceous, elytra castaneous, with the suture and sides piceous, antennæ and tarsi dark red, with some minute grey setæ visible on the posterior declivity.

Differs from *E. dubius* in having a less flexuous scape, the rostrum about a third longer and more finely punctate, the head more closely and finely and without any interocular impression; the occiput smoother and slightly incurved between the thorax and the eyes, which are hardly at all prominent; the thorax more closely, scutellum more distinct; elytra striate at the base and alongside the suture, their interstices not rugose, and with their apical margins a little dilated or thickened. Antennæ inserted almost behind the middle.

♀. Length, $1\frac{1}{2}$ lines; breadth, $\frac{3}{8}$ line.

Parua. One only.

E. breviceps, Broun. 950. Man. N.Z. Coleopt., p. 535.

Rostrum finely and somewhat rugosely punctate, with an angular impression near the apex. Eyes small and subdepressed. Funiculus short, so that the club appears to equal it in length. Thorax cylindrical, nearly as broad in front as at the base, slightly constricted in front, much more closely and finely (and somewhat rugosely) punctured than that of *E. dubius*; the intervals between the punctures densely and minutely sculptured, as is also the case on the rostrum. Body rufo-castaneous.

♂. Length, $1\frac{1}{4}$ lines; breadth, $\frac{3}{8}$ line.

Parua. Unique.

The type, unfortunately, was dislodged from the mica slab on which it was mounted, and lost.

E. amplus, Broun. 951. Man. N.Z. Coleopt., p. 535.

Rufo-piceous, moderately nitid. Larger than typical examples of *E. dubius*, the head and rostrum more finely punctured, the former appreciably longer and a little constricted midway between the eyes and thorax, antennæ more elongate, the linear interocular impression prolonged to the middle of the rostrum, thorax more deeply constricted, the base of the elytra bi-arcuate, the sutural striæ distinct.

♂. Length, $2\frac{1}{8}$ lines ; breadth, nearly $\frac{1}{2}$ line.

Parua.

E. littoralis, Broun. 952. Man. N.Z. Coleopt., p. 536. (Plate XVI, fig. 12.)

Piceo-rufous, elytra sometimes piceous, the legs and antennæ red.

Of peculiarly elongate cylindric outline, with small inconspicuous eyes. The rostrum, head, and thorax very finely, almost minutely, punctate ; the thorax nearly cylindrical, very gradually narrowed anteriorly, and hardly at all constricted ; elytra quite cylindric and rather finely striate-punctate, interstices with minute distant punctures.

Length, $1\frac{1}{2}$ lines ; breadth, nearly $\frac{3}{8}$ line.

Tairua, East Coast. Under logs, on the seaside.

E. cylindricus, Broun. 2206. Man. N.Z. Coleopt., p. 1252.

Piceo-rufous or castaneous, generally of the latter colour, underside included.

Closely resembling *E. littoralis*, the rostrum more distinctly marked off, narrower than the head : eyes transversely oval and rather more prominent ; there is an interocular fovea ; elytra slightly narrowed near the posterior femora so as to appear a little dilated behind, more striate, the serial punctures on the suture and interstices closer and more distinct ; the body itself rather less slender.

Length, $1\frac{3}{4}$ lines ; breadth, $\frac{3}{8}$ line.

Otago. On the sea-beach.

E. parvulus, Broun. 2207. Man. N.Z. Coleopt., p. 1253.

Shining, testaceous, legs and antennæ rufescent. Head and rostrum nearly smooth, the few minute punctures distant from each other, the eyes slightly more prominent, the thorax not constricted in front and exactly the same width as the smooth occiput, elytra finely striate-punctate, with but few interstitial punctures.

Length, $1\frac{1}{4}$ lines ; breadth, $\frac{1}{4}$ line.

Taranaki, West Coast. One.

Obs.—The transference of *E. littoralis*, *cylindricus*, and *parvulus* to a distinct genus might be considered justifiable, the eyes being different from those of *Eutornus*.

Stilbocara, Broun. Ann. Mag. Nat. Hist., November, 1893.

Subdepressed, fusiform, glabrous, glossy.

Rostrum nearly as long as the thorax, very obviously marked off from the strongly globose occiput, arched, subparallel, or slightly and very gradually narrowed behind, moderately stout but not broad. Scape stout, very short, inserted just before, in the female at, the middle ; it does not reach backwards as far as the eye. Funiculus closely articulated, joints 2–7 gradually become shorter and broader. Club elongate, oblong-oval. Eyes prominent, placed at the sides of the rostrum, subtruncate behind, and extending considerably downwards. Head much swollen behind, and extending downwards below the level of the prosternum; above it is curvedly contracted towards the eyes. Thorax longer than broad, its sides moderately rounded, a good deal narrowed and constricted in front. Scutellum distinct. Elytra biarcuate at the base and wider than that of the thorax, gradually narrowed backwards.

Legs of moderate length, tibiæ strongly uncinate, their inner angle acute. Tarsi narrow, basal joint nearly as long as the terminal, 2nd longer than broad, 3rd narrow, excavate but not lobed.

Underside nearly plane. Metasternum elongate, rather longer than the basal 2 abdominal segments taken together, indistinctly sulcate, basal segment very broadly impressed but not concave. All the coxæ widely separated. Rostrum, underneath, with a distinct median carina.

Stilbocara in its general appearance does not resemble any of our genera of the Cossonides, but looks like *Toura* (904), one of the Pentarthrides. The body of *Stilbocara* though subdepressed is quite unlike *Arecophaga*. The scape is very short and thick, the tibial hooks strongly developed, and the polished occiput is remarkably prominent in every aspect. The rostrum though shorter is similar to that of *Toura longirostre*.

Stilbocara nitida, Broun. Ann. Mag. Nat. Hist., November, 1893.

Glossy, sparingly clothed with very minute grey setæ, but appearing quite glabrous; castaneo-rufous, rostrum and thorax rufous, tarsi paler.

Rostrum very gradually and slightly narrowed towards the base, finely and rather distantly punctured. Thorax unimpressed, distinctly but not closely punctured, much more finely in front, the constriction forming a slight depression across the front. Elytra evidently punctate-striate, the suture and interstices with fine serial punctures, the 3rd deeply sunk behind. Club large, opaque, but not dark, and densely pubescent. The external hooks of the 4 hind tibiæ are prolonged to the apex of the 2nd tarsal joint.

♀. Length, $1\frac{5}{8}$ lines; breadth, $\frac{3}{8}$ line.

Hunua Range, Clevedon. One.

S. constricticollis, Broun. 942. Man. N.Z. Coleopt., p. 530. (Plate XVI, fig. 5.)

Shining, almost piceo-rufous, elytra lighter.

Thorax rather shorter than in *S. nitida*, more coarsely and closely punctured. Elytra with deeper and broader striæ, near the suture and base particularly; interstices and suture seriate punctate. Funiculus more elongate, the club rather shorter. Scape inserted before the middle.

Female.—Pale rufo-castaneous. Thorax more gradually narrowed anteriorly, antennæ medially inserted.

Underside shining, nigro-piceous, rather coarsely but not closely punctured. 2nd segment with fewer and finer punctures, the 5th smooth in the middle.

♂. Length, $1\frac{1}{2}$ lines; breadth, $\frac{3}{8}$ line.

Whangarei. Three.

S. serena, Broun. 2205. Man. N.Z. Coleopt., p. 1251.

Shining, dark rufous, elytra and legs castaneo-rufous, the former paler near the shoulders.

Like *S. nitida* in form, the legs not as stout. The tibial hooks reach apex of the basal tarsal joint, the minute 4th joint of the tarsi more distinctly visible. The scape more abruptly incrassate. Thorax rather shorter. Club nearly as long as the funiculus. Occiput less swollen. Elytral striæ subcrenate-punctate.

♂. Length, $1\frac{1}{2}$ lines; breadth, $\frac{3}{8}$ line.

Dunedin. One.

Arecophaga, Broun. Man. N.Z. Coleopt., p. 533.

Body subdepressed, elongate-subovate, moderately nitid, sparingly clothed with slender but distinct hairs.

Rostrum of about the same length as the thorax, arched, moderately slender, cylindrical, indistinctly and gently narrowed medially; between the apex and the middle with numerous outstanding setæ. Scrobes deep, beginning between the middle and extremity, and extending underneath to the eyes. Head globose, immersed nearly to the eyes, rounded in front, distinctly marked off from the rostrum. Eyes depressed, large, their greatest bulk below. Thorax about as broad as it is long, conical, abruptly constricted in front, the apex appearing elevated, and emarginated in the middle, its base slightly bisinuate. Scutellum distinct. Elytra slightly sinuate at the base, which is a little wider than that of the thorax, gradually but considerably curvedly narrowed posteriorly. Scape elongate and slender, flexuous, moderately subclavate at the extremity, inserted between the apex and the middle and hardly attaining the eye. Funiculus laxly articulated, elongate and slender, basal 2 joints nearly equally elongate, 3–7 rather small, the 7th largest. Club elongate-oval, quadriarticulate. Femora medially dilated below, and notched near the extremity. Tibiæ with rather small hooks, somewhat dilated medially on the inside. Tarsi distinctly pseudo-tetramerous, slender, basal joint elongate, 3rd moderately expanded, with a semicircular excavation so as to seem lobate.

Underside flat. Anterior coxæ less approximated than those of *Phlœophagosoma*, the suture between them fine but distinct. Mesosternal suture subtruncate. Metasternum hardly longer than the basal 2 segments, sulcate behind the middle; 2nd ventral segment shorter than the 1st, its frontal suture medially curvate. Punctuation distinct, and rather close, except in front of the mesosternum.

This genus presents a combination of peculiar characters. The subdepressed rather broad oviform body, slender arcuate setigerous rostrum, and retracted head will suffice for immediate identification. The type lives on *Rhopalostylis* (*Areca*) *sapida*.

Arecophaga varia, Broun. 947. Man. N.Z. Coleopt., p. 534. (Plate XVI, fig. 6.)

Variable, ranging from piceous to rufo-castaneous, the antennæ and tarsi rufescent.

Rostrum asperate, indistinctly medially carinate, and with coarse punctures and shallow grooves behind the point of antennal insertion, more moderately punctured in front. Eyes large, extending to below the rostrum, occupying nearly the whole side and front of the head, not prominent. Thorax rather closely, moderately coarsely, on some parts confluently punctured, quite finely and very closely in front, sometimes smooth on a central lineal space along the middle. Elytra with closely punctured striæ, interstices more or less rugose, the sutural rather closely seriate punctate.

Legs somewhat asperate and finely setose. The rostrum, underneath, tricarinate in front, smooth behind.

Female.—Rostrum much arched above, longer than the thorax, more slender than that of the male, a little asperate and coarsely rugosely punctured at the base, the punctuation more distinct, finer, and subseriate towards the front, and bearing some short setæ along its sides behind the antennæ, which are inserted just before the middle.

Var. ♂.—The coarse lateral setæ of the rostrum near the front obsolete or absent.

♂. Length, $2\frac{1}{4}$ lines; breadth, $\frac{5}{8}$ line.

Parua and Hunua Range. Both sexes.

Pogonorhinus, Broun. Man. N.Z. Coleopt., p. 532.

Depressed, moderately broad, subfusiform, opaque, bearing semi-erect slender yellow setæ.

Rostrum about as long as the thorax, slightly arched, cylindrical, not quite half the breadth of the head, and marked off at the base by a transverse linear impression: at each side, from the extremity to behind the middle, it is fringed rather thickly with long conspicuous bright-yellow setæ; this fringe is prolonged underneath and becomes finer, and approximated to its fellow, near the eye. Scrobes profound, beginning near the apex and extending to the eyes, linear. Head rounded in front, immersed to the eyes, globose underneath. Eyes not prominent, large, their greatest bulk below, and so situated that vision must be directed nearly straight forwards. Scape inserted between the apex and the middle, moderately stout, nearly straight, gradually incrassate, not quite attaining the eye. Funiculus closely articulated, 2nd joint nearly as long as the 1st, both nearly twice as long as they are broad, 3–7 gradually thickened, transverse, 7th largest. Club elongate, oviform, subacuminate, but little broader at its base than the 7th joint, almost quadriarticulate. Thorax as broad as it is long, subconical, abruptly contracted in front, base subtruncate, the sides well rounded. Scutellum distinct. Elytra gradually narrowed backwards, the base slightly bisinuate and rather wider than that of the thorax. Femora moderately elongate, strongly arched above, widely notched near the extremity, angulate and distinctly dentate medially below: those of the female nearly similar. Tibiæ moderately uncinate, the 2 hind pairs dilated inwardly below the middle, the front pair prominent and finely ciliate at the middle, but emarginated between the middle and extremity in both sexes. Tarsi relatively slender, basal joint shorter than the terminal, the 3rd slightly dilated, deeply excavate above and appearing lobate, but underneath apparently entire.

Female.—Rostrum arched, more slender, not ciliate. Scape inserted before the middle.

Underside nearly plane, minutely setose, moderately coarsely punctate. Prosternum deeply incurved medially in front, the coxæ slightly separated, more approximated than in *Phlœophagosoma*, and with much larger cavities, and more nearly contiguous than those of *Arecophaga*. Mesosternal suture truncate, and very distinct between the coxæ.

This genus most nearly resembles *Arecophaga*, but is differentiated by the more approximated anterior coxæ, shorter and rather stouter rostrum, dentate femora, &c. Out of 122 genera enumerated in Wollaston's "Genera of the Cossonidæ" four only approach this one in structure. *Odontomesites*, from the Canary Islands, comes nearest, but even in it the femoral tooth does not exist in the female; the male, moreover, has only a short rostral fringe.

Pogonorhinus opacus, Broun. 946. Man. N.Z. Coleopt., p. 533. (Plate XVI, fig. 7.)

Fusco-rufous, sometimes more piceous in the male, legs and antennæ always rufescent, the male rostrum piceous, that of the female shining and reddish.

Rostrum coarsely punctured, very closely at the base, indefinitely tricarinate along the middle, longitudinally but finely rugose, and with slender grey setæ, in front. Thorax broadly but not at all deeply impressed on the middle, very closely and distinctly, on some parts rugosely, punctured, much more finely in front, the smooth central portion of the apex of a somewhat metallic coppery hue. Elytra plane, closely punctate-striate, the punctures oblong or quadrate; interstices rugose and seemingly punctate or finely asperate, their sculpture rather ill defined, however, owing partly to the numerous yellow setæ.

♂. Length, $2\frac{1}{4}$ lines; breadth, $\frac{5}{8}$ line.

Parua and Howick. Rare.

Pogonorhinus substituted for *Lasiorhinus* in 1903.

Exomesites, Broun. Man. N.Z. Coleopt., p. 971.

Body robust, nearly plane above, elongate, glossy, very coarsely and rugosely sculptured, sparingly and finely pubescent.

Rostrum nearly as long as the thorax, stout, widely incurved between the point of antennal insertion and the base; the portion in front of the antennæ, more than a third of the whole length, much dilated and subpterygiate. Mandibles prominent. Scrobes quite open above near the apex, deep and very oblique towards the lower surface. Scape elongate, stout, and gradually incrassate, inserted between the middle and the apex, attaining the middle of the eye. Funiculus distinctly articulated, 2nd joint as long as the basal one, 3–7 subquadrate, narrowed towards the base, the last 2 especially. Club not annulate, broadly oval, moderately large. Occiput smooth and convex, curvedly narrowed towards the eyes but without any line of demarcation above. Eyes moderately prominent, large. Thorax oblong, its sides nearly straight, abruptly contracted in front, base strongly bisinuate. Scutellum minute or obsolete. Elytra strongly bisinuate at the base, distinctly broader than the thorax, gradually narrowed behind the middle. Legs moderately stout and elongate, tibial hooks strongly developed. Tarsi narrow, the basal joint rather shorter than the terminal one, 3rd joint narrow, concave in front but not perceptibly lobed, entire below; claws rather small.

Underside nearly plane, sparingly and minutely pubescent, very coarsely punctured, the prosternum very closely, the abdomen more distantly, 2nd segment more finely, its frontal suture obliterated in the middle. Mesosternal suture obsolete. Metasternum short, not longer than the basal ventral segment, with an indistinct impression behind. Anterior coxæ only moderately separated, slightly further apart than in *Pogonorhinus.*

The peculiar *Otiorhynchus*-like rostrum, oblong thorax, obsolete scutellum, and the glossy coarsely sculptured surface distinguish the handsome species which forms the type.

Exomesites optimus, Broun. 1754. Man. N.Z. Coleopt., p. 972. (Plate XVI, fig. 11.)

Shining, piceous; the shoulders, sides, and apical portion of elytra rufo-castaneous or testaceous, the disc sometimes fuscous; legs yellow or fusco-testaceous, the base of the femora and the knees fuscous or piceous.

Rostrum very coarsely and closely punctured, sometimes however there is only one interocular puncture, near the antennæ there are short longitudinal rugæ and striæ, the apex more finely sculptured. Thorax with a more or less evident smooth median line, its punctuation very coarse but irregular, with some smooth intervals, the punctures finer and more confluent in front. Elytra somewhat uneven above, slightly impressed across the middle; their sculpture coarse and irregular, punctate-striate at the base, striate behind, interstices with fine serial punctures, 3rd, 5th, and 7th subcarinate near the base, humeral angles slightly porrect.

Female.—Incog.

♂. Length, $2\frac{3}{8}$ lines; breadth, $\frac{5}{8}$ line.

Mount Egmont and Mount Te Aroha. Very rare.

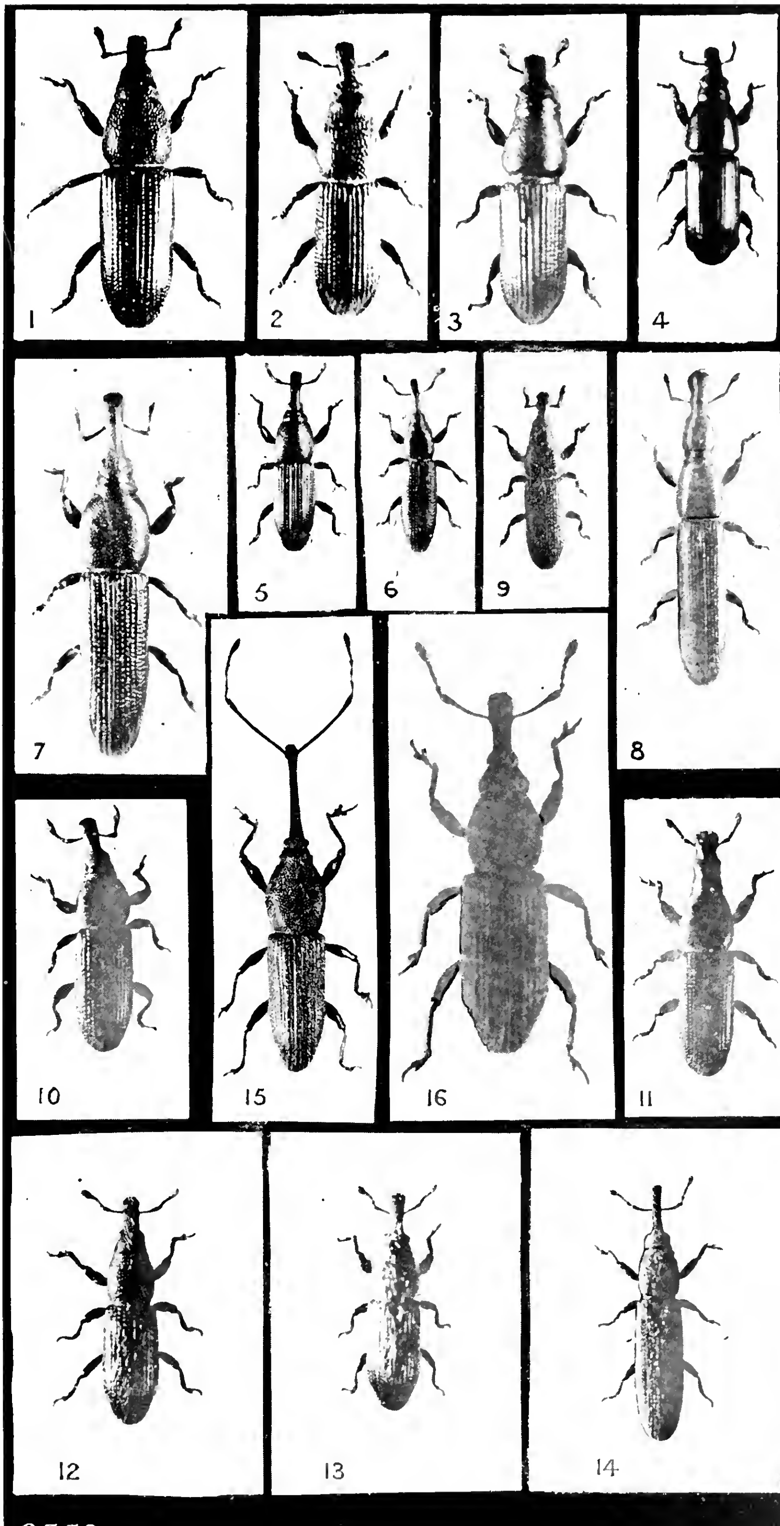
Allaorus, Broun. Man. N.Z. Coleopt., p. 1494.

Body rather small, convex, almost elongate-ovate, shining, apparently glabrous.

Rostrum of nearly the same length as the thorax, arched, stout but not broad, almost parallel, usually very slightly dilated at the point of antennal insertion, distinctly marked off by a transverse frontal impression on the head: the rostrum, near its base, is more evidently arched than it is elsewhere. Scrobes deep, oblique, almost convergent underneath. Scape stout, gradually incrassate, inserted quite in front of the middle, reaching the eye. Funiculus finely setose, basal joint stout, 2–7 distinctly articulated, transverse, gradually thickened so that the 7th is nearly as broad as the base of the club, which is ovate or oblong-oval: the large basal articulation is nearly nude, the remainder densely pubescent and indistinctly annulate. Eyes minute but distinct, placed somewhat near the surface and the thoracic apex. Thorax longer than broad, oviform. Scutellum minute or altogether absent. Elytra obovate or cordiform, their base slightly wider than that of the thorax, and slightly oblique towards the suture; they are much narrowed near the extremity. Femora simple, stout, and elongate. Tibiæ evidently uncinate, the anterior emarginate and ciliate inwardly below the middle, and acute at the extremity. Tarsi slender, their basal joint as long as the terminal, 3rd narrow, not at all lobate; claws minute.

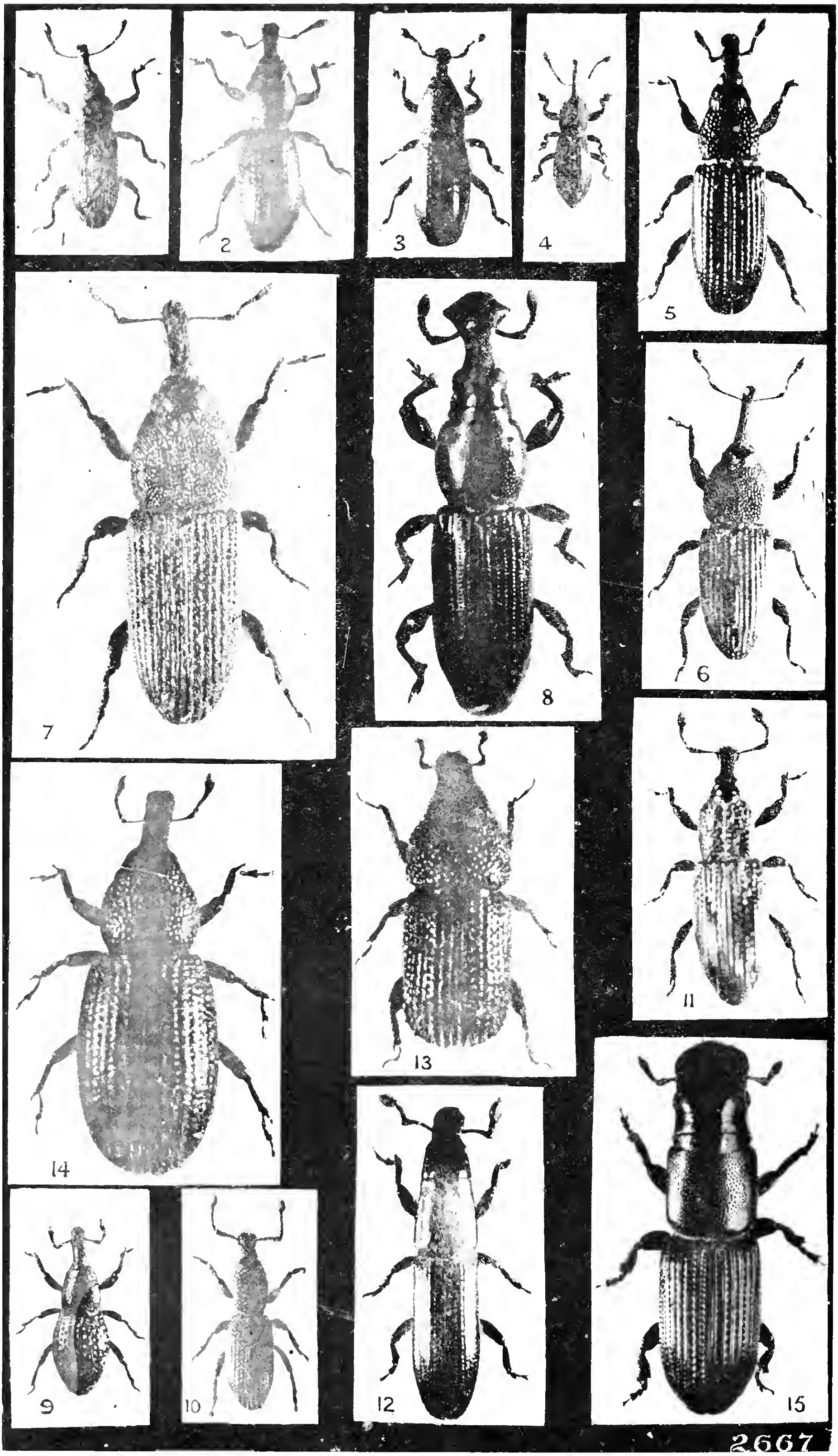
Prosternum deeply incurved in front, the coxæ almost contiguous. Intermediate coxæ distinctly but not at all widely separated. Metasternum abbreviated, not longer than the 2nd ventral segment, broadly impressed. Basal segment large, broadly impressed, its hind suture fine and indistinct.

Five genera, three of which are European, one American, and the other belonging to the Sandwich Islands, agree more or less with *Allaorus*, particularly as regards the abbreviation of the metasternum. *Oodemas* is at once differentiated by its æneous surface and bilobed tarsi, and *Cotaster* by its short basal abdominal segment. In *Aparoprion* the thorax is subglobose and the tarsi lobate. *Lymantes* is insufficiently described, but has the thorax elongate-quadrate and the rostrum subquadrangular, two characters manifestly inapplicable to *Allaorus*. The other, *Styphloderes*, is distinguished by its subdepressed body and broadly lobed 3rd tarsal joint.



NEW ZEALAND COSSONIDÆ.—Broun.

Face p. 208.



NEW ZEALAND COSSONIDÆ. Broun.

Allaorus, though belonging to the same section as these five genera, may be separated by the almost contiguous anterior coxæ, abbreviated metasternum, well-developed basal ventral segment, minute eyes and claws, simple 3rd tarsal joint, minute or obsolete scutellum, oviform thorax, and convex body. In the New Zealand list it should be placed near *Pselactus*, which, however, has the metasternum considerably longer.

Allaorus urquharti, Broun. 2577. Man. N.Z. Coleopt., p. 1495. (Plate XVI, fig. 9.)

Shining, brownish piceo-rufous, tarsi testaceous, antennæ ferruginous.

Head globose, but immersed nearly to eyes. Rostrum with some fine distant punctures. Thorax slightly wider behind the middle than it is elsewhere, rather narrower in front than at the base, without any apical stricture; very distinctly, moderately coarsely, and rather distantly punctured, more finely at the apex. Scutellum very minute. Elytra widest near the middle, much narrowed posteriorly, convex; each with 4 series of discoidal punctures, about 7 in each row, these hardly extend beyond the disc; the posterior declivity is striate. The setæ are slender and indistinct.

Underside shining, rufo-piceous, metasternum and basal segment with distinct distant punctures, 2nd with very few minute ones, 5th finely and more closely punctate except at the nearly smooth base. The setæ slender, scanty, and yellowish.

Length, $1\frac{1}{4}$ lines; breadth, $\frac{3}{8}$ line.

Mount Pirongia. Four.

A. pedatus, Broun. 2578. Man. N.Z. Coleopt., p. 1496.

Shining, fusco-testaceous, apex of thorax and base of elytra darker; the setæ scanty, very slender, and inconspicuous.

Rostrum very slightly narrower behind than in front of the antennal insertion. Thorax shorter than that of 2577, widest before the middle, more coarsely punctured. Scutellum obsolete. Elytra widest in line with the posterior femora, with coarser punctures than 2577, and more deeply punctate-striate behind. Penultimate tarsal joint more expanded and concave.

Length, $1\frac{1}{10}$ lines; breadth, $\frac{3}{8}$ line.

Mount Pirongia. Two.

A. sternalis, Broun. 2579. Man. N.Z. Coleopt., p. 1496.

Rufo-piceous tinged with fuscous, antennæ and tarsi red, club infuscate; setæ inconspicuous.

Thorax widest at the middle, evidently more narrowed in front than behind, coarsely and rugosely and more closely punctured than the preceding species. Scutellum absent. Prosternum truncate and ciliate in front. Metasternum nearly smooth. Basal 2 segments, combined, with 3 transverse series of punctures. Mesosternum quite smooth.

Length, $1\frac{1}{10}$ lines; breadth, $\frac{3}{8}$ line.

Mount Pirongia. One.

A. ovatus, Broun. 2580. Man. N.Z. Coleopt., p. 1497.

Shining, fuscous, slightly tinged with red, antennæ rufous; setæ indistinct.

Thorax shorter than that of 2577, the punctures rather closer and only slightly coarser. Scutellum absent. Punctuation of elytra very irregular and coarse, only 4 or 5 punctures in some rows on the disc.

Length, 1 line; breadth, $\frac{3}{8}$ line.

Mount Pirougia. One.

A. versutus, Broun. 788. Man. N.Z. Coleopt., p. 447.

Broad, less convex than the other species, slightly shining, testaceo-fuscous, antennæ dark red; setæ scanty and slender, most easily seen on the rostrum and elytral apices.

Most nearly resembles 2578, the thorax not so coarsely but more closely punctured, rather short. Elytra cordiform, more rounded, with regular series of large punctures, the sutural 2 series, on each elytron, somewhat depressed at the base, so that the interstice outside appears a little elevated. Legs more robust.

Length, nearly $1\frac{1}{4}$ lines; breadth, quite $\frac{3}{8}$ line.

Mount Manaia, Whangarei. Three.

A. rugosus, Broun. 2155. Man. N.Z. Coleopt., p. 1223.

Shining, fuscous, antennæ red, club piceous, the pubescence most easily seen on the rostrum.

Thorax apparently longer than broad; coarsely, rather closely, and rugosely punctured. Scutellum absent. Elytra cordate, unusually short and broad, with irregular series of coarse punctures; 3rd and 5th interstices costiform, the 4th similar behind the middle, the 2nd also raised along the posterior declivity. The most remarkable feature in this species is the rather sharply defined sides, which almost appear marginated.

Length, $1\frac{1}{8}$ lines; breadth, nearly $\frac{3}{4}$ line.

Waitakerei Range. Unique.

A. pyriformis, Broun. 2154. Man. N.Z. Coleopt., p. 1223.

Robust, somewhat pear-shaped, shining, pubescence scanty and indistinct, piceous; the antennæ, tip of rostrum, middle of thorax, and the base and apex of the elytra piceo-rufous.

Rostrum distinctly but not abruptly narrowed behind the antennal insertion, almost longitudinally finely rugosely punctate. Thorax longer than broad, more narrowed in front than behind, rather closely and rugosely but not very coarsely punctured, with a smooth median line. Scutellum obsolete. Elytra suboblong, wider at the base than the thorax, sides moderately rounded, slightly impressed before the middle, rather closely punctate-striate, subcrenate, interstices finely seriate punctate. 3rd tarsal joint moderately dilated and excavate above. 2nd joint of the funiculus distinctly longer than the 3rd. An aberrant species.

♂. Length, quite $1\frac{1}{4}$ lines; breadth, nearly $\frac{3}{4}$ line.

Mount Arthur. Two.

A. piciclavus, sp. nov.

Shining, fuscous, antennæ and tarsi rufescent, club nigrescent, its pubescence griseous: setæ scanty, slender, rather elongate, quite inconspicuous.

Rostrum very slightly narrowed behind the antennal insertion, moderately punctate, slightly rugose, more finely and sparingly in front, and bearing numerous slender greyish hairs. Head immersed nearly to the eyes, which are only slightly prominent. Thorax slightly wider near the middle than elsewhere, rather more narrowed anteriorly than behind, not constricted, hind angles subrectangular; disc slightly convex, coarsely, closely, and somewhat rugosely punctured, the intervals narrow, the median line nearly smooth, frontal punctuation finer. Scutellum absent. Elytra cordiform, base oblique towards the suture, widest near the hind thighs, much narrowed and declivous near the extremity: rather coarsely striate-punctate, the punctures regular and distinctly separated, quite striate behind; the suture and interstices with fine serial punctures, 3rd and 5th slightly elevated throughout, the 2nd towards the extremity only. 2nd joint of the funiculus longer than the 3rd. Penultimate joint of the tarsi distinctly broader than the 2nd, not lobate.

Underside shining, piceo-fuscous, minutely pubescent, rather coarsely and irregularly punctate, mesosternum smooth in front, metasternum and basal segment broadly impressed.

When compared with *A. sternalis*, its nearest ally, the cordiform elytra are seen to be broader and regularly sculptured, the thorax is much less narrowed in front, with more rugose and closer punctures, the rostrum is subopaque instead of shining, and the vestiture is entirely different.

Length, $1\frac{1}{4}$ lines; breadth, nearly $\frac{1}{2}$ line.

Clevedon. Hunua Range.

Pselactus, Broun. Man. N.Z. Coleopt., p. 972.

Body robust, transversely convex, slightly nitid, sparsely but distinctly setigerous.

Rostrum about as long as the thorax, stout and moderately broad, parallel; female rather more slender and elongate, but not very narrow. Head globose, rather short, curvedly narrowed anteriorly, a little depressed towards the rostrum, which is about half the width of the occiput. Scrobes directed obliquely downwards. Scape short, moderately curvate and slender, thicker at the extremity, inserted medially, a little further back in the female, it reaches the eye. Funiculus much longer than the scape, basal joint stout, 2nd rather longer than 3rd, joints 3–7 submoniliform, transverse, 7th larger than the preceding one. Club oblong-oval, densely pubescent, indistinctly annulate. Eyes placed in front of the head, widely distant, depressed, transverse, suboval, truncate in front. Thorax of nearly equal length and breadth, its sides distinctly rounded, obsoletely constricted in front, base truncate. Scutellum absent. Elytra oblong, evidently broader than the thorax, the shoulders a little curvedly narrowed, their sides slightly rounded, posterior declivity nearly vertical. Legs moderate, tibial hooks strongly developed. Tarsi very long and slender, penultimate joint slightly expanded and bilobed; claws minute.

Anterior coxæ contiguous. Prosternum deeply incurved. Mesosternum on an abruptly lower level than the metasternum, which is shorter than the basal 2 ventral segments and somewhat angularly impressed behind, 2nd segment rather shorter than the 1st, the suture sinuate.

In some respects similar in structure to the Crotian *Cotaster*, but the thickset body, depressed transverse eyes, the short slender somewhat arcuate scape of the male (which, however, is longer and less curved in the female), the short rounded thorax, abbreviated metasternum, contiguous anterior coxæ, and the absence of the scutellum, taken together, prevent its location in the vicinity of the section in which *Cotaster* has been placed. The front of the prosternum, too, is angularly depressed, but in front of and beyond the coxæ an elevated area comes in contact with them, whilst a slight angular process, apparently cariniform in the middle, projects behind them. The setæ are suberect, slender, and in unabraded specimens rather thickly scattered over the elytra. It is an inhabitant of the sea-shore.

Pselactus punctatus, Broun. 1755. Man. N.Z. Coleopt., p. 972. (Plate XVI, fig. 14.)

Piceous, slightly nitid, antennæ and tarsi piceo-rufous, pubescence yellowish.

Rostrum with moderate, somewhat longitudinally rugose punctuation, rather finer but not rugose in front, the occiput moderately punctured. Thorax coarsely but not very closely punctured, more finely at the apex, more rugosely at the sides. Elytra rather coarsely striate-punctate, the spaces between the punctures as large as the punctures themselves, the suture and interstices indistinctly seriately punctured, more rugose in the female than the male.

Underside shining, piceous, with some minute slender but quite perceptible brassy setæ. Front of prosternum with shallow, the metasternum with rather coarse, punctures; 2nd ventral segment more finely and distantly, the terminal closely and finely, punctured.

Female.—Rostrum hardly appreciably longer or more slender, its punctuation fine, with four or five setigerous and more distinct punctures near the apex.

♂. Length, $1\frac{3}{4}$ lines; breadth, $\frac{5}{8}$ line.

Taranaki: on the underside of logs imbedded in sea-sand.

P. ferrugineus, sp. nov.

Rostrum and thorax rufous but not dark, the elytra pale castaneo-rufous, legs darker, antennæ ferruginous, tarsi testaceous; pubescence yellow.

Female.—Similar to the same sex of *P. punctatus*, but with the scape rather shorter and more curved, like that of the male. The rostrum and head with slightly finer sculpture. Thorax a trifle shorter, and, instead of being nearly glabrous, bearing numerous slender yellow hairs. Elytra less rounded at the sides and rather broader behind; the pubescence more seriate.

♀. Length, $1\frac{7}{8}$ lines; breadth, nearly $\frac{3}{4}$ line.

Taranaki. Unique.

Inosomus, Broun. Man. N.Z. Coleopt., p. 739.

Body robust, subparallel, narrowed anteriorly but not at all behind, coarsely sculptured, subopaque, sparingly but distinctly setose, on the posterior declivity especially.

Rostrum short and broad, subparallel, without any basal line of demarcation but on a slightly lower plane than the head. Scrobes deep, expanded in front of the eyes. Head short and broad, curvedly narrowed to the width of the rostrum, strongly globose underneath. Eyes depressed, strongly transverse, their greatest bulk below, and, though large, hardly visible above. Scape very short and stout, still thicker at the extremity, medially inserted, and attaining the front of the eye. Funiculus longer than the scape, compactly articulated, basal joint as long as the following 3 combined, joints 2–7 transverse. Club broadly oval, apparently triarticulate, the glabrous basal joint half of the whole length. Thorax slightly broader than it is long, truncate at base, somewhat curvedly narrowed towards the front, scarcely at all constricted there. Scutellum small but distinct. Elytra oblong, as wide as the thorax; broadly rounded, distinctly marginated, and denticulated behind: the base slightly biarcuate. Femora short and stout, with 3 or 4 minute denticles underneath. Tibiæ straight, moderately slender; the anterior with a nearly straight mucro at the external apex, and a minute denticle at the inner angle; the 4 hind pairs are prolonged externally and bifid, the inner angle of the prolongation is slightly longer than the other, and appears hooklike. Tarsi nearly glabrous, elongate and slender, 3rd joint also rather narrow, not lobate; claws distinct.

Prosternum deeply incurved in front, the coxæ large, prominent, almost quite contiguous. Intermediate coxæ not at all widely separated by the minutely margined mesosternal process; the mesosternum itself is longer than usual. Metasternum broadly sulcate behind, of about the same length as the abdomen. Basal ventral segment very short at the sides, obviously truncate behind, and on a higher level than the very short 2nd segment; 3–5 on a still lower plane, but level with the narrow epipleuræ.

Dr. Sharp stated that "this is a remarkably distinct genus, having the appearance of a Scolytid," &c.

The Indian *Himatium* has similar eyes, but the anterior coxæ are widely distant from each other. In the genus *Coptorhamphus*, pertaining to Borneo and Java, the femora are armed with an acute tooth. *Stenoscelis* is undoubtedly more nearly similar, but is at once distinguishable by its obsolete scutellum; its species have been found in South Africa, St. Helena, and Japan.

In the New Zealand list I place it between *Pselactus* and *Xenocnema*. The old name, *Stenopus*, has been superseded by *Inosomus*.

Inosomus rufopiceus, Broun. 1312. Man. N.Z. Coleopt., p. 739. (Plate XVI. fig. 13.)

Rufo-piceous, slightly nitid, antennæ and tarsi dark red.

Rostrum coarsely longitudinally rugose, with some slender erect setæ. Head rather closely and finely punctate. Thorax convex, moderately closely and coarsely punctured, finely near the smooth apical margin, very closely and rugosely at the sides, which underneath are minutely dentate or crenulate. Elytra almost punctate-striate, the sutural striæ deep but not distinctly punctured, interstices more or less rugose and near the sides and apex studded with minute tubercles; shoulders slightly prominent and reddish.

Underside shining, sparingly setose. The metasternum with only a few rather fine punctures; the prosternum and 1st ventral segment with coarse sculpture.

Length, $1\frac{7}{8}$ lines; breadth, nearly $\frac{3}{4}$ line.

Wellington; Otago; Greymouth; and at Howick, near Auckland. Apparently rare, and without well-marked sexual distinctions.

Xenocnema, Wollaston. Man. N.Z. Coleopt., p. 536.

Body robust, subparallel, rather broad, subdepressed above, apparently glabrous, but bearing some slender hairs on the hind part of the elytra and conspicuous yellow setæ at the extremity of the rostrum.

Rostrum quite half the length of the thorax, in front quite as broad as the head, without any basal demarcation, its apex depressed and emarginate in the middle. Mandibles prominent, bifid at apex. Scrobes subapical, deep, and linear, and extending obliquely inwards at a considerable distance from the eyes. Scape proportionally rather slender, gradually incrassate, inserted medially, and attaining the middle of the eye. Funiculus 7-articulate, short and compact, the basal joint short, truncate at the apex and produced (usually) inwardly, 2nd hardly longer than 3rd. Club ovate, sometimes elongate and narrow and acuminate, quadriarticulate, the basal joint large. Head short and broad. Eyes quite lateral, somewhat transversely oval, slightly convex. Thorax subquadrate, with a deep short stricture close to the apex, posterior angles oblique and obtuse. Scutellum distinct, but relatively small. Elytra slightly wider than thorax at the base, humeral angles slightly porrect; they are subparallel or very gradually narrowed backwards, and do not always cover the pygidium entirely. Front coxæ only moderately separated. Metasternum evidently medially sulcate, nearly as long as the abdomen. Basal ventral segment truncate behind, very distinctly separated from and on a higher level than the shorter 2nd. 3rd and 4th each not much shorter than the 2nd, all except the basal one on the same level as the epipleuræ. Legs finely setose, rather short. Tibiæ somewhat laterally compressed; the anterior, at the inner angle, with a stout spur directed outwards, the external angle bidentate; the 2 hind pairs strongly curvedly expanded inwardly, and externally terminating in a broad lamelliform process which is minutely denticulate at the extremity, the inner ends with a small spur. Tarsi sparsely rubescent, basal joint about as long as the terminal one, which, in the posterior pair particularly, is rather slender; claws rather small but distinct; 3rd tarsal joint indistinctly lobed.

This curious genus, owing to the hylastideous structure of the tibiæ, is placed last on our list, near *Inosomus*, from which, however, it is essentially different. Its single exponent lives in kauri timber (*Agathis australis*), and varies considerably in bulk and coloration.

Xenocnema spinipes, Wollaston. 953. Man. N.Z. Coleopt., p. 537. (Plate XVI, fig. 15).

Piceo-rufous or piceous, moderately nitid.

Rostrum closely and rather finely longitudinally rugose and punctate. Head finely and distantly punctured. Thorax slightly longer than broad, its sides nearly straight, rather closely and finely punctured, the apex and a linear median space nearly smooth. Elytra with deep, regular, closely punctured striæ; interstices obtusely costiform, each costa with a finely punctured definite groove along the middle, so that the interstices appear duplicated.

Underside shining, nearly glabrous, almost regularly, moderately finely, relatively punctured, the abdomen more coarsely, the terminal segment, however, and the mesosternum behind very closely and finely.

Female.—Rostrum oblong, the dense punctuation of the head ceasing abruptly behind the eyes, occiput smooth and shining, thorax gradually narrowed anteriorly.

♂. Length, 3 lines; breadth, $\frac{7}{8}$ line.

Auckland.

The description has been taken from specimens in my own collection. The maximum measurements are given. Wollaston's specimen was only half as large, $1\frac{2}{3}$ lines.

Hectæus, Broun. Ann. Mag. Nat. Hist., August, 1904.

Body small, subdepressed, elongate but not parallel, finely setigerous, shining, quite red.

Head and rostrum combined as long as the thorax. Rostrum in front as broad as the occiput, subpterygiate there, incurved at the middle, arched; at its base on a lower level than the head. Scrobes subapical, quite open and visible above. Head globose, with a frontal fovea. Scape flexuous, finely setose, elongate and stout, gradually incrassate, inserted near the apex, and attaining the front of the thorax. Funiculus also very long, laxly articulated, basal joint large, joints 2–7 gradually decrease in length, 2nd longer than broad, only slightly longer than 3rd. Club oblong-oval, indistinctly annulate. Thorax elongate, oviform, without any frontal stricture, its base rounded, the disc nearly flat. Elytra longer than the thorax, rather broader, of almost similar form, incurved at the base. Legs moderately long and stout; tibiæ gradually and slightly expanded, subtruncate at the extremity, with a slender mucro at the inner angle. Tarsi moderately stout, the anterior rather short, with their 3rd joint slightly bilobed, but not expanded; the corresponding joint of the other pairs concave but not lobed, the terminal as long as the basal 3 conjointly, with distinct claws.

Prosternum elongate, emarginate in front. Anterior coxæ slightly separated, placed near the hind margin of the prosternum; the intermediate pair distinctly, the posterior widely, separated. Metasternum short. Abdomen elongate, basal 2 segments broadly impressed, 3rd and 4th moderately short.

The disproportionally long and stout antennæ, the complete absence of the tibial hooks and scutellum, and its apparently blind condition, the eyes being obsolete or altogether wanting, make its position unique. In the genus *Idus* these important characteristics are almost precisely similar, with the exception of the antennæ, but it belongs to the Pentarthrides. Both genera are concolorous, and are found amongst leaves on the ground.

Hectæus rubidus, Broun. Ann. Mag. Nat. Hist., August, 1904. (Plate XVI, fig. 10.)

Nitid, ferruginous, antennæ and tarsi testaceous; sparingly clothed with suberect slender yellow setæ, the legs with more obscurely coloured ones.

Rostrum a little uneven, with indefinite sculpture. Thorax not twice as long as broad, its sides gently and regularly rounded, nearly flat, moderately coarsely but not closely punctured. Elytra subdepressed, their sides rather less rounded than the thorax, evidently striate-punctate, the punctures subquadrate and distinctly separated, substriate behind, the suture and interstices seriate-punctate.

Metasternum and basal ventral segments distinctly but not closely punctate.

The female, from which the orignal description was drawn up, has a rather narrower and less apically dilated rostrum, with filmlike slender squamæ at its base.

♂. Length, $1\frac{1}{8}$ lines; breadth, nearly $\frac{3}{8}$ line.

Broken River, Canterbury. One of each sex.

EXPLANATION OF PLATES XV AND XVI.

[The micro-photographs were prepared by Mr. A. Waterworth, of Northcote, Auckland.]

Plate XV.

Fig. 1. *Pentarthrum zealandicum*, Wollaston.
Fig. 2. *Euophryum rufum*, Broun.
Fig. 3. *Zenoteratus macrocephalus*, Broun.
Fig. 4. *Torostoma apicale*, Broun.
Fig. 5. *Toura longirostre*, Wollaston.
Fig. 6. *Stenotoura exilis*, Broun.
Fig. 7. *Merisma sharpiana*, Wollaston.
Fig. 8. *Dioedimorpha wollastoniana*, Sharp.
Fig. 9. *Rhinanisus fulvicornis*, Broun.
Fig. 10. *Macroscytalus laticollis*, Broun.
Fig. 11. *Proconus asperirostris*, Broun.
Fig. 12. *Sericotrogus subænescens*, Wollaston.
Fig. 13. *Gaurocryphus auricomus*, Broun.
Fig. 14. *Agrilochilus prolixus*, Broun.
Fig. 15. *Arecocryptus bellus*, Broun.
Fig. 16. *Eucossonus comptus*, Broun.

Plate XVI.

Fig. 1. *Agastegnus longipes*, Broun.
Fig. 2. *Mesoxenophasis brouni*, Wollaston.
Fig. 3. *Microtribus huttoni*, Wollaston.
Fig. 4. *Novitas dispar*, Broun.
Fig. 5. *Stilbocara constricticollis*, Broun.
Fig. 6. *Arecophaga varia*, Broun.
Fig. 7. *Pogonorhinus opacus*, Broun.
Fig. 8. *Protogonum helmsianum*, Sharp.
Fig. 9. *Allaorus urquharti*, Broun.
Fig. 10. *Hectæus rubidus*, Broun.
Fig. 11. *Exomesites optimus*, Broun.
Fig. 12. *Entornus littoralis*, Broun.
Fig. 13. *Inosomus rufopiceus*, Broun.
Fig. 14. *Pselactus punctatus*, Broun.
Fig. 15. *Xenocnema spinipes*, Wollaston.

Art. XXIX.—*A Very Rare Maori Implement*—Ahao.

By Dr. A. K. Newman.

[*Read before the Wellington Philosophical Society, 3rd June, 1908.*]

Looking through the collection of Maori curios belonging to Mr. Wilson, of Napier, I spied this whalebone implement, shaped in all respects like an English marlinspike used by our sailors. Mr. Wilson gave me this history of its discovery: A man making a drain near Taradale brought it to him, covered with moist dirt. Archdeacon Samuel Williams, who had lived amongst the Maoris from very early European times, recognised it as a genuine Maori implement, and called it an *ahao*. An old Rangitikei settler told me he knew it—had seen one like it many years ago. Mr. Percy Smith recognised it as a genuine Maori curio, and believed it was called a *kaneha* or *taneha*. I left it with Mr. Skinner, of New Plymouth, a great Maori expert, to show to some old Maoris. Here is his letter:—

"Yesterday I met two old Maori friends and introduced them to your whalebone implement. They recognised it, and called it a *purupuru*. It is a genuine old Maori tool, and was used for caulking the holes made for lashing the topsides of a canoe to one another and to the body of the canoe. When the lashing was completed the hole was packed or caulked with raupo, or the fluffy material of the flower of the raupo. Considerable force had to be used in doing this, so as to make the canoe sea-going (watertight), and for that reason the whalebone tool was much prized, wooden ones not standing so long. This particular one they said was made from the jawbone of the sperm-whale, and was a good one—so good that they advised me to keep it and not let it go back to Wellington. The elder Maori Heta te Kauri is an acknowledged expert on all canoe and fishing business, so you can rest assured you have a genuine and valuable old Maori implement."

I showed it to Archdeacon Williams, of Gisborne, who also recognised it. He had seen one exactly like it, but made of greenstone. This particular greenstone one was greatly prized by the Maoris. It was a sacred article, used by the priests in religious ceremonies: they passed it through the gills of fish offered to the gods, with many prayers. This greenstone *ahao* was used only for holy purposes.

Its Rarity.

This implement was found in Hawke's Bay, and Archdeacon Williams saw one of greenstone. It was used in Rangitikei and in Taranaki, and doubtless in many other districts. No specimen exists in museums, nor is it figured in Hamilton's great work on "Maori Art." The greenstone one passed into the hands of Europeans, but its whereabouts is not known.

Its Structure and Ancestry.

The greenstone *ahao* must have been a great rarity even in old Maori days. Common ones were made of hard wood, but they were not strong enough for much hard work, and were only used when they failed to get the bone of a stranded whale.

My *ahao* is 14 in. long. It is beautifully cylindrical in shape, smooth, and accurately rounded. About 3 in. from one end it begins to taper to a sharp point. Mr. Percy Smith noted that when it began to taper, and for some distance on, it is quadrilateral—gradually its sides lessening towards the point. He points to this four-sidedness as being the Maori way of tapering off. Had it been made by a European it would have begun to taper in the round. The diameter of the *ahao* is nearly ½ in. At about one-third of the length (starting from the butt) are two parallel circular lines about ⅓ in. apart. Rising from the butt to the first of these two consecutive circles are engraved eleven straight lines, not perpendicular, but slanting—a rare form of Maori carving, its meaning unknown to us, but, like all Maori engraving, certainly very ancient.

The fact that *ahaos* were used in Rangitikei, Hawke's Bay, Poverty Bay, Taranaki, and doubtless in other parts would tend to show that they had been in use from very remote ages: in fact, as there is, I believe, no single Maori work of art indigenous to aborigines in New Zealand, it probably was used, like all others, in the ancient fatherland, Hawaiki—it was probably a tool used by their Aryan forefathers in India. As our own Aryan forefathers in western Asia were the forefathers of the Maoris, before our ancestors went west into Europe and their fathers invaded north-west India, and thence spread to Indonesia and the isles of the Pacific, it is perhaps a prehistoric tool: hence this Maori *ahao*, and its exact counterpart the English marlinspike, may have had a common Aryan ancestral marlinspike. Nor is this idea far-fetched, for when I showed my beautifully carved Maori fishing-dredge or *roukakahi* to Colonel Whitney, who had never seen one, he exclaimed, "An oyster-dredge from the Severn," and declared it was the identical dredge. Like the big wooden Maori trumpet used in temples in India and old French churches, like the nasal flute, the drums, the conch-shell, pan pipes, and hosts of other articles, this *ahao* probably goes back to the old Aryan times.

Its Names.

Archdeacon Samuel Williams called it an *ahao*. A Maori spelt it for me *ahau*. The word does not occur either in Williams's, or Colenso's, or Tregear's, or the Hawaiian, or Niue, or Mangarewa, or other dictionaries, which shows the instrument had nearly gone out of use. *Hao* in Maori = to do and round, to enclose, to shut in, to encircle as a fisherman draws in a net. This *ahao* draws together the gills of fishes, the top of a basket, and shuts in the contents. *Hao* is a word used for hard substances of bone; *hahao* = to put up in a basket; *sao* = to collect food; and *totao* = a sharp point. In Mangarewa *ahao* is to put into a basket, and *taotaomu* is a wooden implement used to collect fish out of a pond. Among the negroes of Assam, a closely allied race, *dao* is a sharp-pointed substance of wood or bone. In Niue a fish-spear was *taohokaika*; *haohao* is a fish with a beak, and *pulu* is cocoanut-husk. The Taranaki Maori expert, Kauri, called it a *purupuru*—an instrument used for caulking purposes. *Puru* in Maori is a plug or cork—to plug. In Mangaia *puru* is the fibre of cocoanut, used in caulking canoes to make them watertight. In Samoa *bulu* (New Zealand Maori *puru*) is a kind of gum used as pitch in caulking canoes. It will be noticed that Maoris used their marlinspike exactly as did the English sailors—for caulking purposes. The European used tow and the Maori cocoanut-fibre or raupo; the European sailor used pitch, the Maori sailor used gum; and centuries ago both sailors used a similar implement to fasten planks together with cords. European and Maori sailors alike used it with its holes for reeving purposes.

As the various tribes of Maoris used the same instrument, it is clear that the names and the implement itself were known in the ancient Hawaiki. It will also be seen that its names *ahao* and *purupuru* refer to the two main purposes to which the tool was put.

Mr. Percy Smith recognised the implement, having known similar ones years ago. He thought it was called a *kaneka* or *taneka*, words which have not been preserved in Maori dictionaries, the idea being suggestive of the word "piercer," which would suggest one of its uses. *Aneane* or *aneha* means "sharp-pointed." A *tao* or *kao* is a sharp-pointed spear. Thus in the various Maori dialects this instrument was called by many names.

This paper, short as it is, embodies a considerable amount of research, I having ransacked much literature and consulted many experts in Maori lore, to many of whom the implement was quite unknown. I think this embodies all that will ever be discovered about the *ahao*.

Art. XXX.—*On the Trisection of an Angle.*

By H. W. Segar, M.A., Professor of Mathematics, Auckland University College.

[*Read before the Auckland Institute, 17th August, 1908.*]

Three problems of an apparently simple character are famous as having engaged the attention of the ancients, who sought in vain for solutions by means of the straight-edge and compass. These were (1) the trisection of an arbitrary angle; (2) the quadrature of the circle; (3) the duplication of the cube.

These have generally ceased now to be objects of attack by mathematicians, because it is now known that it is impossible to solve any one of these problems by means of the straight-edge and compass. The proofs of this impossibility are available to the English reader in the translation of Klein's "Famous Problems in Elementary Geometry," published by Ginn and Company. Occasionally, however, one or other of these problems takes possession of some person unaware of these investigations, and with only a slight knowledge of mathematics. I was recently approached by Mr. Viggo Hansen, of this city, who submitted to me what he considered was a solution of the first problem—the trisection of an angle. On testing his drawing I could discover no inequality in the three parts into which his construction had divided the original angle. Thinking that the construction happened to suit the particular angle chosen, I carried it out for three other angles very different in magnitude from one another and from Mr. Hansen's, with exactly the same result. It was evident then that Mr. Hansen had obtained an approximate solution of the problem of exceptional interest, especially as the construction is very simple, and depends on the bisection of angles. The construction was as follows:—

Let AOB be the given angle. With O as centre, describe a circle meeting OA, OB, in C, D, and these lines produced through O in E, F, respectively. Let G, J, be the middle points of the arcs CD, EF; and

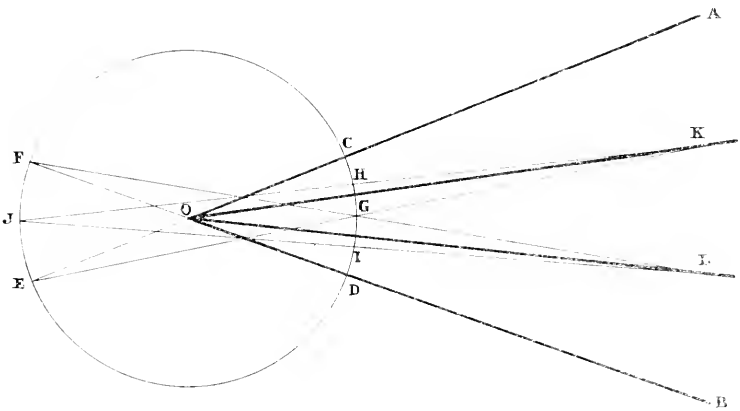


FIG. 1.

H, I, those of the arcs CG, GD, respectively. Now draw JH, EG, meeting in K; and JI, FG, meeting in L. Then OK, OL, are the trisectors as given by this construction.

We shall now proceed to investigate the degree of approximation. We shall use the methods of co-ordinate geometry.

Take OK as the axis of x, and a line through O perpendicular to OK as the axis of y. Let the angle GOH be α. Then we easily obtain the following system of co-ordinates :—

Point.	x.	y.
H	$a \cos \alpha$	$a \sin \alpha$
G	$a \cos \left(\alpha - \frac{\theta}{4}\right)$	$a \sin \left(\alpha - \frac{\theta}{4}\right)$
J	$-a \cos \left(\alpha - \frac{\theta}{4}\right)$	$-a \sin \left(\alpha - \frac{\theta}{4}\right)$
E	$-a \cos \left(\alpha + \frac{\theta}{4}\right)$	$-a \sin \left(\alpha + \frac{\theta}{4}\right)$

where θ is the original angle AOB.

The equation of JH is

$$\frac{x - a \cos \alpha}{y - a \sin \alpha} = \frac{\cos \alpha + \cos \left(\alpha - \frac{\theta}{4}\right)}{\sin \alpha + \sin \left(\alpha - \frac{\theta}{4}\right)}$$

which reduces to

$$\frac{x - a \cos \alpha}{y - a \sin \alpha} = \cot \left(\alpha - \frac{\theta}{8}\right) \ldots\ldots\ldots(1)$$

The equation of EG is

$$\frac{x - a\cos\left(\alpha - \frac{\theta}{4}\right)}{y - a\sin\left(\alpha - \frac{\theta}{4}\right)} = \frac{\cos\left(\alpha - \frac{\theta}{4}\right) + \cos\left(\alpha + \frac{\theta}{4}\right)}{\sin\left(\alpha - \frac{\theta}{4}\right) + \sin\left(\alpha + \frac{\theta}{4}\right)}$$

which reduces to

$$\frac{x - a\cos\left(\alpha - \frac{\theta}{4}\right)}{y - a\sin\left(\alpha - \frac{\theta}{4}\right)} = \cot\alpha \quad \ldots\ldots\ldots(2)$$

These meet on OK at K. Hence put $y = 0$ and equate the resulting values of x. We get

$$\cos\alpha - \sin\alpha\cot\left(\alpha - \frac{\theta}{8}\right) = \cos\left(\alpha - \frac{\theta}{4}\right) - \sin\left(\alpha - \frac{\theta}{4}\right)\cot\alpha$$

which becomes

$$-\frac{\sin\frac{\theta}{8}}{\sin\left(\alpha - \frac{\theta}{8}\right)} = \frac{\sin\frac{\theta}{4}}{\sin\alpha} = \frac{2\sin\frac{\theta}{8}\cos\frac{\theta}{8}}{\sin\alpha}$$

$$\therefore \sin\alpha = 2\sin\left(\frac{\theta}{8} - \alpha\right)\cos\frac{\theta}{8} = \sin\left(\frac{\theta}{4} - \alpha\right) - \sin\alpha$$

$$\therefore 2\sin\alpha = \sin\left(\frac{\theta}{4} - \alpha\right) \quad \ldots\ldots\ldots(3)$$

Now, OK being almost coincident with a true trisector, we have α nearly equal to $\left(\frac{\theta}{3} - \frac{\theta}{4}\right)$—*i.e.*, to $\frac{\theta}{12}$. This may also be seen from (3). Hence put

$$\alpha = \frac{\theta}{12} - \epsilon$$

where ϵ is very small. Then (3) gives

$$2\sin\left(\frac{\theta}{12} - \epsilon\right) = \sin\left(\frac{\theta}{6} + \epsilon\right)$$

Expanding and retaining only the first power of ϵ, we get

$$2\sin\frac{\theta}{12} - 2\epsilon\cos\frac{\theta}{12} = \sin\frac{\theta}{6} + \epsilon\cos\frac{\theta}{6}$$

and therefore

$$\epsilon = \frac{2\sin\frac{\theta}{12} - \sin\frac{\theta}{6}}{2\cos\frac{\theta}{12} + \cos\frac{\theta}{6}}$$

Here $\frac{\theta}{6}$ and $\frac{\theta}{12}$ are proper fractions. Expanding in powers of θ, and retaining only the lowest power of θ that remains, we get

$$\epsilon = \frac{\theta^3}{5184}$$

This is the angle between a trisector as given by the construction and a real trisector. The accuracy of the construction increases rapidly as the angle diminishes, the error being approximately proportional to the cube of the angle.

If the given angle be a right angle the error is 0·067 of a degree, for an angle of 45° it is 0·008 of a degree, and for one of 30° it is only 0·002 of a degree.

In conclusion, we shall indicate briefly how the trisection of any angle between 0° and 180° can be derived from that of an angle not greater than 45°, and therefore be effected by the construction of this article with an error less than one-hundredth of a degree.

Let the angle AOB lie between 45° and 90° (fig. 2). Draw OC perpendicular to OA, and on the same side as OB. The angle BOC will be less than 45°. Let OD, OE, be the trisectors, OD being the nearer to OC. The trisectors OK, OL, of AOB will make angles of 60° and 30° with OB, OE, respectively; and the angles 60° and 30° are easily constructed with straight-edge and compass.

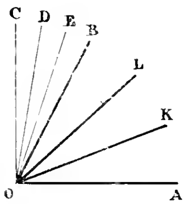


FIG. 2.

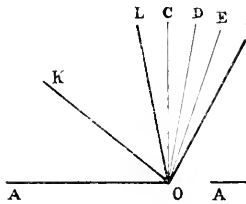


FIG. 3.

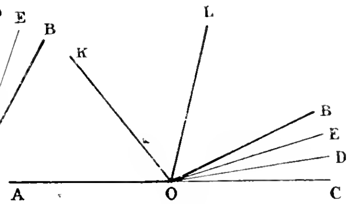


FIG. 4.

Let the angle AOB lie between 90° and 135° (fig. 3). Draw OC as before. The angle BOC will again be less than 45°. Let OD, OE, be the trisectors, OD being nearer to OC. The trisectors OK, OL, of AOB will make angles of 60° and 30° with OD, OE, respectively.

Lastly, let the angle AOB lie between 135° and 180° (fig. 4). Produce AO to C. The angle BOC will be less than 45°. Let OD, OE, be the trisectors, OD being nearer to OC. The trisectors OK, OL, of AOB will make angles of 120° and 60° with OD, OE, respectively.

ART. XXXI.—*Insanity: Some Comparative Statistics.*

By H. W. SEGAR, M.A.

[*Read before the Auckland Institute, 17th August, 1908.*]

INTRODUCTION.

THE purpose of this paper is to supply some answer to three questions: Are the native-born of this country less liable to insanity than the remainder of the population? Is that portion of the population which is not New-Zealand-born more liable to insanity than the people they have left behind in the countries of their birth? And have the women of this country an exceptionally small liability to insanity? The answers which this paper will supply to the first two questions are in the negative, and the answer to the third, while in the affirmative, will not indicate a very great difference between the women of this country and those of England and Wales.

The answers being of so negative a character, some explanation or apology would appear necessary to justify the existence of this paper. This is supplied by the report on the mental hospitals of the colony for 1906, issued by Dr. F. Hay, Inspector-General of Mental Hospitals. In that report are given some remarkable deductions from the statistics of insanity in New Zealand, and the questions above are not merely raised and answered in the affirmative, but in each case the differences represented as existing are of a character that may fairly be described as sensational. Dr. Hay further theorizes on the influences that have brought these differences into being, and goes so far as to consider the advisability of Governmental action with a view to giving these influences less free scope in the future. If, then, Dr. Hay's deductions are more or less unfounded, it is highly important that the fact should be clearly demonstrated, both in the interests of statistical and sociological science and of public policy. It is the more necessary as Dr. Hay's conclusions on two of the questions here raised are again brought forward in the report for 1907.

The New-Zealand-born and the Immigrant.

The report represents the native-born in New Zealand as far less liable to insanity than the immigrant. "The outstanding feature disclosed by these calculations," it says, "is the remarkably low incidence of insanity among New-Zealand-born." The figures finally given as representing the situation are :—

Not New-Zealand-born	..	..	1 insane in 118·9
New-Zealand-born	..	..	1 insane in 246·9

indicating, apparently, a tendency to insanity in the immigrant more than double that in the native-born.

Now, in spite of these figures, I may say at once that this or any similar deduction will be shown to be absolutely unfounded in fact. But I shall first endeavour to make clear the nature of the mistake made in the report. Dr. Hay himself modified his figures and moderated his conclusions in comparing the immigrant with the native-born by allowing for the facts that (1) there is comparative immunity from insanity below the age of twenty, and that (2) the age of the large majority of immigrants is from twenty upwards, nearly the whole of our population under twenty being native-born. He did this by eliminating those under twenty and comparing only the populations of the two classes over twenty years of age. This altered his first figures considerably. The original figures were—

New-Zealand-born	..	..	1 insane in 613·6
Not New-Zealand-born	..	..	1 insane in 129·2

The modified figures are, as before stated,—

New-Zealand-born	..	..	1 insane in 246·9
Not New-Zealand-born	..	..	1 insane in 118·9

This amendment was in the right direction. It removed the influence of that portion of the New-Zealand-born population under twenty, amounting to considerably more than one-half of the total, to which corresponded only a very small fraction of the immigrant population, and which was under the age of substantial liability to insanity. But this manner of correction was not carried nearly far enough. The report deals with the question as if

(1) liability to insanity were independent of age once the age of twenty is reached, and as if (2) the age-distribution for ages above twenty were the same for both the native-born and immigrant populations. Now, this is very far from being the case in either particular. For instance, at the ages 20–25 there are only 13·32 lunatics to 10,000 of population; at 65–70 there are 133·34, an increase in the ratio of 1 to 10; and the increase is steady from the one age-period to the other. Again, in the former of these age-periods the native-born population is more than five times the not-native-born; in the latter it is less than one-seventieth: and again there is a steady change from the one position to the other in between the two age-periods. Fig. 1 represents by graphs the age-distribution of the whole population and also that of the native-born. It represents also the lunacy-rate—that is, the number of lunatics to 10,000 of population at each age-period. The diagram shows clearly how, as the lunacy-rate increases, the ratio of the native-born to the whole population of the same age-period becomes less and less, until by the time the lunacy-rate has reached its maximum this ratio is very small. Consequently, in the two populations of over twenty, the native-born are to a far greater degree than the others concentrated in the earlier age-periods, in which the liability to lunacy is much smaller than in the later ones, and consequently the number of native-born lunatics is to be expected to be very much less than it would be if with the same populations these differences did not exist. We have further to allow for the population not New-Zealand-born containing a large majority of males, with their greater liability to insanity.

In Table I, I have made an attempt to allow for these differences. The table gives the whole population and then the native-born population in quinquennial age-periods. The fourth and fifth columns give the latter divided into males and females. The next two columns give the number of lunatics per 10,000 of population for each age-period. On the hypothesis of equal liability to lunacy at the same ages in both classes of population it is now a simple matter to calculate the proper number of native-born lunatics of each sex in each period. The results are entered in the last two columns.

This method, it should be noted, still exaggerates the estimate of the number there ought to be of native-born lunatics if they had the same liability to insanity as the remainder of the population. For the condition of things we are trying to allow for still holds for each of our age-periods. The proportion that is native-born is greater in the earlier than in the later years of each age-period, and up to about seventy years the liability to lunacy is continually on the increase as the age increases, while after this age the contribution to the number of lunatics is small by reason of the smallness of population. It is impossible to allow for this feature with perfect accuracy. If we took yearly age-periods the error would be smaller, but the problem is hardly worth this, and it is sufficient for our purposes that it should be clearly understood that the estimate in the table is distinctly an overestimate. The figures in the table are all taken from or based on the census returns for 29th April, 1906. The lunacy-rates quoted here and elsewhere are those for New Zealand as determined by this census, but their general character is in no way peculiar. Their main feature is general—namely, an increase in the rate up to sixty-five or seventy years of age, after which there is a not very great reduction, due to the greater mortality of he insane causing a reduction in their relative numbers.

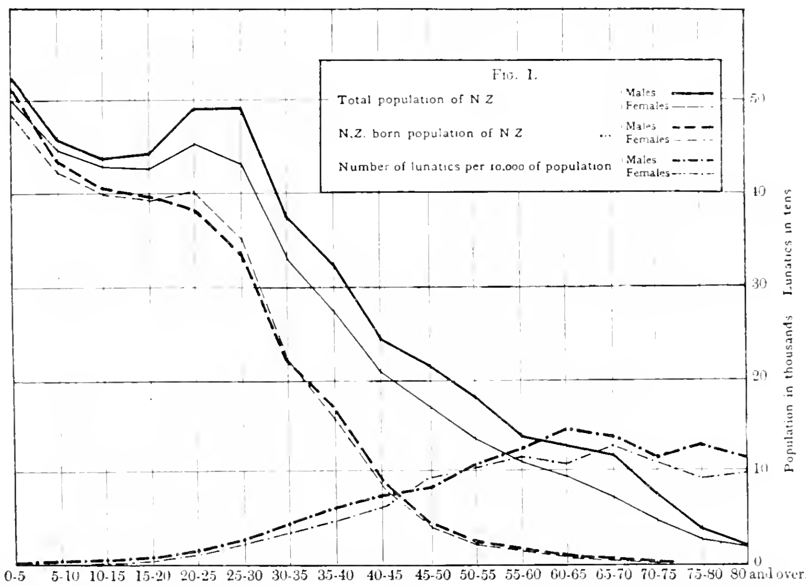
TABLE I.

Ages.	Population.	New-Zealand-born.			Number of Lunatics per 10,000 of Population.		Proportionate Share of Lunatics for New-Zealand-born.	
		Total.	Males.	Females.	Males.	Females.	Males.	Females.
0–5	102,745	100,117	51,229	48,888	0·19	..	1	0
5–10	90,288	85,827	43,542	42,285	2·18	2·02	9	9
10–15	86,758	80,875	40,778	40,097	4·56	1·40	19	6
15–20	87,117	79,587	39,955	39,632	7·46	5·83	30	23
20–25	94,608	78,849	38,478	40,371	15·39	11·05	59	45
25–30	92,448	68,388	33,278	35,110	25·74	22·95	86	81
30–35	70,419	44,087	21,975	22,112	41·80	33·72	92	74
35–40	60,123	33,026	16,610	16,416	60·32	48·93	100	80
40–45	45,381	17,945	9,096	8,849	75·66	63·54	69	56
45–50	38,427	8,504	4,364	4,140	86·35	92·92	38	39
50–55	31,899	4,406	2,264	2,142	105·26	103·96	24	22
55–60	24,942	2,458	1,268	1,190	120·85	114·07	15	14
60–65	21,894	1,452	745	707	145·36	105·91	11	8
65–70	19,123	263	133	130	138·84	125·02	2	2
70–75	12,183	77	42	35	111·01	106·15	..	..
75–80	6,071	40	21	19	127·10	92·71	..	..
80 and over	3,411	11	4	7	112·60	97·02	..	..
Total ..	887,837	605,912	303,782	302,130	39·47	30·50	555	459
							1,014	

According to this calculation the number of native-born lunatics there should have been in this colony at the time of the last census, if the liability to insanity in the native-born were the same as in the rest of the population, would be substantially less than 1,014. Now, the actual number of registered insane of New Zealand birth on the 31st December, 1906, was 988—a very noteworthy agreement. We may make some allowances for the interval of some months between the time of taking the census and the end of the year, for the possibility of the registered insane including a small proportion of idiots, and for some discrepancy between the census and registration returns, and still the conclusion appears reasonable and certain that the statistics indicate that there is no appreciable difference between those of the population of this country that were born in New Zealand and those not born in New Zealand with respect to liability to insanity. The argument justifying this conclusion may be put in another form. Our investigation shows that if the native-born has the same lunacy-rate at each age as the remainder of the population the native-born lunatics should constitute materially less than 0·328 of the whole: according to the numbers of registered insane on the 31st December, 1906, the native-born insane constituted 0·311 of the whole. There is thus absolutely no basis for any argument designed to show that the native-born are less liable to insanity than the immigrant population of the country.

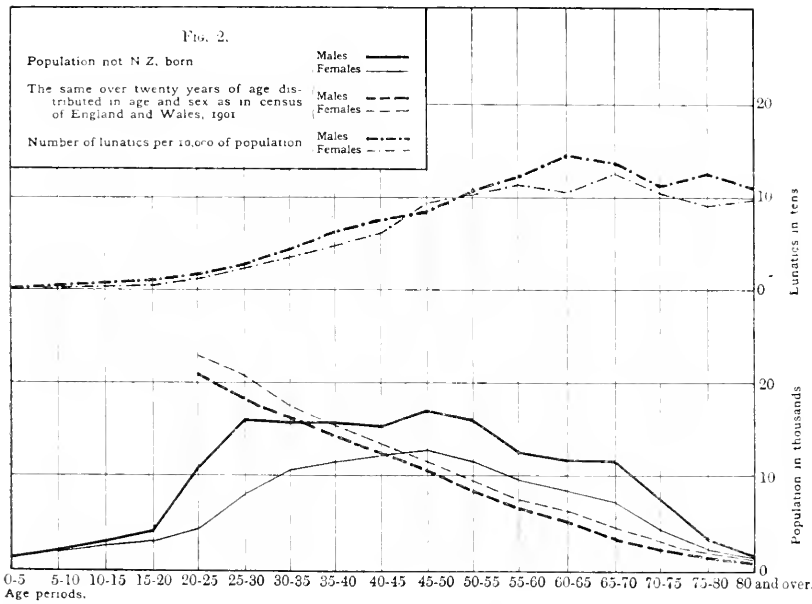
THE IMMIGRANT AND HIS COUNTRYMEN.

But in the report the immigrant is compared to his disadvantage not only with the New-Zealand-born, but also with his countrymen remaining behind in his native country. The deduction is drawn "that he is not an average type of the country of his origin," but, on the contrary, is "below the average of the country of his origin." This is said first of all to be suggested by the comparison of the immigrant with the New-Zealander, in which it is pointed out that the insane of the immigrant population above the age of twenty is as great as 1 in 118·9. After the inquiry in the preceding section of this paper, this suggestion would appear to cease to have any force. It is then stated to be verified "by contrasting our figures with the English figures (only approximate) of 1 insane person below twenty to 2,069 of the population of the same age, 1 in 173 of the population above that age, and 1 in 283 of all ages." Now, in arguing from these bare figures serious mistakes have been made similar to those made in contrasting the New-Zealand-born with the immigrant. The remarkable age-distribution of those of our population not born in this country, combined with the increasing liability to insanity as age increases, is not taken any account of above the age of twenty.



To illustrate the extent of this peculiarity that has to be allowed for, let us compare the age-periods 20–25 and 45–50. The number of lunatics per 10,000 in the later period is more than six times as great as it is in the earlier. Our total population in the later period is about two-fifths of that in the earlier, whereas our immigrant population of the later period is almost double that of the earlier. Further, whereas in the period 20–25 our immigrant population only constitutes one-sixth of the whole population of that age-period, in the later age-periods it practically constitutes the whole population of the periods. We have further to take into account the very considerable excess of males in our immigrant population, amounting to nearly 50 per cent., and their greater rate of insanity, and also the excess of females in older countries. In fig. 2 we have the graphs representing the population of New Zealand not New-Zealand-born. The excess of males stands out clearly, and a comparison of these graphs with those in fig. 1 for the whole population reveals clearly to the eye the exceptional character of the age-distribution of those not born in New Zealand. The graphs representing the rates of lunacy for the two sexes are also repeated in fig. 2, and two other graphs are given representing how our population above twenty years of age and not New-Zealand-born would be distributed in age and sex if such distribution were the same as that of the population of England and Wales as given in the census of 1901; or, in other words, representing the age and sex distribution of a portion of the population of England and Wales over twenty equal in number to that of our population over twenty not New-Zealand-born. A comparison of these graphs with

Fig. 2.



the others in the same figure again reveals clearly the exceptional character of the age and sex distribution in question. It is obvious, then, that, in view of the very different rates of insanity prevalent in the various age-periods, the figures as presented by Dr. Hay cannot be accepted as any indication of the comparative insanity of the immigrant and his countrymen at home.

In Table II I have made an endeavour to roughly measure the correction that must be applied to allow for the features I have pointed out. The first column gives the age-periods beginning at 20–25, the next two give the population of New Zealand according to age-period and sex, and the next two again our immigrant population classified in the same way. The sixth and seventh columns give our total immigrant population above the age of twenty redistributed in respect to both age and sex proportionally to the population of England and Wales according to the census of 1901. The next two columns again give the New Zealand rates of lunacy, which have been already shown to apply generally to the New-Zealand-born and the immigrants as a whole. The last two columns give the number of immigrant lunatics there would be if our immigrant population of twenty years and over were distributed in age and sex as the population of England and Wales is distributed.

TABLE II.

Ages.	Population.		Not New-Zealand-born.				Number of Lunatics per 10,000.		Number of Lunatics in Distributed Population.	
			Actual.		Distributed.					
	Males.	Females.	Males.	Females.	Males.	Females.	Males.	Females.	Males.	Females.
20–25	49,370	45,238	10,892	4,867	20,542	22,994	15·39	11·05	32	25
25–30	49,308	43,140	16,030	8,030	18,528	20,872	25·74	22·95	48	48
30–35	37,798	32,621	15,823	10,509	16,147	17,766	41·80	33·72	68	60
35–40	32,329	27,794	15,719	11,378	14,430	15,496	60·32	48·93	87	76
40–45	24,451	20,930	15,355	12,081	12,519	13,295	75·66	63·54	95	85
45–50	21,424	17,003	17,060	12,863	10,601	11,342	86·35	92·92	92	106
50–55	18,336	13,563	16,072	11,421	8,874	9,662	105·26	103·96	93	100
55–60	13,984	10,958	12,716	9,768	6,939	7,742	120·85	114·07	84	88
60–65	12,452	9,442	11,707	8,735	5,725	6,698	145·36	105·91	83	71
65–70	11,524	7,599	11,391	7,469	3,938	4,853	138·84	125·02	55	61
70–75	7,567	4,616	7,525	4,574	2,725	3,498	111·01	106·15	30	37
75–80	3,698	2,373	3,677	2,354	1,648	2,111	127·10	92·71	21	19
80 and over	1,865	1,546	1,861	1,539	977	1,494	112·60	97·02	11	14
Total ..	284,106	236,823	155,828	105,508	123,593	137,823	..	..	799	790
	520,929		261,416		261,416				1,589	

The result is to give us 1,589 lunatics, to which ought to be added the share of idiots to get the total insane for comparison with English figures. But, even ignoring these, this is at the rate of 1 in 164·5—a very considerable change from the actual 1 in 118·9, and approaching pretty closely to the 1 in 173 of England and Wales which Dr. Hay takes for comparison, especially when we remember that the dealing with quinquennial age-periods does not make by any means a complete correction.

The design of Table II is not perfect, but perfection cannot be attained with the statistics available. The immigrant population contains large numbers born in Scotland, Ireland, and Australia. Those born elsewhere are relatively so few as to make no material difference in the argument. The Scotch differ from the English only slightly in respect to liability to insanity, and the population of Scotland is distributed with respect to age very similarly to that of England and Wales. Those of English, Welsh, and Scotch birth form the great majority of our immigrant population. Those of Irish and Australian birth are not very unequal in numbers—their contributions to the insane when combined are about equal proportionally to that of the other nationalities—and the age-distributions of the populations of Ireland and Australia vary in opposite directions from that of Great Britain, Ireland having a greater proportion of older and Australia of younger people. So the table does not altogether fail in taking the immigrant population of New Zealand and finding what the position would be if their age-distributions were similar to those of the native countries of the immigrants. The inference is that there is no appreciable evidence that in the total the immigrant is any more liable to insanity than the people of his native land; and, even if there were in the mere statistics, the question would arise to what extent the apparent differences were really due to differences of classification and of circumstances in the different countries leading to more or less perfect returns, and differences of asylum accommodation and treatment of the insane leading to greater or less longevity.

There appear to be exceptions in the particular cases of the Irish and Australians, the former appearing to contribute far more and the latter very many less than their proportional share to the insane of this country. It is possible an investigation would not prove the contrary, but it probably would show that the situation is not as extreme as it appears. The necessary statistics for such an investigation, however, are not available.

The Females of New Zealand.

The report further calls attention to the fact that the smaller number of women relatively to men in our mental hospitals contrasts strangely with the numbers in the United Kingdom. This is partly explained in the report by the fact of there being 53,438 fewer women than men in this country, and by the fact that nearly all this deficiency of females obtains in that part of our population which is not New-Zealand-born, and to which the report, as we have seen, attributes a far higher rate of insanity than to the native-born. The proper statement of the case is that the deficiency of males, being almost entirely amongst those not New-Zealand-born, comes mostly in the age-periods where the rate of insanity is greatest. But not only is this generally so, but in the quinquennial age-periods, as we take later periods and the lunacy-rate becomes greater, the deficiency of females also becomes greater, until we come to the last few periods, which do not supply any large portion of the total. We have also to take into account in the comparison that in the United Kingdom and other old countries there is an excess instead of a deficiency of females, due to the greater longevity of females and the greater loss by emigration of males, and that this excess is relatively greatest generally in the ages of maturity, and specially in the later age-periods. The result is that the ratio of females to males in New Zealand for the age-periods at which the lunacy-rate is very high is less than three-quarters and in some periods actually less than one-half of the corresponding ratio in England and Wales.

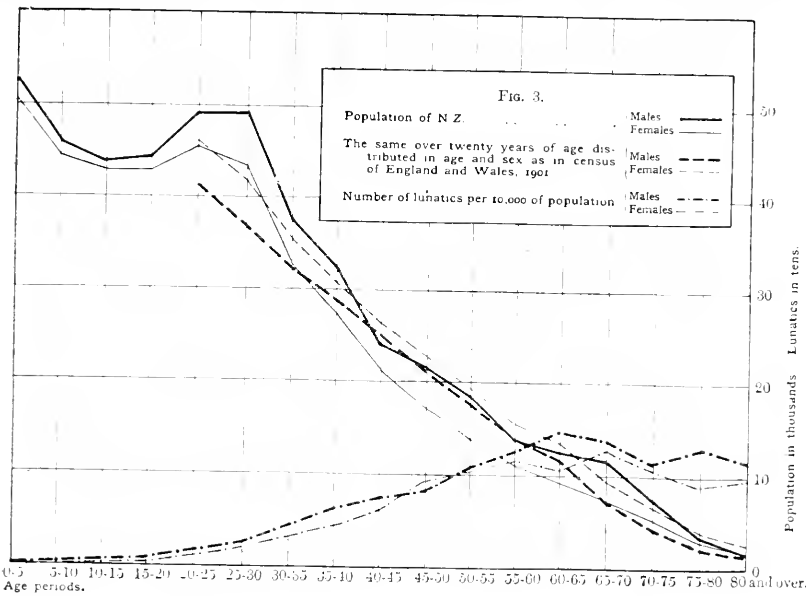
Table III gives for quinquennial age-periods the lunacy-rates for New Zealand, and the ratio of females to males both in New Zealand and in England and Wales.

Table III.

Ages.	Number of Lunatics in 10,000 of Population.		Ratio in Population of Females to Males.		Ages.	Number of Lunatics in 10,000 of Population.		Ratio in Population of Females to Males.	
	Males.	Females.	New Zealand.	England and Wales.		Males.	Females.	New Zealand.	England and Wales.
0–5	0·19	..	0·96	1·00	50–55	105·21	103·96	0·74	1·09
5–10	2·18	2·02	0·97	1·01	55–60	120·85	114·07	0·78	1·12
10–15	4·56	1·40	0·98	1·00	60–65	145·36	105·91	0·76	1·17
15–20	7·46	5·83	0·97	1·02	65–70	138·84	125·02	0·66	1·23
20–25	15·39	11·05	0·92	1·12	70–75	111·01	106·15	0·61	1·28
25–30	25·74	22·95	0·87	1·13	75–80	127·10	92·71	0·64	1·34
30–35	41·80	33·72	0·86	1·10	80 and over	112·60	97·02	0·83	1·53
35–40	60·32	48·93	0·86	1·07					
40–45	75·66	63·54	0·86	1·06					
45–50	86·35	92·92	0·79	1·07	Total	39·47	30·50	0·89	1·07

Fig. 3 also illustrates the same features. It represents the male and emale populations of New Zealand, and also the population of twenty years and over, redistributed in respect to both age and sex proportionally to the census of 1901 for England and Wales.

The question now arises, Will these differences fully account for the deficiency of female lunatics as compared, say, with England and Wales? Some attempt has been made to answer the question in Table IV. In this table is calculated the number of male and female lunatics over twenty years



of age there should have been returned at the various age-periods in the census of 1906 if our population over twenty had been distributed in age and sex as was that of England and Wales at the census of 1901.

TABLE IV.

Age-periods.	Population of New Zealand.		The Same redistributed.		Lunatics per 10,000 of Population.		Number of Lunatics.	
	Males.	Females.	Males.	Females.	Males.	Females.	Males.	Females.
20–25	49,370	45,238	40,947	45,831	15·39	11·05	63	51
25–30	49,308	43,140	36,933	41,603	25·74	22·95	95	95
30–35	37,798	32,621	32,190	35,415	41·80	33·72	135	119
35–40	32,329	27,794	28,763	30,889	60·32	48·93	173	151
40–45	24,451	20,930	24,954	26,502	75·66	63·54	189	168
45–50	21,424	17,003	21,131	22,613	86·35	92·92	183	210
50–55	18,336	13,563	17,690	19,262	105·26	103 96	186	200
55–60	13,984	10,958	13,812	15,434	120·85	114·07	167	176
60–65	12,452	9,442	11,412	13,347	145·36	105·91	166	142
65–70	11,524	7,599	7,854	9,656	138·84	125 02	108	121
70–75	7,567	4,616	5,435	6,976	111 01	106·15	60	74
75–80	3,698	2,373	3,144	4,210	127·10	92·71	40	39
80 and over	1,865	1,546	1,949	2,979	126·60	97·02	25	29
Total ..	284,106	236,823	246,212	274,717	..	..	1,590	1,575
	520,929		520,929				3,165	

The result of this calculation is to give 3,165 lunatics of specified ages of twenty years and over, of which 1,590 would have been males and 1,575 females—that is, the two sexes would have been almost exactly equal in numbers. The number of such actually returned at the census of 1906 was 3,026, of which 1,793 were males and 1,233 females. Instead, then, of the number of the female lunatics being 0·61 of that of the males, it would have been 0·99, a relative increase of 62 per cent. It must further be borne in mind here, as elsewhere, that the dealing with quinquennial age-periods does not make by any means a complete correction, which would undoubtedly give an actual excess of female lunatics.

The result we have obtained does not, however, explain the whole of the apparent difference between this country and England and Wales, for in the latter there is returned a substantial excess of female lunatics, the numbers recorded in the census of 1901 being—

——	Lunatics.	Imbecile and Feeble-minded.	Total.
Males	37,583	24,480	62,063
Females	46,189	24,402	70,591

But the allowances we have made make the contrast very much less marked, and bring it more within the uncertainties of such international statistics. The difference remaining unaccounted-for affords a rather unsafe foundation for argument and speculation.

In conclusion, we may consider briefly how the female really stands with respect to the male in New Zealand in the matter of liability to insanity. At the census of 1906 there were returned, at specified ages of twenty years and over, 1,793 male and 1,233 female lunatics. I shall not trouble the reader with another table: but if, in the manner of previous tables, we allow for the difference in numbers and in age-distribution of the sexes by supposing there had been a female population equal in numbers and similar in age-distribution to the male population, but retaining the female lunacy-rate at the various ages, we find that there would have been 1,567 instead of only 1,233 female lunatics. The comparison of this number 1,567 with 1,793, the actual number of male lunatics, is the best way of comparing briefly the liability of the two sexes to lunacy, since in it both the inequality in the numbers of the sexes and the dissimilarity in their age-distributions are allowed for.

It is interesting further to notice the influence of alcoholism. In 1906 there were admitted to the mental hospitals of this country 401 males and 277 females. Amongst these cases seventy-three of the former but only eleven of the latter were attributed to alcoholism. In 1907, again, the numbers of admissions were 421 males and 279 females. Of these cases, seventy-one of the former but only eleven of the latter were attributed to alcoholism. In the two years the excess of male over female cases due to alcoholism is greater than one-seventh of the total number of male cases. Unless the proportion of recoveries is much greater for this class of patient than for those that owe their insanity to other causes, these numbers would indicate that the difference remaining between the insanity of the males and females in New Zealand that has not already been accounted for by the differences in numbers and age-distribution is entirely explained by the greater excessive indulgence of the male sex in alcohol, and the ravages this indulgence makes on the sanity of the sex.

ART. XXXII.—*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 II.*

By ELSDON BEST.

[*Read before the Auckland Institute, 18th November, 1908.*]

HARAKEKE (*Phormium tenax*).

THE *harakeke*, or flax, as it is commonly termed, has never obtained to any great extent in Tuhoeland, on account of its being essentially a forest district. Only the inferior varieties of flax were here found growing, and the better varieties were only obtained by means of cultivation. The varieties which produce the better grades of fibre are alluded to as *whitau* (sometimes *hitau*), while those which contain poor, weak, non-durable fibre are termed *harakeke maori*, or common *harakeke*.

The following are the names of the varieties of flax known to the Tuhoe Tribe, which people seem to have imported some of the better varieties from the Waikato, for purposes of cultivation, about six generations ago:—

1. *Oue.*—This variety produces the best fibre, much prized in former times for the manufacture of the better class of garments. It was not indigenous to Tuhoeland, but was cultivated.

2. *Pari-taniwha.*—Produces a good fibre, which, however, requires to be steeped in water when scutched, or it assumes a reddish colour. After being soaked a while it is taken from the water and hung up to dry and bleach.

3. *Wharariki.*—Sleeping-mats and such things are made from the green, unscutched leaf.

4. *Rataroa.*—Produces a fibre of medium quality.

5. *Ngutu-nui.*—Nets and snares are made from the leaf of this variety.

6. *Huhi.*—An inferior variety. Grows in swamps.

7. *Tutae-manu.*—An inferior fibre.

8. *Awanga* (or *Aoanga*).—Variegated variety.

9. *Taneawai.*

10. *Ruatapu.*—Formerly looked upon as being *tapu*, as its leaves, or fibre, were used in dressing the hair of chiefs.

11. *Tukura.*—A swamp-growing variety.

The *rataroa* variety is also known as *motu-o-ruhi*.

Shortland speaks of *rongotainui*, *motuorui*, and *mangaeka* as being the names of varieties of flax (*Phormium*). The latter name is applied by the Tuhoe people to the brownish-yellow strips of flax-leaf inserted in certain Native garments, and which colour is produced by exposing the strips to the heat of a fire. Such a garment is also termed a *mangaeka*. Shortland, however, speaks of the word *harakeke* as though it were a specific term for a single variety of flax, whereas it is essentially a generic term, embracing all varieties.

The *awanga* variety is used in making baskets and mats. Colenso gives *tamure* as another name of this variegated variety. *Te rau o Papoua* is said to be a term applied to growing flax, while *te rau o Huna* describes the fibre when scutched and prepared for use. Hence the former term is applied to a rough cape (*pora*), and the latter to a fine garment of dressed fibre.

Local Natives say that an edible variety of flax formerly grew at Tieke, in the Rua-tahuna district. The leaves were dark-coloured, with reddish edges. The base of the leaves was eaten. This plant has disappeared. In this connection, I take the following from a newspaper item: "Mr. McGregor said that there is an edible variety of flax in the Taupo district. It is called *kopakipaki-ika* by the Natives. The main root grows to a great length. It is white in colour, and resembles celery outwardly. It has a sweet taste, which is a contrast to the bitter taste of the ordinary flax."

Natives profess to know two sexes of the *oue* variety of flax. They state that the leaves of the male plant are more pointed than those of the female plant. The latter leaves are shorter, and do not give so long a fibre. The edges of leaves of the female plant are a light-reddish colour (*puwhero*). Leaves of the male plant have reddish streaks, called *kakaka*, in them, as you see light-coloured streaks in a leaf of *toi* (*Cordyline indivisa*). The fibre produced by the female plant is white and soft, that of the male is somewhat harsh and has a reddish tinge (*ma puwhero*).

The Natives, in former times, often planted the commoner varieties of flax near their dwellings, as the leaves were much used in the manufacture of small baskets to hold cooked food, which baskets were used but once. The varieties producing better fibre were planted usually at the edges of cultivation-grounds. A plant would be divided and the fans planted out in the fourth month of the Maori year—*i.e.*, in the spring. It was considered necessary to put two plants in each *whawharua* or hole dug for the purpose. It was unlucky to plant an odd number (*Mehemea ka kehe, he aitua*)—the plants would not flourish. Such a flax-plantation is termed a *pa harakeke*. The ground around the plants was kept clear of weeds. Any old leaves were cut away so as to promote a more vigorous growth in the plant; also, if the young leaves were considered too numerous, some of them would be cut out. Long rows of cultivated flax were seen at Aotea by early settlers.

The withered outside leaves of a flax-plant are termed *pakawha*. The half-dressed *hukahuka* or thrums of a *pokeka* (rough cape) are known as *pureke*.

In former times the Maori had some curious ideas regarding flax. When making a flax-cultivation—*i.e.*, setting out plants to form a *pa harakeke*—the planter was careful to note what particular wind was blowing at the time; for when the flax was grown, and it was desired that use be made of it, then it was considered to be necessary to cut the leaves when the same wind was blowing as when the flax was planted, otherwise the fibre in the leaves would be found to be of a very unsatisfactory quality—short, weak, and brash. And if a person went to the owner of such a flax-grove and obtained permission to take some of it for his own use, his next question would be, "*He pehea te hau i rumakina ai taua harakeke?*" (What was the wind when that flax was planted?) And if such wind was not prevailing at the time, then he would wait until it did before cutting the flax. Now, if a person went to steal some cultivated flax, he would try the condition of the fibre in a few leaves. Should the fibre prove to be poor as to length and quality, he would know that he had gone a-thieving during the wrong wind. Hence he would wait until the wind changed, when he would try again. When he found that the flax gave a long, strong, desirable fibre, he then knew that he had hit upon the right wind—the wind that obtained when the flax was planted.

A somewhat similar superstition to the above seems to have obtained in regard to the mandrake-plant. In Lang's "Custom and Myth" we read, "'In digging the root,' Pliny says, 'there are some ceremonies observed: first, they that go about this work look especially to this—that the wind be not in their face,'" &c.

When the fibre of flax is prepared for weaving into a fine garment it must be carefully looked after. There are many dangers abroad in connection with the art of weaving: for instance, if that fibre be left at any spot where a person might step over it, it is a most reprehensible act of carelessness, inasmuch as the fibre would never take the dye well if a person had stepped over it.

When flax-fibre of the better grades is being prepared for the making of garments it is deemed extremely unlucky to throw the refuse of the leaves into a fire, for if that refuse be burned, then all the flax in the grove from which the leaves were taken will be spoiled. They will become *kakara wera*—that is, the tops of the leaves will die first, then the whole leaf will become affected and die. I once heard an old Native woman exclaim peevishly, "*Kua kakara wera katoa taku pa harakeke i te mahi a te wahine ra*" (My flax plantation has been ruined by this woman). On inquiry I found that the offending person had begged some of the flax, and had burned the refuse of the leaves after she had taken out the fibre. You will doubtless be relieved to hear that these restrictions, &c., pertain only to the higher-class varieties, those termed *whitau* or *harakeke muka*, and not to common varieties (*harakeke maori*).

The term *makuhane* is applied to short, brash flax-fibre, the same being weak and easily broken: "*Ka mahia te muka, na ka kotihe. Na te makuhane i wheraka ai.*"

In former times long trumpets were made of flax by winding the green half-leaves in a spiral manner. They lasted merely so long as the material remained green. They were called *tetere*.

Some old Natives state that flax was introduced into New Zealand by the Matatua migrants, which is presumably an error.

Leaves of the flax-plant, or strips of such leaves, were often used in certain rites of former times. When a person performed the rite known as *matapura*, in order to preserve himself from the arts of witchcraft as directed against him by persons known or unknown, he first of all obtained some strips of green flax-leaf, which he tied round his body and limbs, perhaps three or four round each, in divers places. This tying-up process is termed *ruruku*. He then recited an incantation to avert the shafts of magic. This peculiar usage was often followed by persons visiting a distant village, when doubtful of the disposition or intentions of the people thereof. It would be carried out shortly before the travellers arrived at such village.

When about to have the *wai taua* rite performed over them, the warriors of a war-party took off all their clothing, and each man tied a half-blade of flax round his waist. Under this belt in front each man thrust some green branchlets of *karamuramu* (*Coprosma*), which thus formed a sort of apron, which was known as a *maro taua*. The officiating shaman, or priest, then took a strip of green flax-leaf and walked into the water (stream or pond) wherein the rite was to be celebrated. He tied a knot in the middle of the flax line and placed it in the water. If a stream, then the knot was placed up-stream. The priest stood between the two ends of the flax—*i.e.*, in the bight of the line—while reciting his charms or spells. *Ka kiia he kuwha tangata taua harakeke* (That flax is likened to the thighs of a person).

Again, when a Maori priest was called in to attend a sick person, one of his acts was to proceed to a clump of flax, where he pulled out one of the young leaves. If a screeching sound was made by the leaf as it was drawn out—a not uncommon occurrence—that was looked upon as a good omen: the patient would recover. This flax-leaf was placed upon the body of the patient when the priest repeated the charms by which he drove out the evil spirits, the cause of the man's illness. These malevolent demons were supposed to leave the sick person's body by way of the flax-leaf: hence, in this connection, it was termed an *ara atua* (demon-path).

In modern times various preparations from flax have been used as medicines by the Natives, for diarrhœa and other ills. In cases of difficult menstruation in women a peculiar decoction is administered: it is made by boiling four pieces of flax-root and four pieces of a plant known as *aka taramoa*. For this complaint these materials must be taken from the east side of the plants, otherwise the medicine will possess no virtue whatever. In making a medicine for any other complaint the materials may be taken from any part of the plants. The roots of the *huhi* variety of flax are roasted and chewed as a cure for constipation.

Scents.

Under the above brief heading we propose to give a few notes anent the various scents used by the Maori in former times. These scents were various aromatic leaves and gums, used for the purpose of imparting a pleasing odour to persons or houses. Some were utilised wherewith to scent oil, which was then used to anoint the body. Fragrant leaves of various trees and plants were used for this purpose.

The sense of smell possessed by the Maori is certainly keen, though they do not appear to object so strongly to foul odours as do we. The term *kakara* is usually employed to denote fragrance—any appreciated odour: while the expression *haunga* would be applied to any smell not appreciated. The word *kakara* is also used as meaning "savoury," as when applied to food.

The items used as scents in former times by Natives of the Tuhoe district were obtained from the following trees, shrubs, &c.:—

Koareare; syn., *raukawa*. *Panax Edgerleyi.*
Tanguru-rake. An *Olearia.*
Kotara. Probably *Olearia Cunninghamii.*
Tarata. *Pittosporum eugenioides.*
Pua-kaito. *Celmisia spectabilis.*
Kopuru. A moss.
Karetu. *Hierochloe redolens.*

There are other shrubs, plants, &c., that provided aromatic leaves for the dwellers in other districts, but the above are the items that obtain in Tuhoeland. Of these, the *kotara* and *pua-kaito* are found only at Maungapohatu, in the Tuhoe district, while the *koareare* and the *tanguru-rake* are found only on the high ranges.

The leaves of the above trees, &c., as also those of the white *manuka*, were used in various ways. They were often enclosed in small bags or sachets, usually made of bird-skin with the feathers left on, which bag was suspended from the neck and hung down on the wearer's breast. The skin of the *toroa* (albatros) was prized for this purpose. The aromatic gum of the *tarata* tree was also placed in such sachets. Not only are the leaves of this tree most fragrant when crushed, but the gum that exudes from the wounded trunk has also similar properties. It is obtained by making an incision in the bark and wounding the trunk, thus causing it to bleed. The gum, on being exposed to the air, soon solidifies, and is removed. It was often used for the purpose of imparting a pleasant odour to oil used for toilet purposes. The oil used was obtained from the berries of the *titoki* tree (*Alectryon excelsum*) and from the fat of the wood-pigeon. Sometimes this oil was scented by placing in it crushed leaves of white *manuka*, or of the trees and plants enumerated above. A calabash of such oil scented with gum (*pia tarata*) was termed a *taha tarata*. The skin of a *pukeko* or other bird would be dipped in this oil and then rolled into a ball with the feathers outward. This was known as a *pona tarata*, and was suspended from the neck of the wearer. It was a somewhat greasy neck-pendant.

Chaplets of the fragrant leaves, twigs, &c., were sometimes worn by women, and the sleeping-places or houses of persons of rank or of distinguished guests were occasionally strewed with these aromatic leaves. The *kotara* and the *pua-kaito* were sometimes transplanted and grown near the Native hamlets.

A gourd of scented oil used for anointing the hair was termed a *taha koukou*, from *taha*, a calabash, and *koukou*, to anoint. In an old Native song we find the following:—

He wai tarata ra
Me patu kia kakara
Kia ingo mai ai.

The last line explains one of the principal uses of scents the wide world over—viz., to attract the opposite sex. Women often wore belts made of the fragrant *karetu* grass. The flax belts which were made double were often filled with odorous herbs. Hence we see in song.—

Tu ake hoki. E hine
I te tu wharariki
Hai whakakakara mo hine ki te moenga.

We will now turn our attention to the fauna of the Tuhoe district—or, at least, that portion of it that entered into the domestic economy of the Natives of these parts.

Lizards.

The generic names for lizards are *ngarara* and *moko*. The following is a list of the various kinds found in Tuhoeland:—

Tuatara. *Sphenodon punctatum*.
Koeau.
Moko-ta.
Moko-kakariki. ? *Naultinus elegans*.
Mokomoko.
Moko-tapiri. }
Moko-papa. } ? *Naultinus pacificus*. These three names are applied to one and the same species.
Ngarara-papa. }
Moko-parae.

The last-mentioned (*moko-parae*) is possibly a duplicate name for one of the preceding species. Again, *ngaha* was given as another name for the *mokomoko* by one Native, while another states that *ngaha* is a generic term, and includes the *mokomoko*, *moko-parae*, &c.

The *tuatara* was the largest of these lizards, and it was the only species that was eaten by the Tuhoe Tribe. It is said to have been numerous on the mainland in pre-European days, and certain places were famed for the number of these lizards they produced. Such places were Wai-o-hau, Tawhiu-au, and Mount Edgecumbe. The latter hill is known as Pu-tauaki to the Maori. An old saying has it, "*Ko Putauaki te maunga, he ngarara tona kai.*"

There was no superstitious feeling among the Natives in regard to the *tuatara* and *mokomoko*, but it was deemed an evil omen to see any of the other species of lizards.

At the present time the *tuatara* seems to have been exterminated on the mainland, and is in this district only found on the Rurima rocks, off Matata. It is there found, say the Natives, often living in holes in the ground or rocks wherein the *kuia*, a sea-bird, nests. Speaking of this bird, a Native said, "*He iro nona a te tuatara*"—meaning that the bird produces, or is the origin of, this singular lizard.

At page 152 of vol. v of the "Transactions of the New Zealand Institute" is an account of the Moutoki Islet of the Rurima Group, wherein Captain Mair describes the haunt of the *tuatara*, and states that two Ure-wera lads who accompanied him showed no signs of superstitious fear of the *tuatara*.

The lizard known as *koeau* to the Tuhoe Natives is probably the same as the *kaweau* of other tribes. Colenso states that it was known as *tuatete* in some districts. Local Natives describe it as being larger than the green lizard (*moko-kakariki*), as being light-coloured, and as living in the ground in winter-time: also, that it stands high up on its legs, the under-part not sagging down on the ground as with other lizards. The body is also thicker than in other species. Mehaka tells me that the body of this *koeau* looks as though it were covered with a fine fur or down, and compared its appearance to that of a newly-born kitten. It is said to be about 9 in. in length. Another Native says that it is marked *he mea whakairo*, adding that, "When seen it is an evil omen; disaster follows" (*Kia kitea, he aitua, he kaupapa tahuri*). It is also an evil omen to see the fœces of the *koeau* about your dwelling, or on your path when travelling, for that lizard represents the spirits of your dead relatives, who thus send you a sign to join them in the underworld.

The *koeau* (sometimes called *koea*) is said to be extremely nimble, and could easily escape should any person endeavour to catch it—which is, however, the last thing a Native would think of attempting. If you take your eye off it for a moment it will have disappeared when you look again. It seems to have lived much on forest-trees. Tuhoean bushmen say that the *iro*, or embryo, of the *koeau* was sometimes found in *rua kaka*—holes in trees wherein the *kaka* parrot nested. It is a whitish or light colour at this stage. The *koeau* grows as large as a small *tuatara*, and grown specimens are of a reddish (*puwhero*) colour.

The Native who gave the above notes added, "It is a very bad omen to see a *koeau*. Te Rangi-ua saw one, and, observe—all his elders have died."

The *moko-ta* is said to be another name of the *moko-kakariki*.

The *moko-kakariki* is the common green lizard. An old Maori myth has it that this lizard originates from the bird called *kakariki*; that when the eggs of this bird are hatched out the portion of egg-matter left in the nest develops into an *iro*, or maggot, from which is developed the green lizard.

The *mokomoko* is a small dark-hued lizard with a long tail. Buller gives the scientific name of this species as *Tiliqua zealandica* in the "Transactions of the New Zealand Institute," vol. ix, page 319.

The *moko-tapiri*, also known as *moko-papa* and *ngarara-papa*, is said to be found in forest country, in holes in trees, &c. A carved representation of this species on the large house Te Whai-a-te-motu, at Rua-tahuna, shows it of a short, squat form. It is said to be of a mottled colour. One very old man stated that it is about 4 in. or 5 in. in length, has a rough (*whekewheke*) skin, and is light-coloured. Natives state that this lizard is the parent of the small cuckoo (*pipiwharauroa*). Another authority says that a kind of maggot found under the young chicks of the *tihe* bird in the nest develops into the *moko-tapiri*, which differs much in appearance from the *moko-kakariki*, and is much feared by the Maori people.

The *moko-parae* is said to be another name for the *moko-kakariki*.

The *tara-kumukumu* is said to be a species of lizard somewhat resembling a *moko-parae*, but it may be a marine creature. It has an unpleasant habit of afflicting mankind, and any complaint that causes a swelling in the region of the thighs is attributed to it. This lizard is never seen now. It is sometimes confused with the *kumukumu*, a sea-fish, but the evidence is not clear.

Lizards are said in Maori myth to be the offspring of one Punga, who was a descendant of Tangaroa; hence the term *te aitanga a Punga* (offspring of Punga) is applied to reptiles. It is also applied to very dark-skinned or ugly, ill-favoured persons. The immediate offspring of Punga were Tu-te-wehiwehi, Tu-te-wanawana, and Kumukumu, the latter being a sea-fish. In Maori fable the latter adopts the ocean as its home, while the two former, representing lizards, keep to their land home. Hence the lizard said to the *kumukumu* (gurnard). "Go on your way to the ocean, but soon I shall see you caught and cooked for food." "Not so," remarked the latter, "but I shall see you destroyed by fire when the fern lands are burned." The lizard replied, "No one will injure me, for all will fear me on account of my appearance."

Lizards are sometimes seen in the Native wood-carvings. One is so seen on a *parata* on a food-store known as Te Hau-o-puanui, at Rua-tahuna. In this case a lizard is hanging from the mouth of a carved human head, as though it were to replace the tongue. The tail of the lizard is in the mouth, while the fore part of the body, the fore feet, and head hang down below the chin. In the house Te Whai-a-te-motu, hard by, is the carved figure representing an ancestor named Kahu-tarata, which has a lizard hanging from the mouth in the same way. This ancestor is said to have been a noted eater of lizards.

"*Ko Putauaki te kainga, he ngarara tana kai*" (Putauaki is the place where reptiles are eaten). This is an old saying applied to Mount Edgecumbe and its environs, on account of the scarcity of food there. *Tuatara* were formerly collected for food, placed in baskets, and taken alive to the village, where they were cooked and eaten. "If women of the party ate of the *tuatara* they would suffer for it, and probably perish, for they would be assailed by many lizards of that species." So sayeth the Maori.

"*Ko te kekerewai, ko te tuatara nga kai o Wai-o-hau*" (*Kekerewai* and *tuatara* were the foods of the Wai-o-hau district), said an old Native to the writer. The former is the small green beetle found on *manuka* bushes in summer.

Lizards were sometimes selected as guardians of property or places in former times, presumably on account of the dread the Natives had of them. In some cases a lizard would be located on a tree much frequented by birds, in order to guard it against poachers; or one was stationed near the forest *mauri* in order to protect or guard the same. In giving evidence in the Rau-ngaehe Block case Te Kaha said, "Te Purewa had a *tutu* (tree on which birds are snared) at Te Rua-ngarara, near Taumata-miere. A stage was made among the branches of that tree, and a lizard was kept at its base. Hence the place was called Te Rua-ngarara (the reptile's den)."

Lizards were often selected or looked upon as the form of incarnation of a god or demon. Thus the god Peketahi, of whom Te Purewa was the human medium, appeared in the form of a lizard. Another such demon, known as Te Hukita, appeared in the form of a *mokomoko*; while Tamarau, a deified ancestor who possessed the power of flying, is represented by a *kaeau*.

Insects and other "Small Deer."

The generic terms for insects are *manumanu* and *ngarara*. In Native myth they are said to be the offspring of Punga, of whom we have already spoken—albeit some insects, &c., are credited with having other and apparently more immediate progenitors. Thus the mosquito and sandfly are said to be the grandchildren of Te Hekapona and Te Monehu, while the *purerehua* sprang from Hu-te-hue (origin of the *hue*, or gourd), the *kihikihi* from Hikawaru, the *pawerewere* from Katipo, the *ngaro* from Moenga-nui, its offspring being Iroiro (maggots). Earthworms originated from Panewharu, whose younger relative was Mokoroa; the next born was Whiti, and the next Tea. The enemy of these was Tangaroa (fish). The *anuhe* sprang from Nuhe. It was Nuhe who saw the fine markings of the *tawatawa* (mackerel), a descendant of Tangaroa, and forcibly took some of those markings for himself: hence the fine appearance of the *anuhe*. These marks are compared to certain patterns of tattooing. The *anuhe* and *toronu* are said to descend from the heavens—probably because their origin is not clear to the Maori—when they appear in great numbers on *kumara* plants.

We give below an incomplete list of Native names of insects, earthworms, &c., as collected in this district:—

Anuhe; syn., *hotete*. A species of caterpillar.
Awheto. *Cordiceps robertsii*.
Hihue. Hawk-moth.
Huhu. ? *Prionoplus reticularis*.
Kahukura. Butterfly.
Kapowai. Dragon-fly.
Katipo. A spider.
Kekerengu. A bug or beetle.
Kekerewai. Small green beetle seen on *manuka*.
Kihikihi. Cicada.
Kikihi. Cicada.
Kowhitiwhiti. Grasshopper.
Kuharu. An earthworm.
Kurekure. An earthworm (*Tokea esculenta*, Benham).
Manumanu. Generic term for insects.
Moka. Caterpillar.
Moko-roa. A grub found in *houhi*, *mako*, and *kaiweta* trees.
Moko-tawhana. A caterpillar.
Mu. Probably a species of spider.
Namu. Sandfly.
Ngarara. Generic term for insects, lizards, &c.
Ngaro. Generic term for flies.
Ngata. Slug, leech.
Noke; syn., *toke*. Generic term for earthworms.
Noke-tai. A species of earthworm.
Ngoru. A species of earthworm.
Ngutara. *Cordiceps robertsii*.
Pakaurere. Winged grasshopper.
Papaka. A species of beetle.
Pepe. The *huhu* at one stage of development. ? Moth.

Pihareinga. Cricket. Said to be an introduced species.
Pokorua. Ant.
Pokotea. An earthworm (*Tokea urewerae*, Benham).
Popokoriki. } Ants.
Popokorua. }
Purerehua. Generic term for moths, and possibly includes butterflies not brightly marked.
Puwerewere. } Spiders.
Pungawerewere. }
Ro; syn., *whe*. The mantis.
Tai. (See *Noke-tai.*)
Tarao. An earthworm (*Rhododrilus edulis*, Benham).
Tarapoa. A large moth.
Tataka. (See description of *huhu.*)
Tititi-pounamu. Katydid.
Toke. Generic term for earthworms.
Toke-rangi. *Rhododrilus besti*, Benham.
Toronu. A species of caterpillar.
Tuiau. A species of midge.
Tunga. A grub.
Tunga-rakau. } (See account of *huhu.*)
Tunga-rere. }
Tungoungou. The larva or chrysalis of the *hihue*.
Tutaeruru. Some winged insect.
Waeroa. Mosquito.
Wharu. A species of earthworm.
Weri. Centipede.
Weta. An insect.
Whe; syn., *ro*. Mantis.
Whiti. A species of earthworm.

A foolish or foolhardy person is compared to a moth that flies into a fire.

If many moths are seen around a fire at night, such is deemed a good night for eel-fishing.

The *awheto* is known to us as the vegetable caterpillar (*Cordiceps robertsii*; also, apparently, known as *C. hugelii*). In its living state it is known as *ngutara*. When it burrows into the earth and there dies it is termed *awheto*. These creatures are collected and burned and used to make a black tattooing-pigment. The *hihue* is classed as a *purerehua* by Natives: it is the hawk-moth. The larva or chrysalis of this species is found underground, in which state it is called *tungoungou*. When it acquires wings it is found upon the white blossoms of the *hue* or gourd-plant (but not on those of pumpkins). Natives state that it thrusts its proboscis down into the flowers in order to draw up the liquid found therein, and that it received its name from this act (*hi*, to draw up).

The *huhu* is a grub found in such timbers as *rimu*, *matai*, and *kahikatea*, which it attacks at the first sign of approaching decay, as when one of these trees has been scorched by fire. In its grub state this creature is known as *tunga-rakau*; when it ceases to bore, remains in a cell, and casts its skin, it is termed *tataka*. When its legs and wings are formed, though still white, it is known as *pepe*. When it emerges from the tree or log and flies about, a brown cockchafer, it is called *tunga-rere*. In its grub state this species is prized as an article of food.

Butterflies are called *kahukura*, though possibly the name is applied only to bright-coloured species. The *katipo* is a species of *puwerewere*, and is found on the coast, but apparently not inland. It is often found about *tauhinu* scrub. Its bite is much dreaded, and seems to cause considerable pain. The Native cure for *katipo*-bites is to hold the afflicted person over a fire which is made to give forth much smoke, the process being known as *whakapua.* They were also often laid in a stream, so that the body was covered with water.

The *kikihi*, or *kihikihi*, or *kikihitara*, is the cicada or singing-locust. Said an aged Maori to the writer, "I will give you the song of a certain people of this world: those people are the *kihikihi.* They are an exceedingly numerous people. During the *waru patote* (eighth month of Maori year) those people cling to their ancestor, Tane-mahuta (settle on trees), and sing lustily. Here is the song of those people:—

"Kaore te waru nei
Ka piri au ki a Tane-mahuta
Ki toku tupuna
Tu takere! Tu takere! Iere nui au
Kohiti ko Makaro, iere au
Popo nunui, popo roroa, ko wai e aha atu
Na Tane ano au i awhi ki tua te arorangi
Ka whiti mai ko te iwa
Ka hoki au ki raro ra ki tona kainga
Maua tahi ko taku taina ko Nuhe
I tonoa iho nei ki tona tungane, ki a Rongo
Hei manawa mona
Koia ka tumoumoutia—ha!"

The cicada is treated in Maori fable as the personification of slothful carelessness, and the ant as the emblem of industry and forethought.

Fable of the Ant and the Cicada.

The *pokorua* (ant) said to the *kihikihi* (cicada), "Let us be diligent and collect food during the summer, that we may retain life when the winter arrives." "Not so," remarked the cicada; "rather let us ascend the trees and bask in the sun on the warm bark." Even so, the ant laboured at collecting and storing food for the winter. The cicada said, "This is true pleasure, to bask in the warm sun and enjoy life. How foolish is the ant, who toi's below!" But when winter came, and the warmth went out of the sun, behold, the cicada perished of cold and hunger, while the ant, how snug is he in his warm home underground, with abundance of food!

As the cicada clung to his tree, rejoicing in the warmth of summer, he sang,—

He pai aha koia taku pai
He noho noa
Piri ake ki te peka o te rakau
E inaina noa ake
Ki te ra e whiti nei
Me te whakatangi kau i aku paihau.

The following is said to be the song sung by the industrious ant:—

Hohoro mai e te hoa
Kauaka e whakaroa ara ra
Ka turua ta te popokorua
Rawe noa tangata ki whakahauhau—e
Ki te keri i te rua mo te ua o te rangi
Mo te makariri wero iho i te po nei—e
Me te kohi mai ano i te kakano—e
Hai ora mo tamaroto, kia ora ai—e.

The term *purerehua* (also *purehua*) is applied to moths generally, and perhaps also to butterflies of quiet colouring. Some species of *purerehua* were formerly eaten by Natives. The *mokoroa* is a grub found in *houhi*, *mako*, and *kaiweta* trees. The *mu* is said to be a form of spider.

The *namu*, or sandfly, is a relative of the mosquito, according to Maori fable. They are descendants of Haumia and Te Hekapona, and children of Te Monehu (*monehu*, syn. *mokehu*, young shoots of the common fern, *rarauhe*). Other such descendants are the *ro* and *puwerewere* and other such insects. Namu-iria, a son of the *namu*, stole the *hau*, or vital essence, of Tu (god of war and origin of man), for which he was slain by Tu. Hence the sandfly people declared war against Tu—that is, against man. They still assail man in this world. They are exceedingly strenuous in their attacks upon man. The mosquito fears but two things—wind and smoke. The mosquito said to the sandfly, "Let us wait until evening before we attack man, lest we be slain. Then we will attack him, and I will buzz in his ears." But the sandfly would not consent to this. He said, "Though myriads of us be slain, yet will we give battle in the light of day. Though we perish, what matters it so long as we shed the blood of man ?" Even so they went forth, and were slain in their thousands. The mosquito observed this, and said, "I told you to wait until nightfall. Now see how you have suffered."

E ki ana ahau, e taku tainaina
Waiho kia ahiahi ka haere ai taua
Ki te riri i to tuakana
Ki rawa atu au : Waiho kia maru ahiahi
Hei wheowheo i ona taringa.

Such was the song of the mosquito to the sandfly, and to which the latter replied,—

He ahakoa, e taku tuakana
Te mate ai au
I ana toto ka pakaru kei waho—e.

(And you, O mosquito, when you assail man at night, will be smoked to death.)

Noke and *toke* are generic terms for earthworms, of which a good many kinds have special names.

The *papaka* appears to be a kind of beetle.

The *toronu* is a kind of caterpillar which formerly infested the *kumara* plants, and gave considerable trouble to the neolithic agriculturalist. A day was set apart by the sorcerer priests for the destruction of this pest. It was brought about by means of a rite known as *ahi patu toronu*. You might like to know how it was that the crops of man came to be assailed by these pests. When the *kumara* was first obtained by mankind it was stolen by one Rongo-maui from Whanui (the star Vega), who seems to have been the custodian of that prized tuber. In a spirit of revenge, Whanui sent Nuhe (*anuhe*), Moka, and Toronu down to earth to destroy the *kumara* cultivated by man. These are the three species of caterpillar that prey on the *kumara* plants.

The *tutaeruru* is some form of winged insect, perhaps a beetle, which flies around in the evening with a booming sound. This species and the *kekerewai* were sometimes called the *manu a Rehua*. They were both eaten in former times.

In some districts *tapapa* is a lizard-name, but which species it applies to I cannot say.

Molluscan Fauna.

I have collected a good many forms of land-shells in the Tuhoe district, the specimens being examined and named by Messrs. H. Suter and C. Cooper. They are of small size, with the exception of one, known as *pipiko* to the local Natives, which is found up to about ¾ in. in diameter. I will not annoy the guileless reader with a list of the above names.

The fresh-water shell-fish of this district are not numerous. The *kakahi*, or fresh-water mussel, is plentiful in Wai-kare Moana, and is also found in ponds at Te Papuni, Ruatoki, &c., but is not numerous elsewhere. These formed an article of food formerly, but are very insipid. *Unio zelebori*, from a pond at Te Papuni, has a very thick, heavy shell, that district containing limestone, which is not seen west of Maunga-pohatu. *Unio menziesi* (Gray), from a lagoon at Ruatoki, has a thin, fragile shell. Specimens obtained at Wai-kare Moana do not seem to be the same as *Unio waikarense*, described by Colenso. The latter are light-yellow, and larger than those collected at the lake by Mr. Lucas and myself.

The *koura*, or small fresh-water crayfish, is not found in the Tuhoe district, so far as I am aware, save at Te Houhi.

The fish found in the rivers and streams of the district are eels, *kokopu*, *marearea* (syn. *inanga*), *titarakura*, *papanoko*, and the *upokororo*. The last-mentioned has now disappeared. Duplicate names of some of these species, as also names of varieties (from a Native point of view), will be found in a previous article on "Food Products of Tuhoeland" in this journal.

The Kiore, or Native Rat.

The *kiore maori*, or native rat, is said in Maori tradition to have been imported into these isles from Polynesia by the early migrants who settled on these shores, and was not an indigenous animal. These small creatures furnished a considerable amount of food to the forest-dwelling Native tribes in former times, their flesh being highly esteemed. The *kiore maori* is said to have been a clean and even fastidious eater—unlike the introduced rats—and hence its flesh may well have been very good eating.

Many persons stoutly maintain that the old Maori rat is still with us, has not yet died out; but it seems probable that they mistake the black introduced rat for the old-time *kiore*. A writer in the *Canterbury Times* newspaper states that enormous numbers of Maori rats appeared in the northern part of the South Island in December, 1884. These creatures cannot have been the *kiore maori*, but must have been the black rat alluded to above, or some other introduced species. I have never heard that the native rat ever appeared in such migrant swarms.

The above writer refers to his native rat as *Mus exulans*, and says, "The *kiore* is smaller than either of the two rats introduced into the colony by Europeans, and the female is somewhat smaller than the male. Their average weight is about 2 oz. The fur on the upper portions of the head and body is brown finely mottled with dark-grey. The sides of the body are lighter, and all the under parts, including the chin and the feet, are dirty-white. The species is found throughout Polynesia. In New Zealand it is sometimes called the 'bush-rat.' The proper name is *Mus exulans*." This article seems to have been taken from a paper by John Meeson, B.A., published in vol. xvii of the "Transactions of the New Zealand Institute." He states that the following species of rat are now (1884) found in New Zealand: (1) *Mus decumanus* (Norwegian rat), which has driven away the *kiore maori* into remote districts, if it has not exterminated it altogether; (2) a species of *Mus rattus;* (3) a smaller species (Professor Hutton's *Mus maorium*). The writer believes that the migrant swarm of 1884 consisted of the third species (*Mus maorium*), and that this was the old-time *kiore* *maori*, though this statement scarcely agrees with his remarks (see *supra*) on *Mus decumanus*. Mr. Meeson thinks that there may have been two species of native rats.

Dr. Buller's *Mus novæ-zealandiæ* (Trans. N.Z. Inst, vol. iii, page 2, 1870) had "fur above bluish-black." This he claims was a specimen of the old *kiore maori*, or native rat. But this description seems to fit a bluish-black bush-dwelling rat now found in the Tuhoe or Ure-wera district, and which the old Natives say is not the old native rat, but one introduced by Europeans. My local information on this subject was obtained from two old men of the Tuhoe Tribe—Tutakangahau, born about 1830 or 1832, and Te Puia Nuku, who seems to be some years older. They both belong to cannibal days, both saw the old *kiore maori* in their youth, saw it die out, and the two introduced species overrun the land.

Dieffenbach, writing in 1843, said, "The indigenous rat has now become so scarce . . . that I could never obtain one."

Tamarau Waiari, an old man of the Tuhoe Tribe, who was born in 1830, said that the old native rat disappeared in 1838 from the Ure-wera district. Though all the old men state that it rapidly disappeared after the imported species reached this district, yet it is improbable that it was exterminated in the space of one year. It may have been last trapped or last seen in 1838, or the imported rats may have first invaded this district and commenced to wage war against the *kiore maori* about that time. Anyhow, all agree that shortly after the arrival of the imported rats in this district the trapping of the native rat was given up, so scarce had they become.

Judge J. A. Wilson states that the *kiore* was unknown to the original Polynesian people of New Zealand; that it was not imported until the arrival of the last migration. This seems highly probable. It appears, however, that rat-bones have been found mixed with *moa* bones in the South Island, and also in a subfossil state.

The two species of rat found about my own primitive camp in the Tuhoe district, and which are bold and troublesome in winter-time, are the grey Norwegian rat (so called) and a bluish-black rat which I take to be *Mus rattus*. The former appears to be an omnivorous creature, and eats leather, with relish apparently, at times, and has of late made a hearty meal off an Angora-hair saddle-cinch.

Mr. Taylor White speaks of the *kiore maori* as being of a grey colour, and smaller than the so-called Norwegian rat (Trans. N.Z. Inst., vol. xxvii, 1894).

In vol. xxviii of these Transactions, page 3, Professor T. Kirk says, "The place formerly occupied by the Maori rat in the North Island is now so fully occupied by its old enemy the black rat as to afford a striking instance of complete replacement." The above writer states that the *Mus maorium* of Hutton is the old-time native rat, or *kiore maori*, and that it still survives at various places, north and south.

The origin of the rat, according to Maori myth, is as follows: "The origin of the *kiore maori* was one Hine-mata-iti, daughter of Pani (the parent or producer of the *kumara*, or sweet potato)." So said old Pio of Ngati-Awa, of Te Teko, born about 1824. Again, he says, "The first fire given by Mahuika to Maui was the little finger (*to-iti*) of her left hand. That *to-iti* represents Hine-mata-iti, who was the *matua* (parent) of the *kiore*." And again, "The ancestor of the *kiore* was Pani-tinaku—that is to say, a female child of Pani's. Her descendants are the *kiore*, who are a very numerous people. The reason of their being assailed (by man) was because they began to steal the grandchildren (offspring) of Pani-tinaku—that is, the *kumara*." And again, Pio says, "*Tenei iwi te kiore, ko Hine-mata-iti.*"

The Rev. R. Taylor, in "Te Ika a Maui," gives Hinamoki as the creative parent, or origin, of the rat. We shall mention this term again.

We give below a list of Maori names for rats:—

Hinamoki.
Matapo.
Moke.
Muritai.
Pou-o-hawaiki.
Tokoroa.
} These names are known to the Tuhoe Tribe.

Hamua. Given by John White.

Maungarua.
Riroi.
} Given in Williams's Dictionary.

Kiore. Generic term.

The *hinamoki* is said by Paitini, of Tuhoe (who was born about the year 1843), to be the name of the old-time Maori black rat. He used the term *pango* to describe its colour, but this term is used to denote dark-brown, dark-blue, &c., as well as black. He stated that the *hinamoki* is extinct, but that a *pango* (black, or dark-coloured) foreign rat took its place. He himself has never seen the old Maori rat: it was extinct before his time—*i.e.*, before he can remember, not necessarily before his birth. Some years after giving me the above notes he told me that the *hinamoki* was a dark-coloured rat, a bluey-black. Williams's Dictionary simply says, "*Hinamoki*, a kind of rat." This is terse, and, if not sufficient for our purpose, at least shows the cautious mind of the lexicographer. But Mr. Taylor White (Trans. N.Z. Inst., vol. xxvii, page 259) is not bound by earthly rules, and says, "Investigating the structure or composition of *hinamoki*, we find *hina*, grey hair of the head—which would seem to mean white rather than our standard of a grey colour, as of a rat or rabbit. If so, it seems hardly applicable in this case. But *hina* is a personification of the moon, and supposing the original form to have been *mokai*, rather than *moki*, we have 'Hina's pet'—the animal moving about at night."

This is lovely! But why not carry the matter out to the bitter end—I mean, its logical conclusion? Observe: If the original form of *hina* was *Paraone*, and *moki* but a modern rendering of *kau*, then, on the lines of the above reasoning we have "Brown's cows"—which, after all, may be but an overgrown species of rat. There are endless possibilities in the *hinamoki*. And, besides, I know to my bitter cost that cows do move about at night. 'Twas but Monday se'nnight that, as Parearau sagged down on Tokorangi Hill, they (those cows), with evil in their hearts, did make entry into my truck-patch and work much havoc therein, strolling forth therefrom, as the blushing sun rose, followed by divers potsherds, brickbats, and choice profanity in three tongues. *Kati!* Enough! A truce to these idle jests. Here endeth the *hinamoki*.

Matapo.—Old Tamarau Waiari, of Tuhoe, told me that there were two kinds of native rat in former times—the *matapo*, a black or dark-coloured (*pango*) species, and the *tokoroa*, a grey rat. Whether these were two distinct species, or the greyness of the one simply the result of age, it is now impossible to ascertain. Tamati Ranapiri, of Ngatiraukawa, told me that the *matapo* was an old-time native rat, but he did not know the name *tokoroa* as that of a rat.

Moke.—Paitini, of Tuhoe, said that the *moke* was a native rat, but some years after said that it was the name of the light-coloured European rat (Norway rat), so that his evidence is doubtful.

Muritai.—This was given me by a Tuhoe Native as a name for rats, but he said that it was not used in this district, and that he did not know whether it applied to the native rat or an introduced species.

Akuhata te Kaha, of Tuhoe, says (27th August, 1908), "The *muritai* is the same as the *moke*. This species always travelled along their runs in single file, and closely following each other. The fur was dark-coloured (*pupango*), but not black. *He ahua pupango nga huruhuru o te muritai.* The *hinamoki* was *pango* (black, or dark-coloured)."

Pou-o-hawaiki, sometimes *pou-hawaiki.*—Old Tutakangahau, of Maungapohatu, a good authority, said, "I saw the native rat die out in my youth. We called the introduced European rat the *pou-o-hawaiki.* When I was a lad I went with a party to the summit of the main range at Maungapohatu, in order to obtain mutton-birds. On our arrival there we found that a new species of rat had appeared, and had eaten all the young birds." This witness was born about 1830.

Paitini says that the introduced black rat was named the *pou-o-hawaiki* by the Maoris. Mr. White quotes several authorities in his aforementioned paper as to the application of this Native name. Some applied it to the black rat (presumably *Mus rattus*) and some to the old-time native rat, but the best authority (old Tautai, of Taranaki) said it was the introduced European rat. Unfortunately it is not made quite clear as to whether Tautai meant *Mus rattus* or *M. decumanus.* Williams does not give this Native name, but Mr. White has its derivation all fixed up, albeit it was necessary therefor to alter the spelling of the word from its proper form: "*po* = night, *hawaiki* = the far country; and the combination means that the beast was a mysterious visitor from an unknown land shrouded in darkness." Having of late been sadly shaken by *hinamoki* and the identification of the ancient *Pani-tinaku* with Espani (? Spanish), I cannot quite grasp this matter. Was it the beast or the land that was shrouded in darkness, or were they both so shrouded?

Tokoroa.—Already referred to (see *supra*).

Hamua I know not, except the mention of it in John White's works as a name for rats.

Maungarua and *riroi* I have not heard of among Tuhoe.

We will now give a few notes touching upon the old native rat, as obtained from members of the Tuhoe Tribe.

The *kiore maori*, or native rat, nested in hollow trees, and also in burrows in the ground. They came out only at night, remaining in their holes in the daytime. They were more plentiful in *hunua* forests than in those termed *uruora*—that is, they preferred the high-lying forests to those of the valleys or other low lands. Their favourite resorts were the beech forests which occupy the summits and upper parts of the ranges of Tuhoeland—roughly speaking, from about 2,000 ft. altitude upwards. Their principal food consisted of *hua tawai*, or beech-mast. Great quantities of these nuts are produced by the beech forests of the high lands.

The rats came out of their holes at night, and marched in single file along the *ara kiore*, or rat-runs, to their feeding-grounds. Besides the beech-nuts, they also ate the berries of the *patate* (*Schefflera digitata*), the *para* (? pollen) of the *kahikatea* or white-pine, and some other items. They appear to have been clean-eating creatures, avoiding foul matter, and resembling a squirrel so far as their food was concerned. They became very fat in winter-time, and were then trapped and snared in great numbers by the Natives. They became quite thin in summer-time, and were not taken in that season of the year.

The *ara kiore*, or rat-tracks, made by these small creatures to their feeding-grounds always ran along the summits of spurs, ridges, or ranges, and were often many miles in length, though it is unknown as to how far a colony of rats would ramble from their abode in search of food. They used the same tracks year after year. These tracks are sometimes termed *ara tahiti* (= *tawhiti*), or trapping tracks or runs, because the traps for taking the *kiore* were set on them. These tracks or runs were about 3 in. in width, and were smooth, and padded by myriads of little feet: thus they were quite bare, and void of vegetation. The traps—of which more anon—were set every 3 ft. or 4 ft. along the run. A rat-run might be owned by many different persons, and long ones by different *hapu* or subtribes, each person interested having a right to a well-defined portion of the same. Poaching on another's portion was not permitted, and would cause trouble, possibly fighting. As a general rule, among the Tuhoe Tribe these rat-trail privileges were acquired or retained by the female members of a family or *gens*, the males getting the *toromiro* trees (on which birds were snared). When the rats, in passing along their runs, bit off leaves of vegetation and dropped them on the track, then it was known that they were in good condition, fat and plump; hence the trappers would get to work, and the rat season was opened in due form. An experienced trapper, on observing the above-described signs, would say, "*Kua whariki te ara kiore*" (The rat-run is covered). "*Na, kua momona te kiore*" (Then it was known that the rats were fat).

An ancient saying is, "*Kua kitea a Matariki, a kua maoka te hinu*" (When Matariki is seen, then game is in good condition). This, I believe, applies to the heliacal rising of Matariki (the Pleiades), which would mean that the game-trapping season opened early in June.

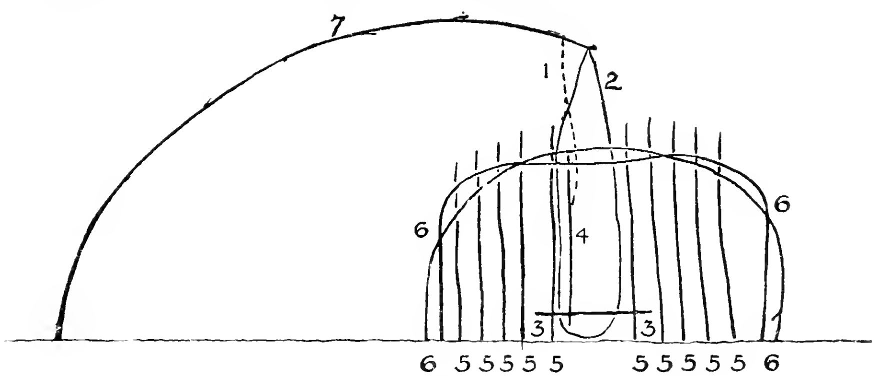
It would appear that the Maori noted the heliacal rising of stars as signs of divers events, &c. "The appearance of the Pleiades on the eastern horizon just before sunrise, in June, marked the commencement of the Maori year," says Tutakangahau. The appearance of Whanui on the eastern horizon in the morning was the signal for lifting the *kumara* crop. Whanui is the star Vega.

Kiore were trapped on the dark nights of the moon. If the traps were set on moonlight nights, then the rats sprung the snares and escaped (*ka turupanatia nga tahiti e te kiore*).

In Taylor's "Te Ika a Maui" may be found some notes concerning the *kiore maori*. He gives two of the *karakia*, or charms, used, one of which is a *taitai*, but the translations thereof are doubtful. He also states that the hunting-parties cut tracks for the rats, which tracks were made in a perfectly straight line up hill and down, however rough the country, otherwise the rats would not follow them. I cannot get any old Maoris to agree to this statement, and hence do not believe it. The *kiore* made its own runs, which were assuredly not straight, for they followed the tops of ridges, with all their dips, angles, and sinuosities. Trappers made no tracks for the rats.

The *kiore maori* was taken in two ways in Tuhoeland—by *tahiti* (trap or snare) and by the *torea* (or pit). Of these, the *tahiti* appears to have been the most frequently used. The most general form of this word is *tawhiti*, but Tuhoe always use the form above given, even as they use *hitau* for *whitau*. Williams gives "*Tawhiti* = a snare, trap." Another form of rat-trap was termed a *pokipoki*. These two forms we will endeavour to describe.

Tahiti kiore.—The two *rupe* are first placed in position. These are two pliant wands. One is forced into the ground at both ends, so as to form a small archway across the rat-track. The other is erected close to it, in a similar way, but is twisted round the first one so as to leave a narrow space between them at the top, through which space the two main *turuturu*, or uprights, are passed, as also the loop snare. These *rupe* are usually pieces of *pirita* (supplejack, a climbing-plant). Twining one round the other prevents them from parting or becoming too loose. The two main uprights (*turuturu*) are thrust down through the uppermost space between the two *rupe*, one on either side of the central opening or passage, which passage is on the rat-run. The other uprights are simply stuck in the ground outside but close against the *rupe*, and are placed close enough together to prevent a rat from passing between them. The only space through which a rat can pass is the central one on the track, in which space the snare loop is suspended. The *whana*, a strong pliant rod, usually a piece of supplejack, has one end thrust securely into the ground, and to the other end is attached the *tohe* or looped cord. This small cord is not formed into a



Tahiti Kiore.

1. *Aho.* 2. *Tohe.* 3. *Kurupae.* 4. *Taratara.* 5. *Turuturu.* 6. *Rupe.* 7. *Whana.*

running noose like that of a bird-snare, but has both ends attached to the *whana* or spring stick, so that the rat is caught in the bight of the cord. Also, attached to the end of the *whana* by means of a string is the *taratara*, a piece of small stick about 4 in. in length, and with which the trap is set. The string (*aho*) or cord is fastened to the *taratara* about ½ in. or ¾ in. from the end of the latter.

In order to set the trap, the operator bends down the *whana* and passes the *tohe* or looped (doubled) cord down between the two *rupe* until that cord nearly touches the ground, the loop being arranged so that the cord hangs close to the two main uprights on either side and does not obstruct the passage. The trapper then, while holding down the spring stick with one hand, takes the *taratara* in the other, and places it in a vertical position at one side of the open space, near the upright. The projecting upper part of the *taratara* is placed on the opposite side of the *rupe* to that on which the securing-cord (*aho*) is, so that the *rupe* rests in the crotch at X. The trapper then holds the *taratara* in a vertical position while he slips the *kurupae*, a small, short stick, between the lower end thereof and the two main uprights. The

strain on the *taratara* holds the *kurupae* in position until the latter is forced down, and free, by a rat endeavouring to pass over it through the space, and so along his old-time trail. The *kurupae* is near the ground, so that a rat cannot pass under it. When he treads on it, the pressure forces it down, releasing the *taratara*, the lower end of which flies upwards, and the upper end slips away from the *rupe*. Thus the *whana* is released and springs upwards, drawing the looped *tohe* up between the two *rupe*. But Master Kiore is right there in that loop when it is released; hence his body is yanked upwards and jammed against the *rupe*, there still being a certain amount of strain on the loop-cord (*tohe*) and *whana*. The latter cannot become wholly free while there is any body in the *tohe* large enough to stop its upward passage through the two *rupe*.

The strain of the *whana* is primarily on the *aho*, then on the *taratara*. There is the upward pressure of the latter on the *rupe* and the side pressure on the *kurupae*. Q.E.D. The *aho* passes down outside the *rupe*. The *tohe* hangs loosely; there is no strain upon it until a rat is caught and jammed against the *rupe*. *Kati. Kua marama pea!*

No bait is used when setting these traps on the runs or tracks, but a bait is used when they are set away from them, as on the feeding-grounds. The bait used was the fruit of the *patate* tree. It was placed on the ground near the trap, and on the opposite side to that from which the rats were thought to be likely to come.

When a rat was caught by the loins it was able to move to a certain extent, and would endeavour to free itself by gnawing the *rupe* or the snare loop. These *kiore kai apuapu*, as they were termed, should they escape, would never be caught again, say my informants: they became too knowing.

The *waharua* was a rat-trap having two entrances—a double trap, which faced two ways. It was really two traps like the one above described, erected a little distance apart. The side spaces between them were blocked with little fences of upright sticks.

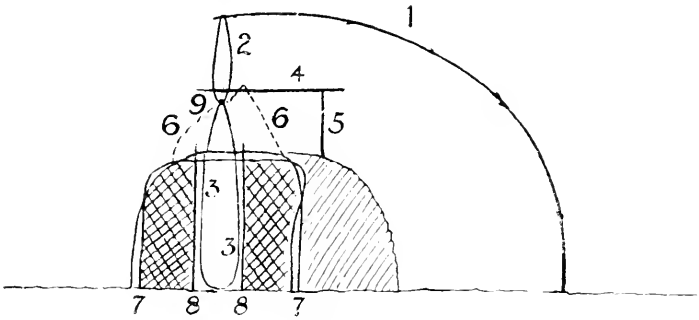
The *tahiti whakaruatapu* (cf. *ruatapu* in Tregear's Dictionary) was a rat-trap having several entrances thereto, and a snare for each. This I have not seen, but the others have been constructed for my benefit by several old Natives.

When rat-trappers were setting their traps on an *ara tahiti* they would carefully remove any leaves, &c., that had fallen on the rat-run.

We now come to that form of rat-trap known as a *pokipoki*. This form of trap was used to take those suspicious or cunning rats that declined to enter the ordinary trap. They seemed to object to passing over the *kurupae*. Like Brer Rabbit, they were "some cautious" and "plenty scared."

In fixing this trap the *rupe* are fixed as before, but the *turuturu*—generally only two of them—are longer. They are inserted in the same manner, and the upper parts, that project above the *rupe*, are bent back, half broken, until their ends rest on the ground. The large leaves of the *wharangi* tree are then used as a lining for the little trap-house behind the *rupe*. These leaves are placed over the bent-down ends of the uprights by which they are supported. Other leaves are used wherewith to block up the front of the trap, with the exception of the central space, where hangs the snare loop, and through which the rat attempts to pass when it sees the bait within. The diminutive enclosure is then covered over with some loose earth, until it resembles a little mound, sloping downwards to the back end. This little hut, or *rua* as it is termed (*rua* = tunnel, cave, hole, pit), is about 8 in. long, and the bait is placed a few inches back from the entrance, inside.

The *katara*, or small upright stick, is thrust down through the roof until the lower end is just above the floor of the little hut. To this lower end is secured the bait of *patate* berries. One end of the *whana*, or spring rod, is thrust into the earth; to the upper end is secured a double cord or loop, knotted near the middle. This is the *tohe*, or snaring-loop. The cord termed *whiti* is secured at each end to the *rupe*, on either side of the entrance. To set the trap, the upper end of the *whana* is bent down, the lower loop being passed between the two *rupe*, and arranged as in the common trap. The *kurupae*, a short stick, is slipped under the *whiti* cord and through the



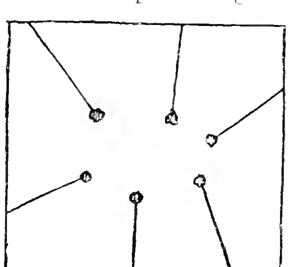
RAT-TRAP. POKIPOKI.

1. *Whana*, spring stick. 2. Upper loop of *tohe* cord. 3 *Tohe*, or snare loop. 4. *Kurupae*. 5. *Katara*. 6. *Whiti* cord. 7. *Rupe*. 8. *Turutura*, or uprights. 9. Knot of loop.

upper loop of the *tohe*, the rear end resting on top of the *katara*. The *whiti* cord is between the *tohe* and the *katara*. Thus the *whiti* saves the situation, takes the upward strain of the *whana* until a rat, pulling at the bait, tugs the *katara* outwards, thus releasing the *kurupae*, which flies off into space. The bent *whana* flies up, dragging up the looped cord, and jamming the rat against the *rupe*, as before. While the trap is set the strain on the *tohe* is, of course, on the knot, the lower end hanging slack. When the trap is sprung the strain is on the rat. The next act is the arrival of John Tenakoe, who pops Mr. Kiore into his game-bag and resets the trap.

The *torea*, or *kopiha kiore*, is the pit trap for taking rats. The first of these two names is the one in common use among the Tuhoe Tribe.

The following was the *modus operandi* in this district. A hole or pit about 4 ft. deep was dug in a suitable place. Some bait was placed at the bottom of the pit, and a piece of wood was placed in the hole in a slanting position, and down which the rats travelled in order to get at the bait. After the food so placed for them was consumed the rats would return above ground by the same route and go about their other business. After the rats had got accustomed to going into the pit for the food the ladder was taken away, and a number of slight sticks were stuck in a horizontal position into the ground at the mouth of the pit, so that each stick projected out over the mouth of the pit. On the end of each stick a bait was tied. The rats walked out on these sticks in order to



ENTRANCE TO A TOREA PIT TRAP, BAITED.

get at the bait, but so slight were the sticks that it was impossible for the rats to turn or return upon them, hence they fell into the pit beneath.

Sometimes a cooked bait was used instead of berries. Presumably the bait of cooked food was the more savoury, and attracted more rats than one of ripe berries. Pio, of Ngati-Awa, born *circa* 1823, says, "This is about rat-killing. Hine-mata-iti was the origin of the rat folk. A pit was made, food was roasted (as bait) in the evening, and stuck on sticks in the middle of the pit. At night the rats go to eat it. The trappers go and find a pit full of rats. They are slain and placed in baskets. Two, three, or four basketfuls may be secured in a night. I trapped rats in the days of my youth. It was interesting work. The rats were very fat."

An interesting note was given to me by Tamati Ranapiri, of Ngati-Raukawa, anent the genial *kiore maori:* "There were two ways of taking rats—viz., by the *tawhiti*, and by digging a pit. A pit would be dug some 4 ft. or 5 ft. in depth, and in such a manner that the top overhung, the pit being wider at the bottom than at the top. A peg was inserted at the bottom of the pit, to which was attached the cords by which the rats descended. Food was placed in the pit as baits, such as berries, &c. When this bait was consumed, then more would be thrown in. That same night the trap would be visited, and the rats slain. The trapper would know right well the particular cord by pulling which he could haul up all the cords, or *aka*, placed for the rats to descend by. By pulling this cord he hauled up all the cords, as also the peg to which they were fastened at the bottom of the pit. He then jumped down into the pit and killed the rats. After these rats were taken out the pit was swept and cleansed, so as to do away with the smell of rats, and so that other rats would enter the pit when it was rebaited. I have heard that the *kiore* swam from Hawaiki to Aotearoa (New Zealand), that they swam hither together. A leader swam in front, the next rat took the leader's tail in his teeth, the next took the tail of No. 2 in his teeth, and so on to the last rat."

In the above we note that, among Ngati-Raukawa, cords or forest creepers were used as rat-ladders in the pits. The final remark, about rats swimming hither from Hawaiki, is of interest. In an article already quoted (Trans. N.Z. Inst., vol. xvii, page 200), Mr. Meeson mentions a swarm of rats that swam across the passage leading into the harbour at Nelson. The lemming of North Europe is said to have swum out to sea in hordes. Hurae Puketapu and other Natives of Wai-kare Moana have informed me that in former times, when the native rat was numerous in those parts, they sometimes took to the water in numbers. On misty nights, when fog lay close on the waters, the rats, frightened by the cries of the *ruru* owl, would swim out into the lake until they were drowned. Some say that the native rats would so take to water when the pollen(?) of the *tawai* tree lay thick on the water's surface.

Return we to our *tahiti kiore*, or rat-traps. Te Puia Nuku, an old man of Tuhoe, who was a fighting-man in 1852, and died on the 20th December, 1906, told me that on the opening day of the rat-trapping season all the trappers were *tapu*. As a man set his first trap he would repeat over it the following charm:—

Kiore—e—e!
Hai konei ra piko ake ai
I te whare nui, i te whare roa
E tataia e te mahanga
Ko rua hamuti te kiore
Te mau ana.

This was repeated over the first trap set only. In Nga Moteatea another version of the above gives the first line as "*Tawhiti—e!*" which reads better. Te Puia put it, "*Ka oti te rapiko, ka karakia i tenei,*" &c. (When the trap was set he recited this). The words *whapiko, tapiko, kopiko,* and *rapiko,* which seem all allied to and bear a similar meaning to *whakapiko* (=to bend), are all employed to denote the forming of looped snares and the bending-down of the *whana* in trap-setting.

The trappers, on returning to the camp or hamlet on this first day of the season, were obliged to be very careful in their behaviour. They might not speak for the balance of the day and following night. They ate their food in silence, and slept without removing their garments. The next morning they went to take the rats from the traps. The *tapu* was then lifted from them and their employment, and they returned to their normal condition.

Tutakangahau stated that the *tapu* of opening the rat-trapping season was similar to that pertaining to birds. When a good many rats had been taken on the first day, and collected, a time was appointed for the *huhunu* or *whakanoa* rite (lifting of the *tapu*, the making common, opening of the season). This function often continued for two days. There were many *karakia* (charms, invocations, &c.), says Tu, pertaining to the opening of the rat, fish, and bird taking seasons, taking the *tapu* off the forest, &c. Some of them came under the generic term of *kaha*. Such were the *tumutumu*, the *tuota*, and the *motumotu*. The *tuota* was a very *tapu* charm, recited in order to bring plenty of rats, birds, or fish to trap, snare, or net. If a hunter employed this *kaha* he would deem it necessary, on his return from the forest, to perform the *whangai* rite. This was an offering to and placation of the *atua* (gods, demons). The *motumotu* was a *noa* charm, free from *tapu*, and could be used by any person, but its object was the same as that of the *tu-ota*. It might be asked of a fowler, fisher, or rat-trapper, "*Ko wai to kaha?*" (What is your *kaha*?) and the answer would be, "*Ko tuota*" (It is *tuota*), or "*Ko motumotu*" (It is *motumotu*), or whichever it was.

The following charm or invocation used in trapping rats was given by Himiona Tikitu, of Ngati-Awa:—

Taku turupou nei
Ko whakaihi nuku, ko whakaihi rangi
Ka poua nei e au
Ki runga ki a Papa-tuanuku
E whakamau atu ana
Ki te tupua, ki te tawhito.
Poua te pou, tu te rupe
Ko te pou na wai?
Ko te pou na Toi.
Ko te rupe na wai?
Ko te rupe na Toi.
Toi i hea?
Toi i hekeheke iho i a Maui-mua
Poua te pou, tu te rupe
Te Pu, te More, te Weu, te Aka, te Rea
Tuia a uta, tuia a tai
Poua te pou, tu te rupe
Kokoia i raro i a Papa-tuanuku
Ki a tutangatanga.
Nau mai ki roto
Poua te pou, tu te rupe
Kokoia i raro i a Tane-mahuta
I te wao kia tutangatanga

Nau mai ki roto
Poua te pou, tu te rupe
Kauhou ariki tu hokai rangi
Tuia i runga i te ara o Tane
Ko Pipiri te ara i heke ai
Ki raro ki Tauwhaiti
Tuia i raro i te ara o Tangaroa i uta
Ko Pipiri te ara i heke ai
Ki Tauwhaiti
Tuia ra, tuia ra!

This is said to have been a charm used by Toi, after whom Te Whaiti-nui-a-Toi was named. The *turupou* mentioned was, says Tikitu, a staff made of greenstone, that was handed down from one generation to another, to Haeana and others.

As to the method of cooking the native rat in former times, they seem to have been either roasted, steamed, or potted in their own fat. The Natives say, "*Ka tunua huruhurutia te kiore*"—by which I understand that they were roasted with the skin and fur on.* When cooked in the *hangi*, or steam-oven, it was by the *kopaki* process, as the *kokopu* fish are cooked. Leaves of the *pororua* plant were wrapped round the rat, which was then cooked in the oven, the leaves being also eaten. Fronds of the *petipeti* fern were sometimes used as a wrapper (*kopaki*) in cooking rats or birds from which the bones had been taken away. Te Puia said, "The native rat was plucked as is a bird, the fur coming off quite easily. The tail, head, and feet were taken off, and the bodies were packed in close-woven water-tight baskets, termed *poutaka*, woven from green flax. These were carefully lined with fronds of the *petipeti* fern, and then with the large leaves of the *rangiora* shrub, so as to exclude the water. The baskets were then immersed in the waters of a stream. When wanted, the rats were taken out of the basket, placed in a bowl formed of half a calabash, and therein stone-boiled."

Rats and birds when potted down in their own fat are alike termed *huahua*, and these fat foods are often alluded to simply as *hinu*.

To prepare rats for potting they were plucked like birds, which exposed a clean, white skin—"*me te kiri pakeha*" (like a white man's skin), said my informant. The extremities having been cut off, the entrails were taken out, and the bones pulled out. The latter process is described as *kounu* (cf. *unu* = to draw out). This is not the same process as that of *makiri*, by means of which the bones are taken out of birds. In the latter case the flesh is cut away from the bones, but in the *kounu* the bones of the native rat are said to have been pulled out easily without cutting, the flesh appearing not to cling to the bones.

The *ngakau*, or entrails, of the native rat were highly prized as a food item—"the best part of the rat," says an old-timer. They were placed, without any cooking, in calabashes, and so kept until the following spring. They were then eaten with various greens, which come under the generic term of *puwha*. When the vessel was opened the entrails were no longer recognisable as such, but simply appeared as a mass of fat matter.

The rats were placed in a wooden trough, or *kumete*, and there left for some time, until much of their fat melted and collected in the trough. Stones were then heated in a fire hard by and dropped into this fat, where they were stirred and moved about with sticks, this process being continued until rats and fat were cooked, or sufficiently so to please the Maori

* Probably only cooked so when cooks were pressed for time.

palate. The rats were then put in calabashes, and the hot fat was poured over them. These vessels were then carefully covered and placed in the food-stores for future use.

Paitini says, "*Ko te huahua manu ka mahia ki te ahi matiti ; ko te kiore anake i rereke, ko tena i kohuparatia*" (The *kohupara* method of cooking consists of wrapping the *kiore* or bird in an envelope of leaves, and then cooking in a steam-oven). The Tuhoe Natives, some years ago, were in the habit of eating the introduced rats, but I am not sure which one it was that was so utilised. They were taken in *tawhiti* set around the potato-gardens, and are said to have been very fair eating when fat on a diet of *toromiro* berries, but by no means equal to the extinct *kiore maori*.

The Natives were in the habit of camping on ranges distant from their forts or hamlets in winter-time, for the purpose of trapping rats and snaring birds, but they could do so only on lands belonging to them, or where they had been formally given a right to take game. Any unauthorised trespass was strongly resented, and often ended in bloodshed. A party of Ngati-Koura, who went from Rua-toki to take game in the forests near Parahaki, were attacked by the Rua-tahuna clans on the Wai-hou tributary of the Mimiha Stream, and severely defeated.

Kiore pao whatu is a term applied to rats in poor, thin condition, while a *kiore tapapa* implied a fat rat, large and in good condition. The word *haukeke* denotes the thieving propensities of rats. A *pataka pu kiore* is a food-store so constructed that rats cannot gain entrance thereto. It is supported by four posts, the tops of which are about 5 ft. above the ground-line. Two broad slabs are placed on the tops of these posts, and the store built on these slabs. Inverted tin milk-dishes now often take the place of the wooden slab. No permanent step or ladder is used to gain entrance to these stores : the notched pole or log so used is placed in position only when in use.

"*Honoa te hono a te kiore*" is an old saying of the Maori, meaning that those addressed should keep advancing, one after another, without cessation, as the rat was wont to march along the rat-runs. Rats were sometimes termed *niho roa* (long or big teeth), on account of their nibbling, thieving habits. A *tau niho roa* implied a season when rats were very numerous, and bold in attacking crops, food-stores, &c. Hence the underground potato-pits are usually lined with slabs of *pu-nui*, or *Dicksonia fibrosa*, which it is said rats cannot gnaw through.

"*Me te kiri kiore*" (Like a rat's skin) is used to denote a smooth, fine surface, as of a woven garment, &c.

On returning from setting rat-traps the trapper would speak but little, and that in a low tone, lest he be unsuccessful in his trapping. Should he have a *tumeke*, or convulsive start, in his sleep, it would thus be known that some rats were badly caught—*i.e.*, were caught in snares by the body and not by the neck.

Torea-a-tai is a place-name at Maunga-pohatu, the hamlet of the Tama-kai-moana clan at that place. (For *torea*, see *ante*.)

After setting the traps on the first day of the season, says one authority, no trapper would partake of food until after the *tapu* was lifted on the following day. This was the occasion of one of the many ritual feasts of the Maori.

If when a trapper examined his traps the first one was found empty it was viewed as a sign of bad luck—but few rats would be found in the other traps.

Such are some items of the methods, customs, and superstitions of the rat-trappers of Tuhoe, the *hanga whapiko tahiti.*

Birds.

We will now give our notes on the bird-lore of the Tuhoe district, some account of divers ways of taking them, as also many myths, customs, rites, &c., concerning the same. We begin with a list of names of all birds found in the district, or that were so found in former times, many of them being now extinct, at least so far as Tuhoeland is concerned :—

Hakoke ; syn., *whekau*. Extinct here.
Hakuwai. Perhaps mythical. Extinct here.
Hirorirori ; syn., *riroriro*, &c.
Hiwaiwaka ; syn., *piwakawaka*, &c.
Horirerire ; syn., *riroriro*, &c.
Huia.
Kaeaea ; syn., *karearea*.
Kaha. No longer seen.
Kahu.
Kaka.
Kakapo. No longer seen.
Kakariki ; syn., *porete*.
Kakaruwai ; syn., *pihere*, &c.
Kakawariki.
Kamana ; ? syn., *kaha*.
Karearea ; syn., *kaeaea*.
Kareke ; syn., *koreke*. Extinct.
Karu-patene ; syn., *pihipihi*.
Karuwai ; syn., *pihere*, &c. ; also *kakaruwai*.
Kawau.
Kea. No longer seen.
Kereru.
Kiwi.
Koau ; syn., *kawau*.
Koekoea.
Koitareke. The New Zealand quail.
Kokako.
Koko ; syn., *tui*.
Kokorihimako ; syn., *korimako*, &c.
Kopara ; syn., *korimako*, *makomako*, *rearea*, &c.
Koreke ; syn., *kareke*. No longer seen.
Korirerire ; syn., *riroriro*, &c.
Korimako ; syn., *kopara*, &c.
Kotare.
Kotuku. No longer seen.
Kukurutoki ; syn., *toetoe*.
Manapau, or *marapou*.
Mata.
Matapu.
Matuku.
Miromiro.
Miromiro.
Moa. Extinct.
Moho. No longer seen.
Moho-patatai.
Mohorangi.
Momotawai ; syn., *momoutu* and *toirua*. No longer seen.
Momoutu ; syn., *momotawai* and *toirua*. No longer seen.
Nakonako ; syn., *pipiwharauroa*.
Nonoroheke ; syn., *riroriro*, &c.
Oho.
Pakura ; syn., *pukeko*.
Papango. Black teal.
Papu, or *papua*. A large cormorant.

Parera. Brown duck.
Pekapeka. The bat.
Pihere; syn., *karuwai, pitoitoi*, &c.
Pihipihi; syn., *karu-patene.*
Pioioi; syn., *whioi.*
Piopio; syn., *koropio.*
Pipitori; syn., *toirua.*
Pipiwharauroa; syn., *nakonako.*
Pitoitoi; syn., *pihere*, &c.
Pitongatonga.
Piwaiwaka; syn., *tiwaiwaka*, &c., Fantail.
Piwakawaka; syn., *tiwaiwaka*, &c. Fantail.
Pohowera.
Porete; syn., *kakariki.*
Pukeko; syn., *pakura.*
Rearea; syn., *korimako*, &c.
Riroriro; syn., *nonoroheke*, &c.
Ruru.
Tarapo.
Tareke; syn., *kareke.*
Tataeko; syn., *popokotea, tataihore*, &c.
Tataeto; syn., *popokotea, tataihore*, &c.
Tataihore; syn., *popokotea*, &c.
Tatangaeko; syn., *popokotea, tataihore*, &c.
Tataruwai; syn., *pihere, toutouwai*, &c.
Tieke. No longer seen.
Tihe. No longer seen.
Tirakaraka. Fantail.
Titi. Mutton-bird.
Titiporangi.
Tititipo.
Tititipounamu; syn., *toirua.*
Tiwaiwaka. Fantail.
Tiwakawaka. Fantail.
Toetoe; syn., *kukurutoki.*
Toirua; syn., *momotawai.* No longer seen.
Totorori. See *Riroriro.*
Totororire; syn., *riroriro.*
Turi-whekoi-rangi. A sea-bird.
Tuturi-whatu.
Weka.
Whekau; syn., *hakoke.*
Weweia.
Weiweia.
Whenakonako; syn., *pipiwharauroa.*
Whio.
Whioi.

We give below a few notes concerning these birds, and identify them where possible.

The *hakoke* was also known as *whekau.* It was about the size of the *ruru*—some say larger. The Rev. H. Williams identifies it as the laughing-owl (*Sceloglaux albifacies*). The Natives say that this bird lived in holes and crevices in cliffs. Such a place was termed a *pari hakoke.* A saying often heard is "*Me te pari hakoke*" (Like a *hakoke* cliff), as in speaking of a steep and stony cultivation-ground. These birds are no longer seen in this district, but Paitini states that he saw them here when he was a youth —say, in 1855. The *hakoke* nested in cliffs.

In vol. xviii of the "Transactions of the New Zealand Institute," at page 97, Mr. Reischek states (in 1885) that he never saw the *whekau* in the north, and that it was extremely rare in the south. It preyed mostly on rats. He refers to it as *Athene albifacies.* At page 63 of vol. iii of the same journal Mr. Potts gives some information concerning this bird.

Hakuwai.—This is possibly but a mythical bird. The Native account is that it was a large bird, very rarely seen. It flew at a great height above the earth, in the night-time, and its cry is given as "*Hakuwai, hakuwai! Ho!*" It is probably the *hokioi* of other tribes. Native tradition says that this bird had four joints in each wing, and that it lived in the sky. Old Pio, of Ngati-Awa, has the pedigree of the nimble *hakuwai*,* which is now no longer seen or heard. He says, "The ancestors who live in the sky are Whaitiri, Nuhe, Toronu, Moka, and Hakuai." (The first is the emblematical name for thunder; the next three are names of three species of caterpillar that when they appeared on the *kumara* plants were said to have come from the sky.) "Tangaroa's offspring were Makara, Tangaroa-akiukiu, Tangaroa-a-roto, and Rona. Tangaroa-akiukiu had Tu-te-wehiwehi, Tu-te-wanawana, Noho-tumutumu, Moe-tahuna, Haere-awaawa, Turuki, and Hakuai." Again Pio says, "The descendant of the star Rehua (Antares) was Hakuai. This bird always stays in the heavens. It has four joints (*tuke*) in each wing, and was heard flying at night and crying '*Hakuai, hakuai! Hoho!*' It was an evil omen to see that bird. Te Rangihoki, an ancestor of ours, came across one near Putauaki, and caught it, hence that place is still known as Te Hakuwai." At another time old Pio said, "Maui-mua married Te Papa-tu-rangi, who was a daughter of Maui-potiki. Their son was Tiwakawaka. The *hakuwai*, who was related to Maui, heard of this, and came and said to Tiwakawaka, 'Get on my back, that I may carry you to the *ao ma tonga*, to Ka-pu-te-rangi.' So Tiwakawaka reached that place, and married Haumia-nui, a descendant of the original Haumia. Tiwakawaka was the permanent settler in these lands (New Zealand). In after-days one Maku came here and found Tiwakawaka living at Ka-pu-te-rangi (at Whakatane). This place, Aotearoa, belonged to the *hakuwai*, who arranged that Tiwakawaka should reside here."

An interesting note on the *hakuwai*, or *hokioi*, may be found at page 435 of the "Transactions of the New Zealand Institute" vol. v. See also vol. vi, page 64; vol. vii, page 494; and vol. xii, page 99.

Sir George Grey gives the following as an old-time saying: "*Pekapeka rere ahiahi, hokioi rere po*" (A bat flies at twilight, a *hokioi* by night).

Hirorirori.—See *Riroriro.*

Hiwaiwaka.—See *Piwakawaka.*

Horirerire.—See *Riroriro.*

Huia.—Given as *Heteralocha acutirostris* in the Rev. H. Williams's list. This bird was never, say my Native informants, a denizen of the Tuhoe district, but of the Ruahine and Tararua Ranges. The long black tail-feathers (*kotore huia*), tipped with white, are highly prized by Natives as plumes for the hair.

Mr. Guthrie Smith, of Tutira, states that he heard of a *huia* having been shot at Wai-reka, near Te Putere, on the Waiau tributary of the Wairoa River; but the Rua-tahuna Natives say that they never heard of the birds as being found in those parts.

Kaeaea (also known as *Karearea*) (*Nesierax novæ-zealandiæ;* Sparrow-hawk).—The male bird is known as *kakarapiti.*

Kaha (*Podicipes cristatus;* Crested Grebe).—This bird has long disappeared from this district. It was formerly found at the Wai-kare-iti Lake, near Wai-kare Moana. The Natives say that it built its nest on the surface of the waters of the above lake, and anchored the nest to the

* Williams queries *hakuwai* as the great frigate-bird.

bottom, so that the nest moved with the water but did not drift away. For an illustration of a nest, see "Transactions of the New Zealand Institute," vol. ii, page 50, and description thereof at page 74. This bird is said to have the power of remaining a long time under water (*he manu ruku roa*). (See note under *Kamana*.)

This bird does not seem to have frequented the rivers of this district; the currents thereof are probably too swift to please it.

In vol. iii of this journal Mr. Travers has a paper on the habits of the *kaha*.

Kahu (*Circus gouldi;* Hawk).—This bird is still common in this district. In former times it was sometimes caught by Natives in a trap termed a *titara kahu*, or *tahiti kahu*. When Taka-moana, of Te Kareke, was slain at O-pokere his enemies utilised his liver as a bait for a hawk-trap. Occasionally a white hawk was seen in former times, but very rarely. They were called *kahu korako* (albino hawks), and this term was often applied to a chief. An old saying was, "*Me haere i raro i te kahu korako*" (Always travel with a white hawk); to which the following is sometimes added: "*kia kai ai koe i te kai, kia whiwhi i te taonga*" (that you may fare well and receive presents). When a chief visited a hamlet he was regaled on the best food, and often received presents, his companions coming in for a share of the good fare.

John White has a singular remark at page 65, vol. ii, of his "Ancient History of the Maori": "The *kahu* was a child of Mahuika, and a god of fire: hence the colour of its feathers."

Kaka (*Nestor meridionalis;* Brown Parrot).—The *kaka* and the *kereru* (pigeon) are looked upon as the two most important of forest birds by the Maori, inasmuch as they formed one of their principal food-supplies, being taken in great numbers in former times.

The origin or parent of birds in Maori myth is Tane-mataahi. This applies especially to the *kereru* and *koko* (*tui*) birds: while the origin or parent of the *kaka* was one Tu-mataika; hence these birds are sometimes spoken of as the "children of Tu-mataika." "*Kaore e rikarika te tama a Tu-mataika e rere nei*" (How numerous are the children of Tu-mataika flying yonder!)—said of a flock of *kaka*.

The following names are applied to the *kaka* bird: *tarariki*, *tatarariki*, *tatariki*. These names are applied to the leader of a flock of *kaka*. Each flock of these birds, say my informants, has a leader, generally a small-sized bird: hence the *riki*. This bird may also be termed a *kaka whakataka pokai*, or "flock-assembling *kaka*." This bird keeps on the outer side, or edge, of the flock, and seems to shepherd them—keeps them within bounds, and prevents straggling. It also calls the flock from one *whakarua*, or feeding-ground, to another, and keeps flying around the outside of the flock. Only one such leader will be found with a flock. A *tarariki* makes the best of decoy-birds, and is said to be a female bird.

Kaka kura: This term is applied to a very rare bird, a *kaka* that has very brilliant plumage, bright-red feathers—unlike ordinary birds of the species, which are of sombre plumage of a brown colour, not possessing so many showy red feathers. The *kaka kura* are said not to travel with any flock, but such a bird keeps aloof from others, with the exception of one companion, a bird of ordinary plumage. These *kura* are very rare: only one such will be found in a district. They are sometimes termed *ariki*, or leaders. Sometimes two *ariki* will be found in a district—one *kura*, or red, and one of white plumage, an albino bird, termed a *kaka korako*.

Albino pigeons are also termed *ariki.* *Korako* (= white, in the sense of albinism, or of rarity) is an expression often applied to chiefs of the *genus homo*—as *kahu korako,* or "white hawk."

Tawaka and *Tata-apopo.*—The term *tawaka* is said to be applied to a large *kaka.* If it has a very large head it is a *tata-apopo.* The *tata-apopo* makes the best decoy-bird for the *pae* method of taking these parrots, while the *tarariki* makes the best decoy for the *tutu* system—of which more anon. The *tata-apopo* is said to be the male bird, and is known by the large size of its head.

Flock names: A flock of *kaka* when flying is termed a *pokai kaka,* but when settled on a feeding-ground is known as a *whakarua kaka;* though the expression *whakarua* seems to mean, primarily, a place occupied or resorted to by a flock of birds—their feeding-ground, in fact.

A flock of pigeons (*kereru*) is alluded to as a *tipapa kereru.* The word *tipapa* seems to = *whakapapa.* A *rakau tipapa* implies a tree much resorted to by these birds, and on which they are snared.

A flock of *koko* birds when flying is termed a *wiri koko,* but when settled on a feeding-ground is called a *hapua koko.* This word *hapua,* like *whakarua,* means a hollow, and was probably first applied to a feeding-ground.

A flock of ducks (*parera*) is termed a *kawai parera.* *Ta* is another flock-name, but I have only heard it applied to the *tatacto* (whitehead) and *kokako* (crow), as a *ta tatacto* and a *ta kokako.*

In the season known as *whaturua,* or midwinter, many *kaka* become so fat that it is difficult for them to take flight—they cannot rise in flight from the ground. When found feeding on the ground they walk to the nearest tree and climb up it—walk up, in fact—and are then caught by hand. When in this state of excessive fatness they are called *keketoi* by some tribes.

The cry of the *kaka* is extremely harsh, but it also emits a deep whistle at times. The screeching sound made by this bird when on the feeding-grounds grates upon the ear, but when flying their cry seems more to resemble a croak. This is often heard in the dead of night and at daybreak by us denizens of the realm of Tane. Like most other native birds, the *kaka* is becoming scarce, but appeared in considerable numbers at Ruatahuna four years ago, where, near my camp, a single Native shot about four hundred.

The *kaka* utters a peculiar cry or screech when alarmed, the cry being known as *tarakeha* among the Natives—*ka tarakeha te kaka.* A similar word is *kareha* (= to cry out in alarm), of a kaka bird; and *kaiewha* has a similar meaning, as also has the term *koriwhai.* "*Ka kite te kaka i te kaeaea, ka koriwhai.*" All these expressions denote *tangi mataku*—fear or alarm cries of the *kaka.*

Tarahae expresses the quarrelling of birds—the querulous or angry sounds emitted by birds when apparently squabbling over food. Kakatarahae is a place-name. *Tarawhete* means to chatter or mutter aimlessly—said to have been originally applied to sounds made by the *kaka,* as when sitting on a perch, but now used to denote the gossiping of persons. *Kowhete* has a similar meaning.

Kaka were often kept in captivity by the Natives, and used as decoys in the fowling season. Such birds while kept at the hamlet were termed *mokai* or *maimoa* (pets), but when taken to the forest to be used as decoys were known as *timori, tirore,* &c.

Tamati Ranapiri, of Ngati-Raukawa, says, "While a tame or captive *kaka* was kept at the village it was simply called a *mokai kaka*, but when taken to the forest and used as a decoy it was termed a *timori*": which amounts to saying that a tame bird was called a pet or captive at home, but when used as a decoy was so described.

The *tirore* was a *kaka* used as a decoy, but it was not a tame or captive bird. When commencing a day's snaring the first *kaka* caught would be used as a decoy. This bird was called a *tirore*, but it was not a *maimoa* (pet) or *mokai* (captive). The fowler would make a perch for this bird above his head where he was perched in the tree-top, by lashing a piece of *aka* or climbing-plant stem to two branches. To this the captured bird was tied by a string secured to his leg. But first the fowler would break the beak of the bird, so that it could not gnaw the cord and so free itself. This bird would attract others by its cries and actions. If other *kaka* do not come readily, then the hapless *tirore* is again brutally treated, for the fowler will break one of its wings, tear out a piece of the bone, and give it to the bird. The bird will clutch the bone in its claws, and gnaw at it, making sounds peculiar to it when eating. This attracts other birds, and they hover round, and some settle on the snare-perches and are caught. These decoys are used in a similar way in the *pae* method of taking birds. The decoy that is placed above the head of the fowler is never taken home or eaten, because it has a certain amount of *tapu* pertaining to it, having been near the sacred head of man. That bird is left to perish miserably in the woods. The *tirore* is sometimes known as a *tionga*. The decoy-birds kept at a village were kept fastened to a *whata kaka*. This was made by placing a wooden trough on the top of two posts, over which a roof was put. In the sides of the trough were made holes, into which were thrust the ends of hardwood rods, about 1 in. in diameter, termed *hoka*. These *hoka* were about 6 ft. long, and formed perches for the captive birds, or *mokai kaka*. Food for the birds is placed in the *waka*, or trough. If the birds fall to quarrelling, then the old ones are each given their food in a small netted bag, made of flax-fibre, and termed a *rohe*, which is secured to the *hoka*.

The birds are secured to the perch by means of a cord fastened to one leg. A bone ring (often made of human bone), often carved, and termed a *moria* (*poria* among other tribes), was placed on the bird's leg. On one side it had a hole bored through it, where the cord was attached. Occasionally these *moria* were made by plaiting the epidermis of the midrib of the leaves of the *toi*, or *Cordyline indivisa*. I lately came across the following in one of the innumerable songs of the poet Piki :—

E koro, Titi—e !
Akuanei au ka whawhati atu ki a koe
Tena tonu ra to moria toi
Kai to waewae e mau ana mai
He tauri komore no te mokai kaka
I mahue noa to turuturu. &c.

The Maoris often speak of certain stones of a reddish colour which are said to have been often found in the crops of *kaka* that have reached New Zealand shores from Hawaiki—that is, presumably, from the isles lying north of New Zealand. These stones are known as *o manapou*. The *kaka* are said to swallow these stones when they leave foreign parts to fly to these shores. It seems a far cry to hale the *kaka* of slow, heavy flight from. I seem to have read somewhere that *manapou* is the name of a Samoan tree. In Mr. J. White's "Ancient History of the Maori" (vol. ii, page 90) we find *manapau* given as the name of a tree of Hawaiki. The very same sentence occurs in Sir George Grey's "Polynesian Mythology." Williams's Dictionary gives "*manapau*, a tree," and refers it to the latter work. Old Pio, of Ngati-Awa, made a remark to me one day, "There is a lake at Pihanga, the green lake. A bird called the *manapou* is found there. It has two topknots on its head. These birds dive to the bottom of the lake in order to bring forth their young. There is also a bird at Rua-wahia, the *tirotiro*, its cry being '*Ti-tiro, ti-tiro!*'"

Another old warrior says, "The *manatawa* is a dark-coloured stone, or kernel, in form like that of the *tawa*. It is found, like the *o manapou*, in the crops of *kaka* that fly hither from Hawaiki, but is somewhat smaller. We believe both to be kernels of tree-fruits of Hawaiki. They are eaten by birds there, and those birds fly here to New Zealand. In olden times the *kaka* used to fly here in great numbers from Hawaiki, and would be so exhausted on reaching land that they were easily caught by hand."

Umanga or *umanganui* is an expression sometimes applied to birds, more especially to *kereru* and *kaka*, as being the two chief species from a Maori point of view. Natives say that the term is derived from *uma*, the breast, most of the meat on a bird being found on the breast. But *umanganui* is also used in other ways, as *Te umanganui o nehe ra, he whawhai*, the origin of which is not so clear.

The *kaka* nests in hollow trees, as also do the *kotare*, *miromiro*, *momoutu*, *ruru*, and *tihe*.

The young of the *kaka* were taken from the nest for food purposes when feathers had grown on their wings, but before they could fly. They were not taken before that age. They would be found very fat, especially so were the *puta* or hollow of the tree a deep one. Paitini says that such a deep hole or hollow in a tree in which *kaka* nested was termed a *rua matini*. To ascertain whether or not the young birds were ready for taking, the fowler procured a green branch and rustled it at the mouth of the hole. If very young the birds uttered no cry, but if they squawked on hearing the sound, then the fowler knew that they were old enough to take.

Kaka resorted to the same hollow tree year after year for breeding purposes, unless they were frightened away by clumsy fowlers. These *puta kaka*, or breeding-holes, were highly prized. Should a person meddle with one to which he had no right he would be pursued and probably slain.

The term *matini*, or *rua matini*, is applied, says Paitini, to a deep hole or hollow in a tree (apparently not to a shallow hole). It was in these deep holes that the fattest young *kaka* were found. Those found in shallow holes, such as could be reached with the arm, were not so fat. In a *matini* the nest may be at the ground-line, but the opening thereto situated 10 ft. up the trunk of the tree. An implement called a *whakawiri* was used wherewith to take young *kaka* from such deep holes. This was a rod or light pole, to one end of which were attached a number of loops of flax or other fibrous leaf. This end was thrust down the hollow into the nest. The young birds, in scrambling about to avoid it, would get mixed up among the loops. The manipulator kept turning the rod round, so that the loops were twisted round the bodies, legs, or wings of the birds, which could then be drawn up. One young bird was always left to "take care of the nest," as the Maori puts it. This was probably done so that the birds would not desert the tree as a nesting-place. Again, if an axe were used on the tree, to enlarge the entrance to the hole or make a new entrance, the birds would desert it.

When young *kaka* are taken from these nests and cooked for food, then it is highly essential that the ashes of the fire at which they were cooked should be taken to the tree and cast into the hollow where the nest is situated. If this be not done, then the parent birds will desert that tree and never again nest therein, but will seek and select another hollow tree elsewhere, this new nest being known as a *puta whakapiri*. For such are the thoughts of the Maori.

The *kaka* is sometimes troubled with a parasite, a kind of worm called *ngaio*, and when so affected is very thin. The worm sometimes found in the *kokopu* fish is called by the same name.

"*He kaka kai uta, he manga kai te moana*" (A *kaka* on land, a barracouta in the ocean) is an old-time saying, both being famously voracious where food is concerned. Also, the parrot rends wood as the above fish rends a net. The *kaka* is often found in the forest by the fowler hearing pieces of wood drop from where a parrot is rending a decayed limb in order to get at the grubs therein.

"*He pakura ki te po, he kaka ki te ngaherehere*" (A swamp-hen at night, a *kaka* in the forest). These two birds mark, by their cries, the passing of the hours of darkness.

"*He wahine ki te kainga, he kaka ki te ngaherehere*" (A woman at home, a parrot in the forest). Another simile. Women and parrots, the two noisiest creatures known to the neolithic Maori. (*E tama! Ko te ahi tawa hai whakarite.*) It is with much pain that the *pakeha* transcriber places this saying on record. Nothing but a stern sense of duty enables him to do so.

When Maruru hinted to his people that it would be a good thing to slay Tu-te-mahurangi he said, "*Ka eke te kaka parakiwai, kaua e takiritia; ka eke te kaka kura, takiritia*" (If a common brown parrot mounts the snare-perch, do not snare it, but if a scarlet parrot mounts it, then snare it). By this the people understood that they were to slay the chief, but spare his people. This item is from Colonel Gudgeon's pamphlet on the Ohura evidence.

Kakapo (*Stringops habroptilus*; Ground-parrot).—This bird is no longer found in the Tuhoe district, but was at one time numerous at certain places, such as the Parahaki lands, on the head-waters of the Waiau River, and at Te Whakatangata, and other such wild, rough forest lands. When some members of the Ngati-Mahanga clan went a-hunting *kakapo* at the latter place it was a trespassing on the lands of Ngati-Tawhaki, who promptly slew, cooked, and ate the offenders.

Kakapo were numerous in former times at Ngatapa, near Manuoha. Their holes were seen in long rows at that place.

Natives say that *kakapo* live together in flocks; each flock has its own range of feeding-grounds, and its own camp, or *whawharua*. Each bird has its own hole (*pokorua*) at the camping-place. Each flock has its leader, called the *tiaka*, which is said to be always a small-sized bird. It is called *tiaka* on account of its smallness ("*tiaka* = dam, mother," is the only meaning assigned to this word by Williams). At night the birds come forth from their holes and collect on a common meeting-ground at the *whawharua*. This place is a playground for all the birds of that particular *whawharua*. Having all gathered together, each bird now goes through a singular performance, beating its wings on the ground and making a roaring sound, at the same time making a hole in the ground with its beak. The Maori says that these birds collect to *tangi*. During the above performance the *tiaka* walks round the outer edge of the playground, as a sort of sentry. Near morn the *tiaka* leads the flock back from the feeding-grounds to the common living-place, which is always situated in a rough, steep locality. (*Ahakoa he rau nga pokorua, ka kiia tena whenua he whawharua. Ko te mahi a nga kakapo ki te whawharua, he patu i ona paihau ki te whenua, me te rara a tona waha ki te tangi.*)

I have before me an article on the American grouse, in which the following occurs: "It is the custom of these birds to prepare their ballroom by beating down the grass with their wings, and then to dance something suspiciously like the "lancers." By twos and fours they advance, bowing their heads and drooping their wings; then they recede and then advance again, and turn on their toes, swelling their feathers and clucking gently."

As to the *tiaka*, or sentinel-bird, a note at page 192, "Journal of the Polynesian Society," vol. ii, says, "These birds when feeding placed one of their number as a sentinel, which hung by its beak to the branches of a tree, uttering a warning cry." This double performance, doubtless a somewhat difficult one, does not seem to have been performed by the *kakapo* of Tuhoeland.

The Natives hunted the *kakapo* (as also the *kiwi*) at night, with dogs. *Kakara*, or rattles, were tied on the necks of the dogs, and the hunters followed the sound of these. They would be careful to approach the *whawharua* on the opposite side to that from which the wind was blowing. When the birds were assembled, and began their dance, elevating their wings preparatory to striking them on the ground, it is said that they could be caught by hand. But it was necessary to catch the *tiaka* (leader and sentinel) first, then the others could be easily caught. If the leader was not so caught, then all would escape. The lure-call used when hunting these birds was made by placing the hand at the side of the mouth.

Kakapo are said to collect berries of the *hinau* and *tawa* trees, and also fern-root (*aruhe*), in the fall of the year, and carry such food to secluded pools of water, in which they place it to preserve it for future use. When summer begins the birds commence to feed on these stores of food.

The *kakapo*, *kiwi*, *kaka*, *kereru*, *koko*, and *weka* were all preserved in their own fat in former times, and so kept for future use.

In former times cloaks were made of *kakapo*, the skin being stripped off, with feathers adhering to it, for this purpose. Such garments were known as *kahu kakapo*. Old Pio, in his quaint way, says, "This is another remark — a different subject: a *kakapo*. This ancestor was like a bird in appearance: it had two wings. It was a bird of high rank. The feathers and skin were stripped off to make garments for chiefs. Then it would be said, 'So-and-so has a *kakapo* cloak.'"

Kakariki; syn., *Kakawariki* and *Porete* (*Cyanorhamphus novæ-zealandiæ*; Green Parrakeet).—This bird is generally termed *porete* by the Tuhoe people. These birds were formerly very numerous, and appeared in flocks about clearings and on the edges of forests, very much as the *pihipihi*, or silver-eye, is now seen.

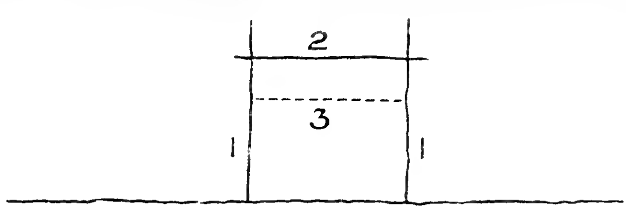
"The origin or parent of the parrakeet," says old Pio, "was one Hine-porete. Her descendants are the *kakariki*, whose cry is '*Torete, kaureke! Torete, kaureke!*' The Maori people slay these birds in the autumn by erecting a *tanga*, and using a lure-call to attract the birds. Now, there was an ancestor named Tutumui (or Tumui), who planted a crop of *kumara* (sweet potatoes) on the land of Hine-porete and her folk. When the *kumara* grew above ground those *porete* folk came and pulled up the whole crop. Tutumui observed the loss of his crop, and so he fixed a *kapakapa* (?) and caught and slew all those folk, except Hine-porete, who flew up on to a tree, a *mata*. She cast her weapon, a *patu mata*, and killed Tutunui, thus avenging the death of her offspring." Which ends this story.

There were three methods of taking the parrakeet—viz., the *koputu*, the *tanga kakariki*, and the *puaka*.

The *koputa*: A rough shed was built at the edge of a forest. Saplings or branches were used, butt ends stuck in the ground, the tops bent over and tied together to form a roof. Branchlets, fern-fronds, &c., used to cover the framework. The front of the shed was left open. Inside the sheds *kurupae* or perches were placed for the birds to settle on. These perches were placed near the back of the shed. Pegs or short stakes (*turu-turu*) were stuck in the ground near the perches, and to these pegs were secured *maimoa porete*, or decoy-birds, to attract the flock. These decoys do not seem to have been kept at the hamlet, as were *kaka*, but each trip a fowler would first procure a few birds for this purpose by means of the lure-call. The fowler procures some fronds of *paraharaha*, a fern, which he carefully arranges in a certain manner and ties to the end of a long stick. Upon seeing a flock of parrakeets (*pokai porete*) in the distance, he takes the above pole and waves it about, which actions attract the flock, and it soon settles upon trees near the shed. The fowler then conceals himself just outside and near the back of the shed. He lures the *porete* by placing the side of his hand to his mouth and imitating the peculiar jerky sounds made by these birds when flitting from tree to tree. The birds soon begin to enter the shed and settle upon the perches, where they intently watch the decoy-birds, which are on the pegs in front of and a little below the level of the perches. The fowler has by his side a number of short sticks, each with a *reti*, or running noose, attached to one end. When he sees that a number of birds have settled on the perches, the fowler takes up one of the sticks, thrusts it through the frail wall of the shed, and slips the noose over the head of a bird. He recovers arms, secures bird, and takes up another stick, until all are used. He then disengages the nooses, sets them anew, and continues his snaring.

Kaka were sometimes taken by means of the *tari*, or noose fixed on a rod.

Tanga porete, or *tanga kakariki*: This is sometimes termed the *pae* method, but differs from the *pae* used in taking *kaka*, *koko*, &c., and is like that used in taking the *pihipihi*. Two upright poles are stuck firmly in the



Tanga Porete.

1. *Pou*. 2. *Rongohua*. 3. Cord, *tau maimoa*.

earth, and to these a horizontal cross-rod is lashed. This serves as a perch for the birds, and is termed a *rongohua*. Underneath the cross-piece a cord is stretched across and tied to the *pou*, or uprights. Several *porete* are so tied to this string that they can struggle to free themselves, and by so struggling, and flapping their wings, attract the free birds. Thus they serve as decoys, and soon the birds begin to alight upon the *rongohua*. The fowler is half-concealed by a rude shelter of branches or fronds of tree-ferns erected near one of the uprights. He uses a striking-stick or rod, termed a *hauhau manu*, to strike down the birds with. He makes a swift strike, running the striker along the perch, thus knocking off any bird that happens to be sitting on it. The blow is downward. The rod is usually a light, slight *mapau*.

The *puaka*: A *puaka* trap is made by making a sort of enclosure of an oblong form, and several feet in length, by sticking a number of rods in the ground in a vertical position. Small rods about 3 ft. in length are used. In this fence-like structure four, six, or eight spaces are left for the birds to enter by. In each space a loop snare is set. Before this trap was constructed, some food would be placed on the spot several times as bait, to get the birds into the habit of coming to the place. The *pihere* was also taken in this manner.

A stronger form of the above trap is used for taking *kiwi*, a *tahiti* like the *tahiti kiore* being set at each entrance.

The crop of a bird is called *tenga*. The same term is applied to goitre in the *genus homo*. The crop of a *porete* is very prominent when full of food. This crop is of a white colour inside, and of the usual rough surface. A white sand, apparently of volcanic origin, deposits of which are common in this district, is known by the name of *tenga kakariki*. It is said to resemble the rough inner surface of a parrakeet's crop.

"*Kakariki e tunua, kakariki e otaina.*" is an old-time saying of the Maori. It seems to have been quoted when food was being prepared in times of serious danger. "Never mind if the food be underdone, let us eat it as it is and get away out of danger."

The *porete* was not a shy bird when in flocks, and was much easier to take than some other species.

Kakaruwai; syn., *Pihere*.—See latter.

Kamana.—A water-bird. A Taupo name. Perhaps the same as *Kaha*.

Kareke.—Rev. H. W. Williams gives this bird as the marsh-rail (*Porzana affinis*). As it is no longer found in this district I could not name it, but, from the description given by Natives, judged it to be a rail. They state that it was about the size of a *moho-patatai*, another rail. One Native told me that *kareke*, *tareke*, and *koutareke* are all names for the one bird. Williams gives the two latter as names for the New Zealand quail, for which see his list in the "Journal of the Polynesian Society." The quail was at one time very numerous in some parts, and was taken by means of a net.

The *kareke* has long disappeared from these parts, but nearly all the elder Natives say that it was a swamp-dwelling bird, and also a *manu tohu*. It was a sign of good or bad luck to fowlers who heard the cry of this bird on the right or left hand.

One old Native states that the *kareke* and *koreke* were the same bird; that it frequented fern country; that it was larger than the *kukurutoki*, and had a different plumage. This sounds like quail.

Kawau (*Phalacrocorax carbo*, *P. varius*, &c.).—Several kinds of shags are known by this name, of which *koau* is a variant form. (It is as well to mention right here that I am cribbing all scientific names of birds from the Rev. Williams's list, for which see the "Journal of the Polynesian Society," vol. xv, page 193.)

Papu or *papua* is another shag-name—a large river-haunting species. The young of this bird were eaten by the Natives in former times. They generally roost in large numbers on a dead tree situated on some steep hill side or cliff overlooking a stream or lake. They will roost on the same tree for many years, leaving it in the morning to go in search of food, and returning to it in the evening. Such a tree, that stood on the banks of the Wai-kohu River in the seventies, was the roost of a flock of about sixty *kawau*. These shaggeries, being usually situated on cliffs or steep sidelings, are termed *pari kawau*. Shaggeries were carefully preserved and sometimes *rahuitia* by the owners of the land, and resorted to every year for the purpose of securing the young birds. There was a famous one at O-whaka-toro, and another, named Whakatangihau, near the O-karika Stream. Both of these were mentioned in Court by Natives establishing their claim to those lands. *Kawau moe roa* is a term applied to bird-snares, eel-pots, and such nets as are left in the water (not merely dragged). Apparently these are likened to the "long-slumbering *kawau*" that sits quietly for hours on a log in a river, but is wide awake when a fish heaves in sight. The nest of this bird is a rough affair.

Captain Cook speaks of broiling and eating some shags at Whitianga. "They afforded us an excellent meal," he says. But, after all, what is the matter with a beefsteak, or even stewed pigeon? And that is all right.

A small species of cormorant is known as the *kawau tatarariki*. These smaller *kawau* are said to represent or be the form of incarnation of an *atua maori* termed Waerore.

When a shag is about to take flight it stretches out its long neck stiff and straight, and so flies. Hence the saying, "*Ka maro te kaki o te kawau*" (The neck of the *kawau* is stiffened), applied to a person or party just about to start on a journey. The expression *kawau maro*, as applied to several columns of troops joining together to form a solid column for the war-dance, has a similar origin.

Kea.—The *kea*, says Paitini, has disappeared. It was a bird that lived in open country. It was smaller than a *kaka*, and had a different sort of bill. *He mea ahua whero taua manu* (Of a brown or reddish colour).

Kereru (*Hemiphaga novæ-zealandiæ*; Pigeon).—We have not much to say about this well-known bird until we come to describe the methods of taking the three principal food-supply birds—the *kereru*, *kaka*, and *koko*.

It is known to most of us that *rupe* is a kind of emblematical name for the pigeon. The local Natives cannot distinguish the sexes of this bird—at least, they have no names for the two sexes. Occasionally nests of the pigeon are found in this district, but not often. They are mostly found in small trees, and about 10 ft. or 12 ft. from the ground. To find a pigeon's nest is looked upon here as an omen of ill fortune, of death or sore affliction for the finder. It is also an evil omen to hear a pigeon calling at night. *He tatai mate tena, he aitua.*

A tree much frequented by pigeons is termed a *rakau tipapa* (*ti* = *whaka*, a causative prefix). Such a tree is usually a *taumatua*, for which see *post*, under "Snaring."

When these birds become fat in winter the expression "*Kua whaturua te kereru*" is heard, meaning that the birds are in good condition, having plenty of fat on the intestines. They get very fat in some seasons when there are plenty of *toromiro* berries, &c. Both the pigeon and *koko* (*tui*) are very fond of the berries of the white *maire* (*maire rau nui*), but do not fatten thereon. They were often snared on those trees The *koko* also eats the berries of the *maire roro*, but the pigeon never does so. When pigeons are feeding on leaves, as those of the *kowhai*, *puruhi* (*houhi ongaonga*, *Plagianthus betulinus*), &c., they get very thin, and the skin gets covered with a kind of scurf (*maihi*).

In some districts the pigeon is called *kuku* and *kukupa*. "*He kuku ki te kainga, he kaka ki te haere*" (A pigeon at home, a parrot abroad) is a favourite apophthegm of the Maori. It may be applied either to a person who is dowdy, careless of personal appearance at home, but who puts on fine feathers when going out, or to a person who is quiet at home but talkative when abroad.

Mr. J. White has preserved ("Ancient Maori History," vol. ii, page 78) an old-time myth as to how the pigeon became possessed of wings, and how its legs and beak acquired their red colour.

I have seen but one specimen of an albino pigeon in this district: it was shot at Tarapounamu some years ago by Mr. C. Anderson. The plumage, however, was not white, but had a pale pink tinge.

Kiwi (*Apteryx*).—This bird is still fairly numerous in some parts of Tuhoeland. At Parahaki and about Tara-pounamu they are common, though, of course, not often seen. When camped at Hei-pipi, near the latter place, their cries were often heard at night in winter, especially so on wet nights. Several were killed by us, and I noted that the fat seemed to be confined to a layer under and adhering to the skin, the rest of the bird being quite thin. The skin is very thick. One good skin I intended to preserve, but old Tutaka, who was camped with me at the time, came across it, and promptly roasted it at a fire and ate it. He rejected the larger feathers.

Kiwi are rare or unknown in some parts of this district. I have only heard one near Rua-toki. As observed, *kiwi* were sometimes caught with a *tahiti*, but the usual method of taking them was to hunt them with dogs at night. *Kakapo* were hunted in the same manner. This seems to have been about the only useful work that the native dog was capable of. The dogs were taken after dark to a place frequented by *kiwi*, and a lure-call was often employed by the hunters to cause the birds to reply thereto. The dogs were released to find, pursue, and catch the birds, but a kind of rattle was fastened to the dog's collar so that the hunters might be able to follow the sound thereof. A dog-collar was made from flax-fibre. When tied up, a stick, called a *potete*, was secured to the collar at one end, and had a cord attached to the other end by which to tie the creature up. The dogs tried to free themselves by gnawing the stick—hence its use. A muzzle, termed a *ponini*, was sometimes used on dogs. The rattle, called *kakara* by Tuhoe, was composed of several pieces of wood (*mapara*, the resinous heart-wood of the *kahikatea* tree), or of bone, sometimes whale-bones. These pieces were about 4 in. long, and about four of them were tied to a dog's collar, and rattled when he moved. Major Mair states that these rattles are termed *tatara* by the Whanganui Natives, and *rore* at Wai-kato.

The word *whakangangahu* seems to define the luring of *kiwi* by means of a call—"*Me haere ki te whakangangahu kiwi ma tatau.*" The word *whakangau* is here only applied to the hunting and taking of pigs with dogs. The deep whistling sound made by a *kiwi* hunter to cause the birds to answer him, and so disclose their whereabouts, is termed *whakahihi*. It is one of the sounds known as *korowhiti*, in making which the bent finger is placed in the mouth. The former name is applied only to the *kiwi* lure-call. "*Ka whakahihitia te kiwi e te tangata.*"

Parties of people used to go a-hunting the *kiwi* in former times. It was cold work in winter for these bushmen, who possessed but little clothing.

Hence the death of Moe-tere and her husband among the snows of drear Huiarau.

The cry of the female *kiwi* is rendered by the Maori as "*Poai, poai!*" and that of the male bird as "*Koire, koire!*" or, as some render it, "*Hoire!*" The cry of the male bird resembles a deep, hoarse whistle—such a sound as is termed *korowhiti*. As old Tutaka put it, "*Mehemea ka poai, he uwha taua manu. Mehemea ka korowhio, penei me te korowhiti, a he tane tena.*"

If the *kiwi* hunter has no dog he takes a firebrand along. He then sounds the lure-call above mentioned, which closely resembles the cry of the male bird. If the birds are not together, but roaming about singly, such a lone bird will approach the hunter, attracted by the call. The merry fowler, on seeing the bird approach him, waves his firebrand vigorously until it bursts into flames, whereupon the *kiwi* thrusts its beak into the earth, and is easily caught by the hunter.

If the birds are roaming in pairs they will not come to the lure-call.

The bird is said to be afraid of the fire when it blazes up (perhaps its eyes are dazzled by the bright flame), hence it sticks its beak into the ground so as to shade its eyes.

The *kiwi* makes its nest in holes among roots of trees, or under overhanging banks, or holes on steep sidelings. Often they are made under the roots of *tawai* (*Fagus*) trees. The Maori has an idea that the bird leaves the eggs to hatch themselves and does not sit on them (*awhi*). This is such a long process (two seasons, some say) that the tree-roots sometimes grow over the egg and prevent the hatching or escape of the young bird. We note a reference to this in a song composed by one Mihi-ki-te-kapua, a prolific song-composer of the early part of the nineteenth century:—

Engari te titi e tangi haere ana—e
Tau tokorua rawa raua
Tena ko au nei, e manu—e
Kai te hua kiwi i mahue i te tawai
Ka toro te rakau kai runga—e
Ka hoki mai ki te pao
Ka whai uri ki ahau.

Cloaks or capes of *kiwi* feathers are still made by Tuhoe and some other tribes. The feathers are woven into and securely fastened to a woven flax-fibre garment. These are termed *kahu-kiwi*.

Koekoea (*Urodynamis taitensis*: Long-tailed Cuckoo).—This bird and the *pipiwharauroa* (*Chalcococcyx lucidus*) were somewhat of a puzzle to the Natives, who never seem to have understood their habit of migrating. Hence the Maoris have cherished two peculiar myths in regard to these birds. One is that they appear from the ground in spring, having buried themselves in the earth or mud in the fall of the year and remained there throughout the winter; the other is that these birds are in some way the offspring of the lizard called *ngarara-papa*.

The cry of the *koekoea* is short, and is rendered by Natives as "*Hoi!*" It emits a hoarse whistling sound, often heard in the dead of night. This cry may be heard from about the time the *manuka* blossoms until the white-pine has ceased to shed pollen.

The local Natives state that the young of the *koekoea* and *pipiwharauroa* are fed by the *tataeto* (syn., *tataihore*). The *pipiwharauroa* appears at Rua-tahuna about the end of October, or early in November. It is also known here as *nakonako* and *whenakonako*, on account of the peculiar markings of plumage. The first of this species heard by me at Ruatoki in 1904 was on the 11th October; but in 1906 I heard one near Whakatane on the 28th September. In 1903 at Rua-tahuna the first I heard was on the 15th October. The *koekoea* appears soon after the *nakonako*. When an old Native at my camp saw the first *koekoea* of the season in that locality he said to me, "*Kua puta te koekoea, wainehu ana te ahua, ara e ahua pokorehu ana*"—by which he seems to have meant that the plumage of the bird was pale or dingy. Possibly it was a young bird, the markings not yet distinct.

Both the above species are said to deposit their eggs in the nests of the *tataeto* (whitehead, *Certhiparus albicillus*), or *tataihore* as it is termed at Te Wairoa, Hawke's Bay. The young birds are fed by the *tataeto* along with its own.

The *koekoea*, it is said, does not eat berries, but lives on insects, lizards, &c. The *nakonako* also eats insects. The *koekoea* attacks and eats the young of the *koko*, and is chased and attacked by the parent *koko* birds. The former does not show fight, but escapes by swift flight. The *koekoea* were formerly taken to provide plumes for the head-dresses of the Maori. The tail-feathers were so used.

The term *koekoea* is sometimes applied to lazy, shiftless folk: "*E! kua rite koe ki te koekoea.*" It fits well a wanderer or vagabond.

In an old *whakatakiri*, or song sung while dandling a child, we find the following:—

> Ko te uri au i te whenakonako.
> I te koekoea
> E riro nei ma te tataihore e whangai.

A substance known as *mimi koekoea*, apparently the excrement of that bird, is eaten by the Natives. It is found on leaves, and is said to be dropped by the bird when flying. It is licked off by the Maori, who says that it has a sweet taste.

The cry of the *nakonako*, or *pipiwharauroa*, differs from that of the *koekoea*, and it also gives different forms of its cry. These are rendered by the Maori as "*Kui, kui! Tioro, tioro, tioro!*" Another as "*Whiti o, whiti o, whiti o!*" But its principal cry is given as "*Kui, kui, kui! Whitiwhiti ora!*" When the cry of this bird is heard, then it is known that the summer is near. When the first cuckoo is heard in the spring the Maori children are heard addressing it as follows: "*E manu, tena koe! Kua tae tenei ki te mahanatanga. Kua puawai nga rakau katoa. Kua pa te kakara ki te ihu o te tangata. Kua puta ano koe ki runga tioro ai, tioro i te whitu, tioro i te waru. Me tioro haere ano e koe tenei kupu e whai ake ki te marae o tama ma, o hine ma. Kui, kui, kui! Whitiwhiti ora!*" (O bird, I greet you! The warm season has now arrived. All trees are blossoming. The fragrance is scented by man. Once more your resounding cry is heard above, sounding in the seventh [month], sounding in the eighth [month]. Go forth and sing the following song o'er the homes of lads and lasses—'*Kui, kui, kui! Whitiwhiti ora!*')

At page 113 of vol. xxxvi of the "Transactions of the New Zealand Institute" may be found a long and interesting paper on the *koekoea*.

The *koitareke*, or native quail (*Coturnix novæ-zealandiæ*), has long disappeared from this district. The younger Natives, who have never seen this bird, often confuse its name with that of the *kareke*, a rail. (See also under "Quail.")

Kokako (*Glaucopis wilsoni*; Blue-wattled Crow).—This bird is known as *honge* among the Ngati-Tipa and probably other tribes. It is now very scarce in the Tuhoe district, a few being occasionally seen among the wild forest ranges of Parahaki, on the head-waters of the Waiau River, where no man liveth. In former times they were taken by means of a call-leaf by fowlers, but not in great numbers. They were, of course, eaten by these bushmen. The blue wattles of this bird are termed *werewere kokako*, a name also applied to a blue-coloured fungoid growth that is found growing on trees. Natives say that when a crow sees this blue object he goes and rubs the sides of his head on it.

A flock of crows is termed a *ta kokako*. An old saying is "*Te ta kokako a Ira-motumotu*" (The crow flock of Ira-motumotu)—whereby hangs a tale.

Ira-motumotu was an ancestor of the Tuhoe people, and it fell upon a certain fine night that Ira's wife went a-fishing for the simple *kokopu*. She brought some home alive in her *puwai*, or fish-basket. Ira opened the basket and the fish promptly jumped out. Here endeth the first canto. Anon, in days that followed, Ira went a-fowling, and snared some crows, the which he secured alive in a basket and carried home to his wife. He told her to cook them, and she, simple creature, opened the basket, whereupon the crows all escaped, and flew away far beyond all beck and call. She made wild clutches at the escaping birds, but never again did she handle those crows. Hence Ira's *ta kokako* has passed down the changing generations as a synonym for the unattainable. Again, when Te Whakatohea raided Rua-tahuna they pursued one Manu-ka-tiu with the pious intention of slaying, cooking, and eating him. One who knew Manu's fleetness of foot said, "You will never catch that man. Just think of his name—'the Soaring Bird.'" One replied, "*Ka rere ia ki hea i te ta kokako a Kotikoti*" (How may he escape from the crows of Kotikoti?) However, the Soaring Bird did escape, and warned Rua-tahuna; hence the night attack on and defeat of Te Whakatohea at Tatahoata, where their chief, Te Piki, furnished a breakfast for the Child of Tamatea.

Anent the origin of the *kokako*—it was in this wise: In Maori myth both the *kokako* and the *pakura* (syn., *pukeko*) are the offspring or descendants of an old-time *tipua* (supernatural being) known as Wairua-kokako, or Hine-wairua-kokako.

Koko; syn., *Tui* (*Prosthemadera novæ-zealandiæ;* Parson-bird).—The origin of this bird was a singular one, according to Maori myth. The *koko* bird and the *inanga* fish (under various names) are both said to be the offspring of Rehua (Antares). In one sense the name Rehua is applied to the constellation Scorpio, except the Scorpion's Tail, which is Te Waka o Tama-rereti. For Rehua is often alluded to as a bird. The curved line of stars extending eastward from Antares is one of his wings—the unbroken one, or *paihau ora*. The other wing of Rehua is broken, as may be seen if you look at the broken line of stars just westward of Antares. This is the *paihau whati* or broken wing of Rehua. Old Pio, of Awa, said, "There is an ancestor roaming across the heavens: it is Rehua. That ancestor is a bird, and has one broken wing and one sound one. His children are the *koko* bird and the *inanga*. Those are the offspring of Rehua. The *koko* bird is with his ancestor Tane (*i.e.*, is a denizen of the forest). This bird provides food for man, the rich *huahua*, only eaten on important occasions or by chiefs, often kept for ritual and social feasts. You cannot equal *huahua* as a food; it is unrivalled."

In the mythical story of Rupe we may note that when that hero visited Rehua in the uppermost or tenth heaven Rehua shook the *koko* birds out of his hair, where they fed upon parasites (*kutu*), and had them cooked as food for Rupe.

The above stories are difficult to understand until we note an explanation given by Mr. Tregear in a very interesting paper on "Polynesian Folk-lore" (Trans. N.Z. Inst., vol. xix, page 490), wherein he states that *lehua* (=*rehua* in Maori) is an ancient name for a forest in the Hawaiian dialect.

The Tuhoe Tribe have two names for each sex of the *koko.* The male bird is known as *kopurehe* and the female bird as *kouwha* from the time of the flowering of the *kotukutuku* until the fruiting of the *hinau.* During the balance of the year the male bird is termed *kokouri* and the female *kokotea* (cf. *parauri* in Tregear's Maori Dictionary).

The term *kouwha* seems to equal *uwha,* and is applied to female animals and female blossoms or trees.

The Natives say that towards the autumn the *koko* will, in some seasons, wake up in the night and "talk" for a few minutes, and then again be silent. This is said to be a sign of a fruitful season coming—all forest food products will be plentiful.

The *koko* was, apparently, the only bird taught to talk by these Natives, and the only one kept as a pet. The *mokai kaka* were kept for use. When a bird was caught which it was proposed should be kept and taught to speak, it had a piece of its long tongue cut off. This bird is a honey-sucker. A famous talking *koko* kept at the Hei-pipi hamlet years ago was named Tauaiti, after an ancestor of those parts. It was *tohia* (end of tongue cut off) by Pirimona, of Maunga-pohatu.

The bird was then placed in a covered place. Two pieces of supplejack were fixed in the ground as hoops, one at right angles to the other, to serve as a framework. This frame was covered with a mat or old baskets. Food was placed at one end and water at the other end of this structure, and the bird soon learned to find them. After some time the bird would be put in a cage made of thin twigs of *manuka.* A small opening was left at each end of the cage, and a small wooden trough, sometimes ornamented with carving, was fixed outside the cage, just under the two apertures. Food was placed in one, and water in the other. These cages were hung in the porches of the houses. After the birds had learned to talk they would begin to air their eloquence very early in the morning. Old-time residents of Pori-rua, of forty or more years ago, will remember such a bird, the property of hale Jimmy Mitchell. That *koko* was a past-master in the delivery of the Maori tongue.

The tongue of a *koko,* or the ends thereof, are termed *puhihi* by Natives, a word also used to denote rays of light, as from stars, &c., and also the tail and side streamers of a kite. These ends of the bird's tongue were cut so as to enable the creature to speak distinctly. If they were not so cut, then the bird's enunciation would be very poor. The *koko* emits some curious sibilant sounds at the end of each "set piece," which sound much like a person spitting.

We here give a few specimens of these songs or recitations taught to the *koko* in former times :—

He Ako Koko.

Kiki tai pari, kiki tai pari
Whakataka horohoro ki tua o Maketu
Maranga mai—e—u—e. E—u—e
Ka ki te tai, ka heke te tai
Ka whakarara koa nga tai o te awa
He tai taua—e, ehe ! ehe !
Kai tuha !

HE AKO KOKO.

1.

Uia te manuhiri me ko wai. Uia te manuhiri me ko wai. Ko Tu koe, ko Rongo koe, ko Whakamau-tarawa. Tahia te wananga—e. Ko Matiti, ko Matiti-kura, ko Matiti-aro.

2.

Ko Tupato, ko Hikairo, te Kuti, te wera, te rapa, te haua. E, ko Apanui, Apanui —e! Mau ki te hoe. Tutaki—e! Mau ki te hoe. Ko te hoe nui, ko te hoe roa, ko te hoe na Matatua. Tikina ra, kaua te tai o Pakihi, kai hika mokai ko koe. Moi, moi—e! Haere mai! Ehe! Ehe! Kai tuwha!

3.

E ai ana, tataki ana te waha o to puta. Ka rure te wahine—e! Te wahine takiri tohetohe, e rere taua. Korihi ake te ata. Karangatia, e! Haere mai! Haere mai, e te manuhiri tua-rangi. Kaore he kai o te kainga. Kai tawhiti te kai. Moi, moi—e! Haere mai! Ehe! Ehe! Kai tuwha!

4.

Koka—e! Tahia te marae. Koka—e! Me tohutohu tu te kai. Me tohu te rua iti. Me tohu te rua rahi. Koi tae ki te whitu, me te waru. Tukutuku karere ki raro ki te whakahawea na. E! Haere mai! E te manuhiri tuarangi. Kaore he kai o te kainga. Kai tawhiti te kai. Moi, moi, e! Haere mai! Ehe! Ehe! Kai tuwha!

5.

Ko te wheu, ko te whare. Te whare patahi—e! Hui te rangiora. E rongo ki waho, e! Haere mai! Haere mai! E te manuhiri tuarangi. Kaore he kai o te kainga. Kai tawhiti te kai. Moi, moi—e! Haere mai! Ehe! Ehe! Kai tuwha.

On comparing a number of versions of the above *koko* speeches I find that part 5 is the latter portion of part 1, and should be added thereto. It will be seen that these birds were taught to cry a welcome to visitors, and to give orders that the plaza of the hamlet be swept and made presentable.

Tamati Ranapiri, of Ngati-Raukawa, states that Maoris know the sexes of some birds, and can distinguish them—*i.e.*, the *kaka*, *kereru*, *tui* (*koko*), *kokomako* (syn., *rearea*, *kopara*), and *huia*. He says also that *manu tute* (quarrelsome birds) and *manu taupua* are always males, no matter of what species.

Manu tute is a term applied to birds that bully and drive other birds away from a food-bearing tree, as the *koko* are sometimes seen to drive pigeons away from a tree (*tutetute* = to jostle).

Manu whakakenakena is an expression applied to a bird when it causes its neck-feathers to stand up like a frill, as the *koko* sometimes does.

The Maoris have a belief that when the *koko* becomes excessively fat, as it sometimes does, it is in the habit of pecking its breast so as to cause much of the surplus fat to exude. I must decline to guarantee the truth of this statement.

That the *koko* is a somewhat strenuous and interfering sort of creature we know well. It has not much use for birds of other species. Some months ago, when ascending a bush-clad hill near my camp I heard a series of angry shrieks and (apparently) shocking oaths, and presently came upon a strange scene. A gentle *ruru* (morepork owl) was standing on the ground, and a *koko* was wheeling and making swift dashes at it, and evidently trying to frighten or drive it away by means of these attacks and discordant shrieks. At last the *ruru* fled down a gully, pursued by its assailant, who again attacked it as it sat on a branch, and the owl again fled. This process was repeated until I got tired of following them, and probably longer. The owl seemed to make no attempt to retaliate or defend itself.

The skins of the *koko* (and also those of some other birds) were used as *pohoi*, or ear-pendants. The skins, with feathers on, but minus heads, wings, and tails, were prepared by inserting a round stick in them, and hanging them up to dry. Thus the skins assumed a cylindrical form. They were suspended from the ears.

Besides being potted and steamed in an earth-oven, the *koko* was often cooked after being wrapped in leaves. A favourite method was roasting before a fire. A green stick with one end cleft, split down the middle, was used as a spit. It was termed a *rapa* or *korapa*, whereas an unsplit stick used as a spit is called a *kohuki*. Five or more *koko* or other small birds were stuck in the cleft of a *korapa*, and the spit was stuck in the ground near a fire.

When fowlers were counting a day's takings they did not count two *koko* as a brace, but reckoned two birds as one, or, in some places, three as one. Hence a *pu koko*, or brace of *koko*, consisted of four birds, or, in some parts, of six birds. This was on account of their small size.

Tahei koko, or snares for taking this bird, were set all over the top branches of trees frequented by them. When visited again by the fowler, he would often find dozens of birds caught on one tree. Then would be heard the saying, "*Me te raparapa tuna.*" So many birds were hanging from the snares that they looked like a lot of eels hung on a stick to dry. Another such simile was applied to pigeons when so caught in large numbers: "*Me te rau rangiora*" (Like *rangiora* leaves). In this case the birds are compared to leaves of the *rangiora*, which are white on the under-side.

"*He koko kai kohe*" (A *kohe*-eating *koko*). When these birds are feeding on the berries of the *kohe* tree they become very fat. This saying is applied to a stout person as a simile. He is compared to a *koko* that has fattened on *kohe* berries. Both the *koko* and pigeon eat these berries.

"*He koko whakamoe, ka mate te tangata*" (When like a benumbed *koko*, men perish). Applied to sleepy-headed, lethargic persons who do not keep a good watch at night; hence they are surprised and slain by enemies. The *koko* gets so benumbed on frosty nights as to be unable to fly, and is then taken by hand.

"*Me he korokoro tui*" (Like a *tui's* throat) is said of an eloquent speaker. This is given by Sir George Grey in his "Maori Proverbs." I have not heard it used among Tuhoe.

Kotare (*Halcyon vagans*: Kingfisher).—The kingfisher is not numerous in the Tuhoe district; a few are seen, usually on the outskirts of the forest region. I have seen them pecking into dead, half-decayed tree-trunks in order to form their nests. At a place called Te Puta-kotare, at Whirinaki, these birds used to make holes for nests in a bluff overlooking a lagoon: hence the place-name. The Natives say that these birds eat lizards, and hence some persons will not use them as food. The young were in former times taken from the nest just before they could fly, and eaten by those who were not too deeply imbued with superstitious dread of consequences.

Kotuku (*Herodias timoriensis*; White Heron).—This bird is no longer seen in these parts, and seems to have been only occasionally seen in former times: hence the saying, "*He kotuku taunga kotahi.*"

In olden days the *kotuku* is said to have frequented a pond or lagoon at Manuoha, a very wild spot and remote, and also the Kaipo Lagoon, which is the source of the Mokau Stream, at Wai-kare Moana.

The plumes of the *kotuku* were highly prized by the Maori in former times, being used by chiefs for sticking in their hair. These feathers or plumes were known by several names, the three kinds used for the above purpose being the *whaitiri*, *tatara*, and *titapu* (or *rau o titapu*). The *tatara* were the outside plumes. Another Native states that the bird has four of these prized long plumes in each wing: the first one is called a *kapu*, and the other three are *kira*. Women were not allowed to wear these plumes: they were only permitted to wear the shorter ones, which had a distinctive name. If a woman were to wear one of the long plumes, all her hair would fall off. Or, as another Native put it, if a man wearing *kotuku* plumes is sitting among us as we partake of food, no woman may come and join in the meal. If one does so, then all *her* hair will fall off. But if the plume-wearer takes it out of his hair and lays it down, then women may join in the meal. These hair-shedding episodes must have been truly annoying to the fair sex of neolithic New Zealand.

Tutaka states that the *titapu* was a very *tapu* object. Perhaps that was why it acted as a depilatory.

The *awe kotuku* are even now much prized. These are very fine and graceful feathers, of delicate texture and appearance, that overlap the tail-feathers of the *kotuku*.

Kukurutoki; syn., *Toetoe*, &c. (*Sphenœacus punctatus*; Fern-bird).—This bird is usually termed *toetoe* by the Tuhoe Tribe, and *kukurutoki* by Ngati-Awa. It is seen flitting among the fern (bracken) and about the edges of swamps. Its ordinary cry is rendered by the Maori as "*Te, te, te!*" but it has other cries which are regarded as tokens of approaching good or bad fortune by Natives. For this bird is a *manu tohu*. By its cry we can foretell the success or failure of an expedition, or hunting-trip, or *kai taonga* (*muru*) raid. If you hear the *toetoe* cry "*Kore ti, kore ti!*" you will not be successful—not at all. That cry is a *puhore* (token of non-success). But if the cry of that bird is "*Toro ki, toro ki, toro ki! Kuri, kuri!*" that is a sign of good luck: you will gain your object. When its cry resembles "*Kuri whatia!*" that is a sign of disaster or death; while the cry "*Kuri ora!*" is a token of life, peace, and prosperity.

Matapu.—A large bird, says my informant, of black (or dark-coloured) plumage. It is like a *kawau* in appearance, but has a shorter neck. It frequents forest-streams.

Matuku (*Botaurus pœciloptilus*; Bittern).—Sometimes called *matuku-hu-repo*, because its peculiar booming cry is heard in swamps. Several auguries are drawn from the cry of this bird. Thus it gives notice of an approaching wet season, when floods are to be many.

Old Pio, of Awa, rambles on anent birds in his usual style: "In the tenth month (April) the sun changes its course and returns to the ocean, to his winter wife, Hine-takurua (Winter Maiden). The sun has many descendants out on the ocean. These are Hine-karoro (origin and personification of the *karoro*, or black-billed gull), the next born being Hine-tara (the *tara*, or tern); the next is Hine-tore. The last born of that lot was Punga, the origin of lizards. This Punga also had Haere-nui, then Noho-tumutumu (origin of the *kawau*), then Moe-tahuna (origin of the *parera*, duck). The next born after Punga was Matuku (origin of the *matuku*, or bittern). I will speak of this person, of how he makes the booming sound. There are two signs in the call of this bird—it calls to its parents, and also gives certain tokens regarding the months and seasons. This person, the *matuku*, goes wandering about in the swamp. It sees a hole, and thrusts its beak down into that hole. The food it contains is an eel. The bird thrusts its head down into the mud and seizes the eel. Then the bird gets out of breath, its fundamental orifice opens and emits a booming sound. Such is the cry of the *matuku*."

The bittern is now scarce in this district, but few are heard.

Mimiro.—See *Miromiro.*

Miromiro; syn., *Mimiro*, *Tarapo* (*Petroica toitoi;* Pied Tit).—These little birds are still fairly numerous in the forests of Tuhoeland. The sexes are known by their different colours, the male bird having black and white plumage, while that of the female is of a dingy pale (*koma*) colour. The female bird is called *tarapo.*

There are two items to record in reference to the *miromiro*. When Maui, the famous hero of Maori myth, went in search of his mother, he reached Paerau, where he found the folk of that place busily engaged in planting their crops. Maui transformed himself into a bird, a *miromiro*, which bird perched itself on the *whakamarama* (crescent-shaped handle) of a *ko* (digging-implement) and sang a *tewha*, or planting-song. After divers adventures, Maui assumed the form of a *kereru*, or pigeon, and finally found his mother.

Again, the *miromiro* bird was often employed to carry love-messages to a sweetheart or absent wife or husband. There was a certain amount of ritual pertaining to this practice. Certain charms, termed *iri* or *atahu*, were recited, and it is said that they were very effective. The bird would go forth and find the desired person, however distant, and perch itself on him or her. At once such person would be seized with a great desire to go to the sender of the bird messenger. Runaway wives or husbands were often brought back by such means, the bird being the active medium employed. I am informed that the above statements are quite true—and who am I that I should doubt them?

"*Ma te kanohi miromiro*" is a saying preserved by Sir George Grey. (It will take a sharp eye to see or find something mentioned—an eye as quick as that of the *miromiro.*)

Missionary Taylor states that the *miromiro* "generally flies about graves." After having known this bird for nearly fifty years, I have come to the conclusion that it gets along very well when there are no graves handy.

Moa.—This creature is no longer met with in the forests of Tuhoeland, I may observe, but it has at one time roamed far and wide over the steep forest ranges of this district. *Moa* bones have been found near the summit of the Tara-pounamu Range, at an altitude of quite 2,500 ft. above sea-level, and probably 2,700 ft. These were found by road-workmen at the base of a *rimu* tree, on a steep sideling. A leg-bone was sent to the Auckland Museum. Natives report *moa* bones as having been seen in caves or rock shelters in the wild forest country at the head of the Tauranga River (called the Waimana by us), and near the summit of Maunga-pohatu—viz., at Nga Whatu-a-maru. A *moa* skeleton was found in a chasm near Awa-awaroa, at Wai-kare Moana, by Mr. McGrath.

Native tradition speaks of the *moa* having lived on the Poho-kura Block in times long past away, and also of a lone *moa* that lived on the Tawhiu-au Range, at Galatea. Presumably these upland *moa* were mountaineers, for they certainly roamed in very rough high-lying country.

The word *moa* is often found to occur in place-names, but whether or not these names have any connection with the bird it is now impossible to ascertain: thus, Moa-whara is a place-name on the upper Whakatane River; Tapuae-moa, a place near Te Teko; Moa-nui, a place on the Waio-eka River; Whanga-moa, on the shores of Roto-kawa; while *rau-moa* is a plant-name.

Tradition states that a *moa* was killed at Whakatane by one Ngahue, a very early voyager to New Zealand, who returned to the isles of the north. Mr. Percy Smith heard this same tradition repeated by a very old Native of Rarotonga.

Pio, of Awa, born about 1823, has his little budget of notes concerning the *moa :* "There were certain folk on this island in ancient times. They were like birds in appearance, and also resembled man in structure. They had two legs, two arms (?), and a head, and a mouth too, but they could not speak. They stood on one leg and held the other up—drawn up. It always kept its mouth open, because it lived on air (or wind). It always stood facing the wind, no matter whence it blew—north wind, south wind, east wind, all were food for those folk. Those creatures had fine plumes, like birds' plumes, that grew under their armpits. These plumes were called *rau o piopio,* and were worn by chiefs in ancient times. They were also used, together with *huia* and *kotuku* plumes, when dressing the hair of a dead chief for the lying-in state. A certain ancestor of ours, whose name was Apa, came across one of those folk on the western side of Putauaki (Mount Edgecumbe). It looked like a man standing there. Apa struck a blow at the leg it was standing on, whereupon the creature kicked Apa so violently with the drawn-up leg that he was hurled over a cliff and killed. Hence that place has since been known as the Takanga-o-Apa. Those folk of that tribe were called *moa.* I say those folk who stood on one leg and held the other up are lost: our ancestors killed them. Those *moa* are no longer seen, but their bones are found—huge bones, like those of cattle or whales in size. They were descendants of Tutunui. They were all slain in ancient times. It was said that survivors of the *moa* were living on high ranges, on precipitous places, in gullies, at Tawhiuau and elsewhere. I saw some of their bones at the base of Tawhiuau (near Galatea). After Christianity was introduced, a party of Maoris went with a European to search for *moa* at Tawhiuau. They did not find any."

The above is the only tradition concerning the *moa* that is known by the Natives of these parts. The ancestor Apa here mentioned flourished about four hundred years ago. The tribe Ngati-Apa, of Putauaki, were apparently of the early inhabitants of New Zealand. The Tuhoe people have preserved no other traditions concerning the *moa.* Their history, legends, folk-lore, songs, &c., are silent as to the *moa*, save for the few notes given here. And Tuhoe are truly of the old-time people of New Zealand, who were in camp here long centuries before the last migration of Polynesians to these shores.

A very singular statement appears at page 494 of vol. vii of the "Transactions of the New Zealand Institute." It is quoted from a letter written by the late Judge Maning: "There is no subject, except perhaps the history of their wars and migrations—none on which the traditions of the Maori are so numerous and particular as those regarding the *moa*," &c. This is somewhat startling when we know that early European settlers and sojourners in New Zealand could gather but very little information anent the *moa* from Natives then living, or from song, story, and legend. Colenso is correct in his statement that scarcely anything anent the *moa* has been preserved save a few fabulous stories. He made inquiries at Te Whaiti and Te Reinga, and many other places, in 1841, but could gain nothing authentic. The Reinga Natives spoke of a lone *moa* that lived in a cave (guarded by a reptile) at Whakapunake. They also stated that a few years before Colenso's visit in 1841 they had been raided by the Ure-wera Tribe and forced to fly to the rugged Whakapunake Mountain for refuge, and where many of them were slain by the Ure-wera (Tuhoe) raiders; but they saw no *moa* in those wilds. Colenso never met with the *moa* in Maori legend, save in that of Ngahue, given above. He collected nine old-time aphorisms concerning the *moa*, and a few references in poetry, but very little else. There was no more *moa*.

"*Na te moa i takahi te rata*" (The *moa* trampled on the *rata*), or "*He rata te rakau i takahia e te moa*," is an old saying that I first heard from Ngati-Hau, of Whanganui. That tree sometimes grows far from upright, and is said to have been forced into that position by a *moa* treading on it. Sir George Grey has preserved "*He mihiau te kohatu i taona ai te moa*" (The *mihiau* stone was used for cooking the *moa*).

The expression *moa kai hau*, or "air-eating *moa*," is sometimes met with in poetry, as—

Kia noho atu au i konei
Hai moa kai hau ki Whakapunake ra.

Moho.—Tutaka states that the *moho* was a flightless forest-bird, but is now extinct; also that the *mohorangi* was a flying-bird found in open country, in fern and swamp. Williams gives *moho-patatai* as the land-rail (*Hypotænidia philippensis*). The *moho-patatai*, says Paitini, is a long-legged bird with a small body. It is no longer seen in the Tuhoe district. The last one here seen was caught at Te Whaiti about the year 1890 or 1892.

Momotawai.—Given by Williams as the bush-wren (*Acanthidositta chloris*). I have been told by Natives that *momotawai*, *momoutu*, *tititipounamu*, and *toirua* are all names for the bush-wren. But others say that the *momoutu* is smaller than the *momotawai*, and the latter has disappeared, while the former is still seen; also, that both are distinct from the *toirua* and *tititipounamu*. Another ruffian says, "The *toirua* resembles the *momoutu*, but is larger, and has no tail. It is the same as *momotawai*." Te Pouwhare also says that the *toirua* and *momotawai* are one and the same bird. The *toirua* is said to be also known as *pipitori*.

To take the *momoutu* the fowler imitates the cry of the bird, and takes a leaf in his fingers, which leaf he shakes and twirls about. This attracts the bird, so that it comes close enough to be caught by hand, even perching on the hand of the operator. Natives say that it mistakes the twirling leaf for its own young. It is a dark-coloured bird.

Nakonako.—See under *Koekoea*.

Nonoroheke.—See under *Riroriro*.

Oho; syn., *Oho-mauri*.—Given in Williams's list as the land-rail, same as *moho-patatai*, &c. My Maori notes say: A bird of light-coloured, marked or patterned plumage. A difficult bird to take. It has a habit of appearing suddenly by the roadside as one passes: hence its name, "the startler."

Pakura.—See *Pukeko*.

Papango (*Fuligula novæ-zealandiæ*).—Black teal.

Papua or *Papu*.—A species of *kawau* (cormorant).

Parera (*Anas superciliosa*; Grey Duck).—A flock of *parera* is termed *kawai parera* when in the water, but *pokai parera* when flying. When young ducklings take to the water, which they do early in life, they are called *kawaiwai*. When the *parera* and *whio* are moulting they are extremely fat, and were in former times caught in large numbers with dogs and even by hand at such times. At other times they were snared. A long cord, termed *kaha*, was stretched tightly a little above the surface of the water, being fastened to stakes thrust into the bed of the lake or stream. To this cord were attached innumerable loop snares (*tahei*, *tahere*), which were attached to the main cord so as to hang down and bring the open loop just above the surface of the water. In swimming to and fro the ducks were caught by the neck in this running noose. Favourite feeding-grounds of the duck in lakes or wide river-mouths, &c., were sometimes entirely surrounded with a ring line of snares.

Maoris do not appear to have been in the habit of taming birds, or keeping them as pets, save in the case of the *koko*. The *kaka* were so kept for use as decoys. Occasionally one hears of other birds being tamed, or partially so. For instance, one Tohi-ariki so kept a *parera* as a *mokai* or pet, and named it Korotau. On going a journey he left the bird in care of his wife. She neglected to feed it: hence it left the hamlet for pastures new. When Tohi returned he composed the following lament for his lost bird:—

Kaore te aroha ki taku nei manu
Titoko tonu ake i te ahiahi
Ka tomo ki te whare takuate kau au
E whae ma, e!
Tirohia atu nga parera e tere atu ra
Ehara tena, he manu maori.
Waiho me titiro ki te huruhuru whakairoiro
Mai no tawhiti.
He rangi au e tatari akuanei
He raro au e tatari apopo
Kai hea Korotau ka ngaro nei
Tena ka riro kai te katokato i te rau pohata
Ka whakataiore tu nui ki te po me te ao
Ka oho ai au
E waiho ana koe hai tiaki hanga
Hai korero taua ki tona taumata
Waiho me ui ake te iwi ngaro.

Pekapeka (Bat).—The bat is termed a bird by the Maori. They are not often seen in this district.

The *pekapeka* was eaten in former times by the Natives. They usually are found living in hollow trees, and in former times, it is said, large numbers frequented such holes. To take them, a fire was kindled in the hole, and the entrance stopped up in order to prevent the escape of the birds. Thus the birds were stupefied by the smoke, and fell to the bottom of the hollow of the tree, where the merry fowler secured them. These resorts of the bat have a powerful and evil odour. The Natives were careful to kill the first bat caught, as this insured a good bag. If this first one escaped, then but few would be taken.

Pihere; syn., *Karuwai*, *Kakaruwai*, *Pitoitoi*, *Tataruwai*, *Toutouwai* (*Miro australis*: Robin).—This bird was called *pitoitoi* on account of its cry (which is rendered by the Maori as "*Pitoi-toi-toi*"), and *karuwai* (watery eye) because small drops of water are seen exuding from its eyes. Ngati-Awa and other tribes call these birds *pitoitoi*: Tuhoe style them *pihere*; while Ngati-Kahungunu, of Te Wairoa, use the name *karuwai*. Tuhoe call the female of this species *mokora*.

The robins practically disappeared from the forests of Tuhoeland years ago, and were rarely seen, though numerous in pre-European days. But in the summer of 1901–2 they reappeared in limited numbers at Ruatahuna, as also did the *rearea*, or bell-bird. Mr. R. C. L. Reay, surveyor, writing from Wai-maha, east of Maunga-pohatu, in 1903, stated, "The *pitoitoi* are numerous in the Hangaroa district. They come near our camp, and follow along the survey-lines we cut. They appear to be darker in plumage than the *pitoitoi* I remember north of Auckland many years ago, and without the white lumps at base of beak."

When in going hunting or fowling in the forest you hear the cry of the *pitoitoi* far in the forest-depths, that is a sign of non-success: your trip will be a failure.

The *pihere* is taken by means of a trap termed a *korapa*, or *whakarapa*. To make this trap a piece of supplejack is bent so as to assume a U shape. Across the two ends a stick is lashed so as to cause the supplejack to retain its shape. It is now like a capital U with a closed top. Dried strips of flax are netted on this frame so as to form a net with a mesh small enough to hold such small birds as the *miromiro*. The trap now resembles an enlarged section of a snow-shoe—not the ski, but the Canadian snow-shoe. The straight cross-piece is termed a *kurupae*, and its ends project a few inches on either side of the trap. The trap is placed in a vertical position on the ground, the *kurupae* resting thereon. Two pegs are thrust in an oblique manner into the ground just above and resting on the projecting ends of the *kurupae*, and on that side of it on which the trapper takes his stand. The trap will probably be held in an upright position by the pegs; if not, then a slight stick will be used to prop it up. A cord some 30 ft. in length is attached by one end to the top of the frame of the trap. This cord is passed through a small hoop of supplejack, like a diminutive croquet-hoop, fixed in the ground just in front of the trap. The cord is carried on to the fowler's stand, he holding the end in one hand. In the other hand he holds a stick, with which he keeps striking a block of wood lying on the ground by his side. This tapping attracts the birds. The Natives say that the birds think it to be caused by some person chopping grubs (*huhu*) from a decayed tree, a common practice in Maoriland. It is a fact that the robins will collect around persons working in the bush, as I know full well, having often watched and fed them under such circumstances.

A bait of berries, earthworms, or *huhu* grubs is placed on the ground immediately in front of the standing trap, and close to it, so that the trap covers it when it falls. The birds, attracted by the tapping sound, draw near, and soon espy the bait and flock to it. When many are collected round the bait the fowler pulls the cord, which causes the trap to fall upon the birds and thus imprisons them. The cord, being passed under the little *korowhiti*, or hoop, holds the trap down close and prevents the birds escaping. All the fowler has to do is to retain his strain on the cord when he advances to secure the birds.

Other small birds, such as *miromiro*, &c., are taken at the same time. It is not the *pihere* alone that is attracted and so taken. No bird is too small to serve as food for the Maori, as witness the taking of the *pihipihi*.

Pihipihi; syn., *Karu-patene* (*Zosterops cærulescens*; Blight-bird, Silver-eye).—This bird appeared in this district before there was any fighting with Europeans in Tuhoeland. It was known here at first as *karu-patene* (? button-eye). This bird is taken in great numbers in the Rua-tahuna district by the call-leaf and striking process, exactly similar to that method of taking parrakeets termed *tanga porete* and *tanga kakariki*, for which see under *Kakariki*.

The decoy *pihipihi* are tied by the beak to the cross-cord with a short string. The fluttering and struggles to escape attract other birds, which perch on the cross-rod, and are struck down by the fowler, who is half-concealed within a shelter of branches or fern-fronds. A call-leaf is also used by fowlers. These birds are preserved in fat in great numbers in the interior of Tuhoeland. They are not carefully plucked—many feathers are left on—and they are not cleaned. But that matters not. The hardy Tuhoean bush-folk crunch up the birds—head, bones, inside, remaining feathers, and all—with great zest. But the *pakeha* looketh sideways at this delicacy.

Piopio; syn., *Koropio* (*Turnagra tanagra;* North Island Thrush).—The North Island thrush is almost gone from the forests of Tuhoeland. There are said to be some still in the Parahaki district, a wild uninhabited tract of rough forest country but seldom visited by Natives, and which but few Europeans have penetrated. These birds are said to have been numerous in former times all over the Tuhoe district, and fowlers used to take them in considerable numbers, attracting them by means of a lure-call. A leaf was generally used whereby to make most of these lure-calls. The plumage of this bird is described by Natives as *pakaka*, or *whero popouri*, in regard to colour. (See *Pohowera.*)

Pipitori.—Said to be another *alias* of the *toirua.*

Pipiwharauroa.—See under *Koekoea.*

Pitoitoi.—See *Pihere.*

Piwaiwaka; syn., *Tiwaiwaka, Piwakawaka, Tiwakawaka, Tirakaraka, Hiraira̲ka* (Pied Fantail).—This is the bird that caused the death of Maui, the hero who endeavoured to gain eternal life for man, and failed at the task, as many others have. In this and some other myths birds are alluded to as Te Tini o te Hakuturi, though it would sometimes appear that the term is applied to fairies. In like manner the expression Tini o te Mahoihoi is sometimes explained by Natives as being a sort of general term for birds, though others state that it is applied to plants, &c.

Pohowera.—I have heard this name applied to the *piopio*, but I do not know that it is a genuine name for that bird. *Pohowera* is certainly the name of a sea-bird. This bird is also found a certain distance inland at times. If its nest is found in a *kumara* cultivation the eggs are carefully counted, for it is, or was, believed that the field will produce twenty baskets of *kumara* (sweet potatoes) for each egg the nest contains.

Porete.—This is the most common name for the parrakeet among the Tuhoe Tribe. (See under *Kakariki.*)

Pukeko; syn., *Pakura* (*Porphyrio melanonotus;* Swamp-hen).—These birds were never numerous in the Tuhoe district, which is essentially a forest country, the realm of Tane. I have not yet seen this bird hereabouts. In former times they were numerous in the Ngati-Awa district, which contains a great area of swamp-lands. They were snared in a similar manner to that employed in taking ducks, except that the apparatus was fixed on land. A long cord was stretched tightly from stake to stake, and from this cord hung many loop snares, at such a height above ground that a *pukeko*, in walking, would be likely to thrust its head into the loops. The expression *kawau moe roa*, or "long-slumbering shag," was applied to all such snares as were so left, unattended by the fowler, for the birds to catch themselves in. It was also applied to eel-pots and all such nets as are left in the water.

The *pakura*, or *pukeko*, was a troublesome bird to the Maori agriculturalist, for it entered the fields at night and scratched out and ate the tubers of the *kumara* (sweet potato).

As we have seen, the *pakura* and *kokako* are sprung from a mythical being known as Hine-wairua-kokako, a *tipua*, or supernatural being. Says

Pio, " The *pakura* are a troublesome folk. They are the offspring ot Hine-wairua-kokako. Most evil are the actions of that ancestress and her offspring in pulling up and devouring the food of the Maori people. When seen assailing the crops a person goes to *hiehie* them (to drive them away by shouting at them). This is the *whakahiehie* :—

Hie ! Hie !
Haere ki te huhi
Haere ki te repo
Haere ki a Hine-wairua-kokako.
Hie ! Hie !
Haere ki a Hine-wairua-kokako
Hie ! Hie !

The sign by which the Maori knows the approach of daylight comes from the *pakura*. Its cry is heard about midnight, again later on, and again a third time. The third cry tells us that daylight is at hand."

Quail.—The New Zealand quail was known in this district, but disappeared many years ago. It was once numerous in open country, and was taken with nets. It is *Coturnix novæ-zealandiæ*. The Native names of the quail given by Williams are *koreke, koikoiareke, koitareke, kokoreke, koutareke,* and *tareke.*

Rearea ; syn., *Korimako, Korihimako, Kopara, Kokomako, Kokorimako* (*Anthornis melanura* ; Bell-bird).—The *rearea* was sometimes speared, and also taken by means of a *puaka*, which is an enclosure made by thrusting sticks or branches into the ground so as to form a sort of fence. Small openings were left by which the birds entered to eat the bait placed inside. Loop snares were arranged in these open spaces, by which the birds were caught. The *porete* was also taken in this manner.

The bell-bird had long disappeared from Rua-tahuna when I first visited those sylvan wilds in 1895, but reappeared there in the summer of 1901–2. I often heard them near my camp in that year ; but they were not numerous. It was not like the delightful clamour heard in the bush of the Wellington District in the early sixties : that was something to remember.

Riroriro ; syn., *Nonoroheke, Nonoroheko, Horirerire, Hirorirori, Korirerire, Totororire* (*Totorori* ?) (*Pseudogerygone igata* ; Grey Warbler).—This is a *manu tohu tau* of the Maori. It shows them what the coming season will be by its manner of building its nest. If its snug little roofed nest is built with the side entrance thereto facing the north, then the prevailing wind of the coming season will blow from the south, and *vice versa*. If the opening of the nest faces the *muri* wind a *tau tokerau* will follow—that is, easterly winds will prevail, and it will be a pleasant, prolific season. If the nest faces the east, that means a *tau hauauru, he upoko maro*—a westerly and cold, inclement season : crops and forest products will not be satisfactory. The *muri* is a wind that blows from the coast up the Whakatane Valley. This wind betokens good fishing weather. It is styled a *hau aroha*, a favourable wind. *Upoko maro* is a term used to denote cold weather—the cold south winds, or *tonga kokoti*.

The cry of this bird is rendered by the Maori as "*Riro, riro, riro!*" When this cry is heard in winter or early spring it is a sign for man to be up and doing—to commence the work of preparing cultivations for crops, &c. It is urging the Maori people to commence the work of the year.

Two authorities give me *totorori* as a name of the *riroriro*. Another Native says it was a bird similar in size and appearance to the *riroriro*, but not the same ; that it was a forest bird, but is no longer seen.

Ruru (*Ninox novæ-zealandiæ;* Morepork).—This well-known bird is sometimes known as *koukou* and *peho*. As Mihi-ki-te-kapua of old sang, when left lonely in her old age at Wai-kare Moana,—

E peho, e te ruru, he tokorua ano
Tena ko au nei, he kotahi.

If a *ruru* is heard to utter its cry at a junction of two tracks it is looked upon as a sign that a hostile party is approaching—a war-party is at hand—look out for squalls. As old Pio put it, "I begin another subject—the warning given by the *ruru* when danger is nigh. If a war-party approaches a hamlet, this bird gives warning of its coming. It calls out to the people of the place in this way: '*Kou, kou! Whero, whero, whero!*' Then the people arise and fly to the forest. The enemy assaults an empty place." So much for the wise owl.

A Native states that the morepork has four different calls, and that if a person imitates the bird's cry it will answer him. Its first cry is "*Kou, kou!*" hence the bird is in some places termed *koukou*—an example of onomatopœia. The next cry is "*E—e—e!*" which is *he tangi aroha ki te tangata*—a kindly greeting to man. Another cry is "*Whe, whe, whe!*" and then "*Peho, peho!*" which latter is thought to betoken anger. Pio, of Awa, says that the bird will answer a mimic call three or four times: "*Ko te ruru, tana korero, kou, kou! Ka utua e te tangata, ka tahi pona, kou, kou! Ka rua pona, kou, kou! Ka toru pona, ka whakarere. Ka wha pona ranei, ka whakarere.*"

These birds were, and are still, eaten by Natives. They are simply knocked down with a stick, or snared by means of a slip-noose on the end of a stick. The fowler takes a leaf between the thumb and one finger of his left hand, and twirls it in order to attract the attention of the bird as he slips the noose over its head.

Native children will cook and eat a morepork, or any other bird, wherever they happen to kill one.

I have a friendly *ruru* at my camp here, beneath the frowning defences of the old Hau-kapua *pa*. On cold winter mornings, when the frost is keen, this bird comes forth from the bush as soon as the sun rises, and perches himself upon my garden-fence, where, with closed eyes, he suns himself for an hour or more. Though very close to the camp he does not get alarmed, knowing by experience that he will not be molested.

In only one case have I heard of a *ruru* being looked upon as the form of incarnation of an *atua maori*. Karukaru, an *atua* or demon of the Natives of the Whanganui River, was brought to this district some years ago (*i.e.*, his cult was so brought, I presume). The *aria* of Karukaru is a *ruru*. This was the familiar demon of Matoru, a would-be shaman of these parts, whose nose was put out of joint by Rua the *keka*. This demon, Karukaru, guards his human mediums from danger, warns them when any one is attempting to bewitch them, &c. One evening old Paitini returned to his home at Heipipi and found a *ruru* perched under the porch of his cabin. The bird was startled and flew away to an open shed, where it perched itself upon a buggy that old Pai had bought. The old man at once suspected something was wrong. A most superstitious man, your elderly Maori. He suspected the poor *ruru* to be the worthy Matoru's demon, sent for no good purpose. He went to the shaman and made inquiries. Matoru told him that he had sent his familiar demon to take possession of the buggy, which was henceforward to be the property of the dread Karukaru. Pai was also told that if he did not quietly give up possession of the buggy, then both he and his wife would die—that is, be slain by black magic. Hence this couple were much disturbed: they wished neither to die nor yet lose their buggy. At this juncture the godless *pakeha* stepped in, and, with incisive vocabulary and impious disregard for gods or demons, broke up the game.

Tarapo.—Williams gives this as a name of the *kakapo.* Akuhata te Kaha, of Tuhoe, says it was a forest bird, smaller than a *kakapo,* and no longer seen. Te Pou-whare states that *tarapo* was the name of the female *miromiro.*

Tataeto; syn., *Tataeko, Tataihore, Tatangaeko, Popokotea, Tatariheko* (*Certhiparus albicapillus;* Whitehead).—These birds are still seen in the Rua-tahuna district, though not numerous as of yore. I have come across flocks of them in remote places there—or, rather, they have come across me. They move in flocks, flitting quickly from tree to tree. Natives say that the *tieke* and *tihe* birds join flocks of whiteheads and accompany them; a few will be seen with each such flock. A flock of whiteheads will sometimes set on to a *ruru* and chase it about, even as the *koko* does.

A flock of whiteheads is termed a *ta tataeto* by Tuhoe and *taki tataeko* by Ngati-Awa. Ngati-Kahungunu, of Te Wairoa, call this bird *tatai-hore.*

Tieke (*Creadion carunculatus;* Saddleback).—This bird has entirely disappeared from the forests of this district, albeit there are here hundreds of thousands of acres of wild forest lands, within the shades of which man is but seldom seen. The Natives say that bees have destroyed the *tieke* by occupying the holes and hollow trees where the bird was wont to breed. This is absurd. Such holes and hollow trees are here by the million in this great forest, but bees' hives are scarcer than in any other part of the Island I have camped in. In the fair vale of Whare-kopae, Poverty Bay, I found nine hives within half a mile of my tent. To find one in the Tuhoean forest would need about a day's search.

When going a-hunting or fowling, if you hear the cry of a *tieke* on the right-hand side of the track it is a *marie,* or token of good luck—you will be successful; but if you hear it to the left, that is a *puhore,* or sign of non-success.

At Repanga, or Cuvier Isle, there are said to be two *tieke* birds, named Takereto and Mumuhau, which are *atua,* or supernatural beings. They are claimed by the migrants of both the "Matatua" and "Arawa" canoes.

In taking the *tieke*—for all forest birds were food for these bushmen—in some cases a fire was kindled. This is said to have attracted the birds.

Tihe (*Pogonornis cincta;* Stitch-bird).—The male bird is termed *tihe-wera.* Its plumage is described by Natives as being *whero manaeka* (? yellowish-red). The female is called *tihe-wai.* This bird disappeared years ago from the forests of this district. It was taken by means of the *puaka* snare-trap.

Titi.—This sea-bird was formerly found in large numbers on the rugged ranges of this district, where they had breeding-places to which they came every year. The Natives used to visit these places every year to take the birds, both young and old. These were preserved in fat in great numbers. They were placed in calabashes by the inland people, but those who had access to the coast used vessels made of a large species of seaweed or kelp. These latter vesssels were called *poha.* The advent of the Norway rat put an end to this food-supply, for they devoured the young birds; hence the *titi* ceased to come to these parts to breed.

Places where these birds were taken by fowlers are known as *ahi titi* (*titi* fires), because a fire was always kindled on such occasions. The tops of cliffs, hills, and ridges seem to have been selected as places whereat to take the *titi.* A net about 20 ft. or 30 ft. in length was set up on the edge of such cliff or slope. This net was fastened to poles or stakes inserted in the ground. Each pair of stakes was lashed together at the top. thus forming an inverted V—so Λ Where these two stakes crossed and were lashed was termed the *mata tauira.* The upper rope of the net was called the *tama-tane*, and the rope on the lower edge the *tama-wahine.* The net was made of flax-fibre. Old persons, past their hard-working days, spent much of their time in making nets, snares, &c. These birds were taken at night-time, about November. A fire was kindled in front of the net and a little distance from it. Behind the fire, and immediately below the net, the fowlers were seated, each having a short stick in his hand wherewith to strike down the witless birds. The birds, attracted by the fire, flew to it, and came into contact with the net. Ere a bird recovered from the shock it was struck down by the fowlers. A foggy or misty night was considered best for taking these birds. Two men only remained standing: their task was to strike down the high-flying birds that flew against the *mata tauira.* Should the first bird taken chance to fly against the *tama tane*, or *mata tauira*, that was looked upon as a sign of poor luck—but few birds would be taken that night; but should it strike low down the net, at or near the *tama wahine*, that was an excellent omen—many birds would be taken. If a menstruating woman chanced to be among the party of fowlers a very poor bag was the result—the birds would fly about, screeching loudly, but keep clear of the net. Also, the fowlers were careful not to cause any of the birds to bleed. If any blood were drawn, then no more birds would come near the fire.

Great numbers of these birds were taken by such means in former days, before the European rat appeared on the scene. The birds were plucked, cleaned, and the bones taken out; then they were prepared at the *ahi matiti* for potting.

A large number of places are pointed out here as former *ahi titi*, mostly on the higher ranges, as those of Huiarau, Maunga-pohatu, &c., and at Wai-kare Moana, O-tukopeka, Te Rua-ngarara, Taumata-miere, and countless other places.

Titiporangi.—The only note I have anent this bird is, "A forest bird, smaller than a *titi.* It has disappeared from this district. It was dark-coloured on one side and light-coloured on the other." This is the rendering of the original Maori. Williams gives *titiporangi* as a name of the black teal.

Tititipo.—This was given me as a bird-name, but more I cannot say.

Tititipounamu.—See Toirua.

Tiwaiwaka. Tiwakawaka.—See *Piwaiwaka.*

Toetoe.—Same as *kukurutoki.* (See latter.)

Toirua.—See under *Momotawai.*

Totorori.—See under *Riroriro.*

Totororire.—See under *Riroriro.*

Turi-whekoi-rangi.—A sea-bird.

Tuturiwhatu (*Ochthodromus obscurus*; Dotterel).—The name of this bird is connected with that of one of the sisters of Taukata—he who brought the knowledge of the *kumara* to Whakatane. The two brothers, Taukata and Hoaki, had two sisters, Kanioro and Tuturiwhatu. These were the children of Rongoatau, of Hawaiki, and descendants of Pani and Rongomaui. This Tuturiwhatu met with an accident and had her chest burnt. The bird of the same name is said to be her, or represent her. It has no place in this list, save the fact that it is sometimes seen on the river-beds of this district.

Weka (Wood-hen).—These birds are not numerous in this district, but are said to have been so formerly. In those days they were snared, and also hunted with dogs.

Whekau.—See *Hakoke*.

Weweia (*Podicipes rufipectus*; Little Grebe).—Natives state that a pair of these birds are always seen in a crateral pond on the summit of Mount Edgecumbe by those who ascend that isolated cone.

Whenakonako.—See under *Koekoea*.

Whio (*Hymenolæmus malacorhynchus*; Blue Mountain-duck).—One often sees these birds when traversing the rough streams of the high-lying interior, as at Rua-tahuna. These birds were taken at night, the fowlers carrying torches, which they flashed suddenly on the birds when near to them. This is said to cause the birds to settle, whereupon they are struck down and secured.

Whioi (*Anthus novæ-zealandiæ*).—Ground-lark.

The following is a list of the birds that have disappeared from the Tuhoe district, and several other species may be marked as doubtful, as the *kokako*, *piopio*, and others. It must be remembered that nearly the whole of this district is covered with dense forest, with few clearings, and that the Native population is small, and residing principally on the outskirts.

Hakuwai.	*Kea.*	*Moho-patatai.*
Hakoke, or *whekau.*	*Koitareke.*	*Moho-rangi.*
Kaha.	*Kotuku.*	*Momotawai.*
Kakapo.	*Moa.*	*Tieke.*
Kareke.	*Moho.*	*Tihe.*

Cutting out the *hakuwai* and *moa*, we have here a list of thirteen species that have disappeared from this district since the coming of Europeans to these isles, whilst some others have almost, if not quite, disappeared. The species that have survived have almost all become greatly reduced in numbers.

The *koroire* is said to have been a water-bird, a species of duck. Mr. C. E. Nelson tells me that he got the name from an old Native of Ngati-Whatua, who had seen it in his youth. It has not been seen for many years. This was the origin of the place-name O-koroire.

We will now endeavour to explain the Native theory or belief as to the cause of the disappearance of native birds—for they firmly believe that it is primarily due to certain ancient customs and faiths having been abandoned by themselves, the Maori people of these isles. They believe that the degeneration of the Maori, and the serious lessening of the Native population, have been brought about by their forsaking ancient customs and old-time cults—by their having become *noa*, or free from *tapu*—debased, in fact—through contact with Europeans. And they hold a very similar belief in regard to the cause of the disappearance of birds, or the lessening of their numbers.

The old-time Maori was, or believed himself to be, an extremely *tapu* person. His system was, as it were, imbued or permeated with a highly sacred, semi-volatile, and all-pervading non-material ichor, a spiritual and intellectual essence or ether. And it was this that preserved man from death or disaster of certain kinds. When speaking of a person's *hau* or *kawa ora*, it is this that is in the speaker's mind. It is the *mauri ora* of man. Even land possesses this quality, as we shall see anon. It is the very essence of vitality. If lost or debased in any way, the person, or tree, or forest, or land is in a truly bad way, and armourless against shafts of magic or other evil influences. Broadly speaking, the above state may be termed *tapu*; but there are many inner terms and definitions which cannot be understood by the *pakeha*.

Said Ngahooro te Amo, of Ngati-Mahanga, "Birds were exceedingly numerous in former times, before Europeans came. In the days of my youth, at Te Whaiti, when the multitude of birds were singing in the early morn, a person's voice could scarce be heard in the forest, so great was the noise. Birds were numerous so long as we cooked them in the ancient manner—that is, in a *hangi* (steam-oven); but when we began to cook them in the *kohua* (iron pots) obtained from Europeans, then it was that the evils of the *tawhanarua* came upon us. For it was unlucky and of evil omen. Then it was that birds began to decrease in numbers."

The word *tawhanarua* means "to cook a second time." When cooking birds, should they be found to be underdone when the oven was opened, then the proper thing to do was to use them in that state, and not attempt to recook them. If they were cooked again, then the birds of the adjacent forest would surely disappear. So sayeth the Maori.

Said Himiona Tikitu to the writer, "In olden times birds were always cooked in the evening. If cooked in the daytime, then all birds would desert the forest. They would be heard flying away in myriads in the night-time, migrating to other parts. The *tawhanarua* or *tao rua* (second cooking) would have the same effect, as also would the use of European cooking-vessels. Because the forest and its denizens became *tamaoatia* (defiled) by these things. Hence the birds would disappear, even as we Maori people did after we became *noa* (defiled, free of *tapu*) by washing in water heated in the cooking-vessels of the white men. But remember that the above restrictions only obtained during the busy part of the bird-taking season—that is, while the birds were being potted down for future use. When this labour was ended, then the above restrictions were removed."

In the above remarks we see how the life principle, the vitality, of man, birds, forest, and land were seriously affected and endangered by certain simple acts of omission or commission.

The scarcity of birds now so remarkable in this forest district became most marked about the middle eighties, though they had been gradually decreasing in numbers for many years before that time.

When forwarding my first contribution of these notes on forest-lore I remarked that the balance must lie over for another year. Alas for human hopes!—for there is still a balance, and a bulky one, I ween. Peradventure we may prepare that balance ere the sun again returns to Hinetakurua, the Winter Maiden, and send it forth as an *amonga* to the modern *whare takiura*, whose priests are the men of the linotype.

It was Kuha-tahi, the husbandman, who cried, "*Hoatu, hoatu! He ra tapahi.*"

ART. XXXIII.—*A Contribution to our Knowledge of the Physiological Action of Tutin.**

By FRANK FITCHETT, M.D. Edin.

[*Read before the Otago Institute, 10th November, 1908.*]

* Being a thesis presented to the University of Edinburgh, for which the degree of Doctor of Medicine was granted.

A. HISTORICAL.

I. GENERAL AND DESCRIPTIVE.

On the 20th May, 1773, at Queen Charlotte Sound, Captain Cook sent on shore a ewe and a ram which he had brought from the Cape of Good Hope with a view to stocking New Zealand with sheep. On the 22nd he "received the unpleasant intelligence that the ewe and ram which with so much care and trouble he had brought to this place were both of them found dead. It was supposed that they had eaten some poisonous plant, and by this accident all the Captain's hopes of stocking New Zealand with a breed of sheep were instantly blasted" (1). He tried again, however, with goats, but with little better result.

Cook's supposition that the flora of New Zealand includes a plant possessing highly toxic properties was well founded. That his ewe and ram shared the fate that has since been meted out to many thousands of sheep and cattle, and to not a few human beings, is in the highest degree probable.

The poisonous plant whose existence was suspected in 1773 has long since been identified as a *Coriaria*, and is known throughout the Dominion by its Maori name *tutu*, or, as Europeans often pronounce it, "toot."

The difficulties met with by Cook in his attempts to stock the country were again encountered by the early settlers. Large numbers of their flocks and herds were destroyed by eating the leaves and succulent young shoots of this attractive shrub, for it abounded everywhere, and grew most profusely where the soil, by its richness, offered an inducement to the pioneer to settle.

Animals hungry and in poor condition were particularly prone to succumb to the effects of the poison; and, as these conditions prevailed with most of the beasts landed from the ships, it will be understood how great an impediment to stocking the country this noxious plant proved. The very first issue of the *Lyttelton Times* (2) notices the death of three out of five cows that had just been landed—one fell over a cliff, and two others were poisoned by eating tutu. The newspaper, in warning settlers of the dangerous properties of the plant, says, "It is impossible to take too much care in landing cattle at this place. To beasts just out of a ship the tutu, of which there is abundance here, is certainly fatal."

The damage done to stock was enormous, as may be gathered from the following quotation from Dr. Lauder Lindsay's article "On the Toot Plant and Poison of New Zealand" (3): "In the course of a tour through the New Zealand provinces during the latter part of 1861 and earlier months of 1862 I was everywhere struck by the abundant evidences of devastation produced among flocks and herds from their feeding on the 'toot' plant, one of the most widely distributed and familiar indigenous shrubs of the country. One settler friend told me of his having lost by 'tooting' two hundred and fifty sheep; another, eighty to a hundred sheep of a flock of four hundred; a third, seven of sixteen bullocks; a fourth, six of twenty-four cattle; a fifth, twenty-four cattle; a sixth, six of eight cattle—each of these instances in a single night. Another flock-master lost four hundred sheep out of a flock of two thousand, twenty-five being frequently dead of a night. In other words, he seemed a fortunate farmer or runholder who had not lost more than 25 per cent., or one-fourth, of his stock from toot poisoning; while in some instances the losses were so high as 75 per cent., or three-fourths. Some of the colonists had suffered so severely from losses of bullocks by toot poisoning that they were at the trouble and expense of attaching a boy to each of their bullock-teams, solely for the purpose of preventing their animals feeding on this pest of the colony. Such incidents I found were of daily occurrence. I met few settlers who had not at some period had occasion from this cause to mourn the loss of sheep or bullocks—the former sometimes by the hundred, the latter by the dozen." These remarks of Lindsay serve well to illustrate the deadly nature of the plant, and the embarrassment it offered to the pioneers of the country. They also point to the importance and great desirability of an investigation of the physiological action of the poison being made, in order that the treatment of its effects may be conducted on rational lines, and as the first step towards the discovery of an appropriate antidote.

But while sheep and cattle have been the chief victims, human beings have not proved exempt, and he was a lucky farmer who lost only his cows or his sheep. Too often one of his children succumbed to the effects of eating the berries or young shoots. Nor is this strange, for the shrub in full fruit is a very striking and attractive object. The numerous racemes of richly coloured, tempting-looking berries — at a glance not unlike black currants—could hardly be overlooked or neglected by the child or thirsty traveller ignorant of their dangerous properties.

Numerous cases of poisoning must have occurred, but the recorded deaths from this cause are not many. The following are all that occur in the literature that has been laid under contribution: 1. Thomson (4), in 1859, mentions that up till that date several children had died from eating the berries. 2. Lauder Lindsay (3) mentions the case of twelve French sailors who were poisoned by eating the berry; four of them died. 3. The *Otago Colonist* (5) records the death of one of two children in 1861 who had eaten the shoots. 4. The *Otago Daily Times* notices the death of a young man in 1862 from eating the shoots (6). 5. Easterfield and Aston (7) put on record the following cases: A girl in 1854 55, from eating the berries; a boy in 1860, from eating the berries; two cases from eating the berries—one died, the other recovered, with impaired memory.

For the purposes of this paper the writer asked of the Registrar-General a return of all cases of death from tutu poisoning that occur in the records. In his reply the Registrar-General stated that he was unable to make a return, as cases of this kind are classed in the vital statistics under the general heading "Accidental Poisoning." He had had the statistical tables relating to inquests examined for thirty years back, and found that only four deaths occurred from eating poisonous berries, one in each of the years 1889, 1891, 1896, and 1902. It is probable that the berry in each of these cases was the tutu-berry, but in only one case—that of 1889—was it stated to be so.

Effect of the Plant on Animals.

Horses.—Statements vary as to the effect on horses. It is said that they have been known to eat freely of the plant without injury (8), and, again, that *C. thymifolia* is highly poisonous to them (9). They are said to refuse the young shoots, but have been known to eat the berries (3). If they escape, it is probably because they do not eat enough of the plant; that they eat freely without evil result is not credible.

Birds are regarded as immune. They certainly eat freely of the berries without ill effect. The question of their immunity will be considered later.

Rabbits are said to be immune (10), (11), and certainly the tutu does not seem to have checked their increase. They probably do not eat the plant.

Elephants.—Sir Julius von Haast (12) records the death of an elephant from tutu-poisoning. The animal was marched inland by its owner for a considerable distance, and on arriving at a suitable halting-place, where the vegetation was abundant, was allowed to feed. The grass had been burnt off during the previous season, and had shot up again, together with a large crop of tutu-shoots. The elephant fed for four hours, and then drank freely from a neighbouring stream. It then began to reel, fell on the ground, and died in three hours.

Sheep and Cattle.—The following extract from a letter received from the manager of a large sheep-station gives an excellent account of the effects of tutu upon sheep: "The effect on sheep is that they will stand still, trembling as if palsied, froth at the mouth, with their jaws going continually, and their teeth grinding. Suddenly they will fall over, with their limbs rigid, as if suffering from strychnine poisoning. If assisted on to their legs they are absolutely mad, and will rush against a fence or over a precipice, and will pay no attention to man, or dog, or animals of their own kind. With animals that have eaten less of the plant, symptoms do not appear unless they are disturbed, and then the effect is shown with terrible suddenness; a bark from a dog or a sudden run for a few yards will be almost certain to start the poison to work. In cases like the above, however, the affected sheep generally recover if left alone." In their wild career they often injure themselves against obstacles, or rush into creeks and are drowned. More frequently they die in convulsions.

Cattle are similarly affected, but the wild delirium is even more marked in their case. Popularly they are said to go mad; and the wild way in which they wheel round and round, gallop aimlessly about, kicking, charging, and rushing blindly against rocks and other obstacles, lends colour to the popular opinion. The wild career continues until the animal, overcome by exhaustion, falls to the ground, becomes comatose, and dies in convulsions.

In the light of this account, the symptoms displayed by one of Captain Cook's animals is interesting: "The ram was taken with fits, bordering on madness. . . . One night he was seized with one of these fits and ran headlong into the sea, but soon came out again, and seemed quite easy. Presently after he was seized with another fit, and ran along the beach . . . and was never seen more" (13).

Animals are frequently found distended with gas, "blown" after death. This is probably due to rapid fermentation of the leaves ingested, and is similar to the condition met with in cattle after eating freely of clover. As with clover, it is more pronounced when the tutu is eaten wet.

Effect on Human Beings.

The symptoms of poisoning by the plant in the human subject include vomiting, giddiness, delirium, great excitement, stupor, coma, and convulsions.

In a fatal case reported in the *Otago Colonist* of the 25th October, 1861, the physician who attended the case stated in his evidence at the inquest that he found the child perfectly pale, with teeth clenched. The breathing was difficult, the lips livid, and the pupils much dilated. For about five minutes the rigidity went off, and the pupils contracted; but a relapse occurred, the teeth were set again, and the child gradually sank back, "without any symptom of convulsion or suffering." In this case it was the young shoots that had been eaten. The jury appended the following rider to their verdict: "The jury would recommend the Provincial Government to keep up a standing advertisement in the public prints warning persons of the poisonous nature of the tutu plant, the young sprouts as well as the berries, and also giving descriptions of the same" (5).

Lauder Lindsay (3) records several cases that had been reported to him. In one case about half a pint of berries were eaten shortly after the evening meal. No effect was produced until 6 o'clock next morning, when, on attempting to rise as usual, the subject suddenly lost consciousness till 11 a.m. He was then conscious for a minute or two, but almost immediately relapsed into stupor, which continued for about twenty-four hours. When he came to himself he had lost his memory, and for half a day was unable to say where he was, or what he had been doing for the previous forty-eight hours. He gradually recovered, and there were no subsequent bad effects. Throughout the illness he had had no pain.

In another case two young men partook of some tutu-berries, about 4 p.m. One swallowed the berries, the other sucked them but spat out the seeds. The latter was unaffected, but the former was seized with convulsions about 9 p.m. The convulsions continued for about forty minutes, and then the patient gradually passed into a state of coma, which continued all next day. On recovering consciousness he was utterly oblivious of the particulars of his illness, and denied having eaten the berries. He was drowsy for a few days, but gradually recovered.

In a third case, retching, vomiting, and convulsions were the prominent symptoms. This case did not recover completely. A mental change, which was permanent, remained after the acute symptoms had subsided.

In a fourth case, in which particulars were given by Dr. Stewart, of Tuapeka Hospital, insomnia was one of the earliest symptoms. This was followed by tonic and clonic spasms, with coma, lasting for two days. During recovery, entire loss of memory was observed. The patients—there were two—did not know where they were, why they had been brought to hospital, or what their occupation was. They did not recollect having eaten tutu.

In a case noted by Dr. Hocken, the symptoms included tonic and clonic spasms lasting two days, coma, and loss of memory.

Considering the highly toxic nature of the plant, it is surprising that so few deaths from poisoning are on record. In the early days probably many fatal cases occurred of which no record was made. Nowadays cases of poisoning are rare. This may possibly be accounted for by the very distinctive appearance of the plant and the widespread knowledge of its poisonous nature. No one who has once seen tutu is likely to mistake it for anything else, and every school-child knows that "toot" is poisonous. Moreover, near the large centres of population the plant is not often now met with in places readily accessible to young children.

Among flocks and herds the mortality has also fallen, not because, as is sometimes supposed, the animals have acquired immunity or tolerance, but because in the more highly cultivated districts tutu has been largely exterminated. Sheep and cattle when moved from place to place are now sent by rail rather than driven. This alone has considerably reduced the mortality, for driven animals are particularly prone to suffer, and tutu is the commonest roadside plant in many districts.

The farmer, too, taught by experience, has become learned in the ways of managing his stock in relation to tutu. He takes care to avoid "toot" country in the early spring, when the too tempting and especially toxic young sprouts are appearing. If sheep are to be turned out where tutu abounds they are first fed freely on English grass, for a well-fed sheep only nibbles tutu as he happens to meet it, and escapes; while a hungry sheep, finding it difficult to resist so ready a means of appeasing its appetite, fills its stomach, and succumbs. Indeed, it is a constant observation of farmers that tutu introduced into an empty stomach is more lethal than when taken into a stomach that already contains food. Cross-breds are said to be less readily affected than the more active and restless merino, and are therefore selected for distribution to tutu-infested areas.

But, in spite of these precautions, accidents, through the ignorance of a shepherd, or the chance of an open gate, occasionally happen, and a heavy loss is experienced, as witness the following instance reported in 1905: "A settler left sixty bullocks about four years old in a field of swedes. In his absence they escaped from the paddock into a gully full of tutu (*C. ruscifolia*), where, on his return, he found forty-three of them dead. Mr. Clayton found the rumen packed with tutu leaves and branchlets" (14).

2. BOTANY.

The tutu plant belongs to the natural order *Coriarieæ*, a small order of very doubtful relationship possessing but a single genus, *Coriaria*. The genus includes some eight or ten species, and has a rather remarkable distribution, species being met with in south Europe, South America, China, Japan, north Africa, India (Himalayas), and New Zealand.

The European species, *C. myrtifolia*, is well known to possess toxic properties. Its leaves have been used to adulterate senna with fatal effect, and numbers of cases of death are recorded from eating the berries. In 1862 several persons were said to be poisoned by eating snails that had been fattened on its leaves and young shoots (15). The symptoms of poisoning include vomiting and convulsions, and, on the whole, closely resemble those of tutu poisoning. In 1863 Riban (15) investigated the chemistry of this species, and separated a glucoside which he named "coriamyrtin." The physiological properties of this compound will be referred to later.

The Himalayan species, *C. nepalensis*, is stated to be non-toxic, but, as the same has been said both of tutu and of *C. myrtifolia*, the statement must be accepted with reserve. The fruit is said to be eaten with impunity.

The American species, *C. thymifolia*, and the New Zealand species are said to be identical, and this statement has been used to prove a former land-connection between the two countries. It is more likely, however, that the order is a very ancient one, which has died out everywhere except in those places in which it is now found (8). Moreover, the identity of the two has been questioned.

The species met with in New Zealand are given by Cheeseman (16) as three in number—(1) *C. ruscifolia*, (2) *C. thymifolia*, (3) *C. angustissima*. The first is known locally as the "tree-toot," the second as the "ground-toot," and to both the name "tutu" applies. The Maoris have no name for *C. angustissima*.

There seems to be some division of opinion as to whether these three really constitute separate naturally distinct species, or whether the two last are merely varieties of the first. Lauder Lindsay, who in 1868 described, though with hesitation, four species—(1) *C. arborea*, (2) *C. tutu*, (3) *C. thymifolia*, (4) *C. angustissima*—says, "If only typical species be examined the student will have little difficulty in accepting the foregoing as good species well distinguished from each other by habit, but if he extend his observations to . . . forms in the living state over wide areas, he will not fail to find them connected by transition states which he will frequently be puzzled to refer to one book species rather than another, partaking as they do of the characters of two or more of these species" (17): and he suggests that it might be preferable to regard them as mere forms of a most variable single type.

Cheeseman says of *C. thymifolia* that in its ordinary state it is distinct enough, but that the large-leaved forms pass directly into *C. ruscifolia*, and narrow-leaved varieties into *C. angustissima* (16).

G. M. Thomson (18) regards *C. angustissima* as a mere altitudinal variety of *C. thymifolia*.

The botanical characters of *C. ruscifolia*, as given by Cheeseman, are: "A shrub or small tree with spreading 4-angled branches, very variable in height and degree of robustness, sometimes attaining 25 ft. with a trunk 10 in. diameter, at others not more than 2–4 ft., with almost herbaceous stems. Leaves 1–3 in., ovate or oblong-ovate, acute or acuminate, rounded or cordate at the base, sessile or very shortly petioled, 3–5-nerved. Racemes drooping, many-flowered, 4–12 in. long or more, slightly pubescent. Pedicels slender, $\frac{1}{4}$–$\frac{1}{2}$ in., bracteolate at the base. Flowers small, green, $\frac{1}{8}$–$\frac{1}{6}$ in. diameter, strongly proterogynous. Sepals broadly ovate, subacute. Filaments elongating after fertilisation. Fruit globose, purplish-black, of 5–8 cocci, enveloped by the persistent enlarged juicy petals" (16).

The herbaceous-stemmed shrub form of this is the more common. It takes this form in the open country and where the soil is dry. The roots creep and interlace below the surface, and in the spring stems shoot up from every part of the root, sometimes forming an almost impenetrable jungle. The stems may grow 10 ft. to 15 ft. in a single season. The tree form often grows solitary in the bush that lines the banks of streams. Shelter and moisture seem necessary to the attainment of this form.

C. ruscifolia occurs abundantly in all three islands of New Zealand, the Kermadec Islands, and the Chatham Islands, and is met with from sea-level to a height of 3,500 ft. *C. thymifolia* occurs only in the North and South Islands of New Zealand; and *C. angustissima* is still more restricted in its distribution, occurring only in subalpine localities in the Provinces of Otago and Canterbury. These two species differ from the former chiefly in the size of the plant and of the leaves, and in their annual habit. All three forms are met with in abundance in the immediate neighbourhood of Dunedin. The tree form of *C. ruscifolia* may be found in the bush that lines the banks of the Water of Leith and its tributaries; while *C. thymifolia* and *C. angustissima* are plentiful on the hills that encircle the town.

All parts of the plant are poisonous, but the young shoots are more toxic than the leaves and fruit. The same has been noted of *C. myrtifolia* (15).

In the case of human beings it is usually the so-called berry that is eaten, though the shoots too are sometimes eaten by children. Of the berry, only the seed is poisonous. The strained juice is harmless, and from it the Maoris and early settlers made a non-intoxicating wine that was drunk in large quantities (19). Indeed, in the very early days the tutu was known as the wine-berry shrub. This wine, however, has not always proved to be above suspicion. Canon Stack (20) relates that on one occasion after partaking of some tutu-wine he was seized with alarming symptoms; he lost all feeling in his extremities, a mist came over everything, and he thought that he was poisoned. The symptoms soon passed off, however, and he was none the worse.

Cattle and sheep are especially fond of the young, tender, asparagus-like shoots, but they also eat the leaves and branchlets with readiness.

3. Work of Previous Observers.

When one considers the harmful influence that this noxious plant has had upon the development of the country, it is remarkable that until recent years little effort was made to determine the nature of the poison.

In 1869 Skey (21) investigated the chemistry of *C. ruscifolia.* He showed that the poisonous principle is not an alkaloid, as was commonly thought, and with ether extracted from the seeds a green-coloured oil, 5 minims of which when given to a cat quickly produced the symptoms characteristic of tutu poisoning. Its highly toxic nature, together with certain peculiar chemical properties possessed by it, inclined him to the opinion that this oil was the active principle.

A year later, 1870, Hughes (10) attempted to separate an alkaloid, using the ground-shoots, and did indeed succeed in obtaining a crystalline substance, but failed to identify it. He thought that a heavy olive-coloured oily fluid which he also obtained and proved to be toxic might be the active principle and "a liquid alkaloid similar to conia." He showed that lime destroyed the activity of the poison, and advocated its use as an antidote. In conjunction with Dr. Acheson, he conducted a series of experiments on cats and dogs, but more with the object of proving the toxicity of his extracts, and of determining the value of lime as an antidote, than with any idea of advancing our knowledge of the physiological action of the poison.

Hughes's results were adversely criticized by Skey (22), who held that the temperature used in Hughes's experiments was such as must have produced many side-products by destructive distillation, and among others acetate of ammonia, the presence of which, he thought, would sufficiently account for the reactions attributed by Hughes to the presence of an alkaloid.

Twenty years elapsed before any further investigation was undertaken, and then, in 1890, W. L. Christie (11) examined the physiological action of the oil that had first been extracted by Skey. He made a series of experiments on mammals, including one upon himself, and briefly summarised the conclusions he arrived at as follows: "(1) That tutu acts on the nerve-centres after absorption into the blood; (2) that the grey matter of the motor cortex is the part chiefly affected, and that this peripheral action (*sic*) causes epileptiform convulsions; (3) that vomiting is chiefly due to central causes, and that by its means, and perhaps by the renal secretion, the poison is removed from the body; and, lastly, (4) that dyspnœa is due to poisoning of the respiratory centres, and when death ensues it is due to asphyxia from this cause or tetanus of the respiratory muscles—both may however, I believe, occur from coma."

The chief interest in Christie's work, however, lies in the experiment upon himself. He took, in all, 9 grains of an extract made from the leaves gathered in the spring. He calculates that each grain of extract represents 100 grains of leaf; but, in the absence of data regarding the amount of tutin in tutu-leaves at different times of the year, and of details as to the exact method of making the extract. it is impossible to calculate what dose of tutin was taken in this case. The first dose ($4\frac{1}{2}$ grains) was taken at 2.20 on Friday afternoon, and a second dose of the same amount at 4 p.m. An hour or two later he felt sick and faint, and began to vomit. The vomiting occurred at frequent intervals, and continued for twenty-four hours. At 8 p.m. he felt slight twitches in the legs and arms; and at 10.40 p.m. the medical student who was acting as clerk of the case noted that "all the muscles seemed to get tight, and there was foaming at the mouth." At 10.50 the pulse-rate was 102 and the breathing heavy. Twenty minutes later the pulse was still 102, but the breathing was normal, and there was profuse perspiration. At 11.24 p.m. the clerk noted that "the subject spoke in a collected manner; getting right, but drowsy." The vomiting continued till 8 p.m. on Saturday. The following day (Sunday) he felt sick and dull, but, though shaky, managed to attend to his duties. He states that sensation was dulled and spirits below par for seven or eight days. For a month he was not in good tone, and then for the first time he felt a sensation of "pins and needles" in his fingers and toes, and felt the floor of his bedroom woolly when he rose in the morning. He could feel accurately with his fingers, but experienced a heavy, stiff, numb sensation when he used them, and this symptom lasted a month.

4. The Active Principle.

The first substantial advance in the investigation of the chemical properties of tutu was made in 1900, when Easterfield and Aston (23) succeeded in isolating a crystalline glucoside, to which they gave the name "tutin." All three species of *Coriaria* were experimented upon, and crystals of tutin were obtained from each. The young shoots were found to yield a greater quantity (0·03 per cent.) than either the berries or the leaves.

Preparation: In the case of *C. ruscifolia*, "the fresh young shoots were finely divided, the juice expressed, filtered, and evaporated to a syrup nearly neutralised by carbonate of soda and shaken up with ether. The ether on evaporation deposited crystals of tutin. These were recrystallized from alcohol until the melting-point was constant."

Properties: Tutin is described as a colourless, odourless, intensely bitter compound, which separates from alcohol in oblique-ended prisms, and from hot concentrated solutions in water in characteristic acicular forms. It is perceptibly volatile, sublimes readily at 120° to 130° C., and melts at 208° to 209° C. (uncorrected). It contains no nitrogen, and reduces Fehling solution after inversion by acid. The compound is therefore to be considered a glucoside, but the hydrolyzed substance yields with phenylhydrazine an amorphous precipitate which is not phenylglucosazone. Examination by Zeissl's method for methoxyl groups gave negative results. Strong sulphuric acid added to a few drops of a saturated aqueous solution of tutin gives a blood-red coloration.

Solubility: 100 grams water at 10° C. dissolve 1·9 grams tutin; 100 grams ether at 10° C. dissolve 1·5 grams tutin; 100 grams alcohol at 10° C. dissolve 8·2 grams tutin. It is very soluble in acetone, sparingly soluble in chloroform, and soluble in benzine and carbon-disulphide.

The optical activity has been determined by Marshall. The substance is dextrorotatory, and the specific rotatory power is + 9·25°. Easterfield and Aston found that when solutions of tutin were evaporated to dryness with slaked lime the tutin underwent decomposition, and could not be recovered. This fact recalls Hughes's statement that lime destroyed the activity of the tutu poison.

The close relationship of the New Zealand tutu to the European *C. myrtifolia*, together with the fact that Lauder Lindsay (17) and others have thought it probable that the active principle of tutu is coriamyrtin, lends interest to the following table of differences existing between the two bodies, as given by Easterfield and Aston (23):—

	Coriamyrtin.	Tutin.
Melting-point	220° C. (according to Merck, 229° C.)	208° C.
Carbon	64·1 per cent.	60·7 per cent.
Hydrogen	6·6 per cent.	5·8 per cent.
With hydriodic acid and potash	Gives fuchsia-red colour	Gives nil.
Solubility in 100 parts of water	1·44 at 22° C.	1·9 at 10° C.
Effect on pupil	Contracts it	Dilates it.

It may be said here, and will be shown later, that tutin has little, if any, action on the pupil when applied locally.

The physiological activity of the new compound was put to the test by Mr. Gilruth (23), then Chief Government Veterinarian in New Zealand. He administered to a pig weighing 17 kilograms, 0·129 grams of tutin, dissolved in water and mixed with half a pound of pollard. In half an hour uneasiness and spasmodic movements of the jaws were observed; then the breathing was noticed to be accelerated, and vomiting occurred. The symptoms gradually increased in severity, until the animal was seized with tetanic convulsions. The convulsions were at first separated by intervals of about fifteen minutes, but they gradually increased in severity and frequency until they became almost continuous. Each convulsive seizure, after beginning with a tonic spasm that lasted half a minute, was accompanied by screaming and stertorous breathing. Finally the animal died in a convulsion five hours after the poison had been administered.

Further experiments on cats testified to the marked toxicity of the compound—*e.g.*, a dose of 0·01 gram killed a kitten weighing 1 kilogram in forty minutes: 0·001 gram administered to a cat weighing 2 kilograms caused a fit in three hours and illness for the next twenty-four hours. The same cat was afterwards killed by a dose of 0·003 gram. A dose of about a milligram caused nausea, vomiting, and incapacity for work for twenty-four hours in a full-grown, healthy man.

B. ORIGINAL WORK.

(For full details of the experiments, see Protocols.)

1. GENERAL ACTION OF TUTIN ON MAMMALS.

(*a*.) *Action on Cats.*

The effect of various doses upon cats will be shown first.

Effects of a large dose: 9·8 mlgm. tutin (3 mlgm. per kilo body-weight) were injected under the skin of a full-grown female cat, weighing 3·28 kilograms (Exp. 1). The animal was placed in a hutch, and watched continuously. Four minutes after the injection it was noticed that respiration was very rapid (48 to the quarter-minute). The animal seemed sleepy and dazed, and curled itself down as if to sleep, but at once raised its head, opened its mouth, and panted for breath, like a dog on a hot day. It moved its head slowly from side to side in a dazed, stupid way. Seven minutes after the injection, thick, ropy saliva began to pour from the open mouth, the respirations were even more rapid, and were now audible, almost stertorous, and the whole body was shaken with the force of the respiratory effort. The pupils at this stage were moderate. Ten minutes after the injection the animal got up and began to walk cautiously about the hutch, picking its way like a cat crossing a muddy street. Half a minute later it was suddenly seized with a violent convulsion, which in every respect resembled a typical epileptic fit. The animal fell on its side, and all the muscles of the body were thrown into intense tonic spasm. The head was bent firmly backwards, the back hollowed, the fore and hind limbs rigidly extended, the digits widely separated, the claws extruded. The hairs of the tail became erect, urine and fæces were shot out with considerable violence, the pupils were widely dilated, respiration entirely ceased, and the nose became cyanosed. This tonic spasm lasted thirty seconds, and was followed by clonic spasms affecting the neck, jaw, limbs, and respiratory muscles, which lasted twenty-five seconds more. As the fit passed off, the pupils contracted, the respirations became deeper and slower, and the nose recovered its normal appearance. An interval of five seconds was followed by another fit like the first, but the tonic stage did not last so long, and the clonic spasms were more marked. Fit succeeded fit in rapid succession. There were no voluntary cries, but the violence of each seizure caused a choking noise as the air was driven through the glottis. Between the fits the pupils always contracted, and they began to dilate just before each convulsion occurred; during the fit they were dilated to the widest possible extent. This alternation happened so invariably that a commencing dilatation of the pupil could be taken as an indication that a convulsion was imminent. As the animal became exhausted the fits diminished in severity and frequency, the respirations became irregular, infrequent, and gasping, and finally death occurred thirty-one minutes after the injection. From the first the animal gave no indication that it suffered any pain, and from the onset of the convulsions it was unconscious, without either ear or conjunctival reflex. The temperature at death taken in the rectum was 102·4° Fahr. On *post mortem* examination the right horn of the uterus was found to contain a nearly full-sized fœtus, which looked as if it had also been affected with convulsions; one hind leg was twisted over the other, the right forepaw was behind the right ear, and the claws were extruded. Beyond some small hæmorrhages in the lungs and a marked congestion of the brain and cord there was nothing noteworthy.

In the next experiment (Exp. 2) the dose was reduced to 2 mlgm. per kilo body-weight, 7 mlgm. of tutin being injected under the skin of a cat weighing 3·5 kilograms. The first symptom noticed (ten minutes after the injection) was trembling of the head and fore part of the body. This was followed, fourteen minutes after the injection, by rapid breathing (56 to the quarter-minute) and by salivation. At twenty-one minutes, slight twitching of the eyelids and ears was noticed. At twenty-four minutes the animal defæcated, discharging a large quantity of fæces. At twenty-five minutes the twitching, which had been gradually getting more marked and more extensive, was severe. At each attack the pupils dilated, but returned to the normal size when the twitching ceased. The respirations were irregular, exaggerated, and suggestive of the Cheyne-Stokes type.

At twenty-nine minutes the animal was seized with a general convulsion, the tonic stage lasting thirty seconds. From this point the convulsive movements continued almost without intermission until the end. The clonic spasms were the more in evidence, but every now and then a tonic seizure would arrest the movements for a few seconds. Gradually the movements became more and more feeble, the respiration slow, irregular, and gasping, and finally the animal died in a tonic spasm fifty-one minutes after the injection had been given. In this case the symptoms appeared more gradually, and the cerebrum seemed less affected than in the first cat. The animal was less dazed and stupid, and frequently "miaued" in a plaintive way, especially after the twitching began. The twitching was a marked feature; it began in a small way, affecting only the eyelids and ears, but the attacks increased in frequency and in severity, and gradually more and more muscles became involved. In the earlier stages, when only the face and neck muscles were affected, the cat at each attack presented the appearance it might have done had it been held and a rapid series of electric sparks discharged close to its face. Later, when the muscles of the shoulders and fore legs were involved, the twitching caused little springs into the air and down again with the fore part of the body, suggesting the appearance of a puppy pouncing at play. When the twitching had got the length of involving the shoulders, it very soon took the form of a general convulsion, and in this case, once convulsions had set in, the symptoms which followed were much the same as seen in the first cat.

In the next experiment (Exp. 3) the dose was considerably reduced, 1·7 mlgm. being injected under the skin of a cat weighing 2·394 kilograms. This is equivalent to 0·75 mlgm. per kilo body-weight. Nothing was noticed for half an hour, and in that time the cat looked quite normal. It then began to swallow rather frequently, as if swallowing saliva, and then suddenly got up and defaecated. It then began to breathe rapidly, saliva could be seen dripping from the mouth, and it vomited. It again attempted to empty the bowels, and now looked miserable, and kept up a constant complaint, though if spoken to it would come forward and purr. Twitching of the face did not appear till thirty-five minutes after the injection, and the first convulsion occurred at forty-one minutes. It lay on its side for a few minutes after the convulsion, and then got up and walked about the cage. Its condition now was much improved on what it was before the convulsion occurred. The breathing was easy, salivation seemed to have ceased, and the twitching which had so annoyed and alarmed the animal was not noticed; but the improvement was not for long. In about a quarter of an hour it began to breathe quickly again, and the twitching returned, and gradually got more and more severe till it culminated in a general convulsion at seventy minutes after the injection. This was a most severe tonic spasm, which lasted four minutes and a half by the watch, and during that time the animal was not seen or heard to draw a breath. From this onwards convulsions continued with intervals of only a few seconds till death occurred, one hour and forty-nine minutes after the injection. In this cat the cerebrum seemed less affected than was the case with the other two. It continued alive to its surroundings almost to the end, and "miaued" voluntarily five minutes before death. It never rose after the second seizure, though it once or twice attempted to do so, and was thrown down by a convulsion. In the intervals between the attacks, running or swimming movements were noticed.

In the next animal experimented upon (Exp. 4) the dose was reduced to 0·375 mlgm. per kilo of body-weight, 1 mlgm. of tutin being injected under the skin of a cat weighing 2·688 kilograms, and, curiously, symptoms made their appearance earlier in this case than in the last. It defæcated and began to breathe quickly within twelve minutes of the injection; salivation was noticed at fourteen minutes, and at twenty-four minutes it was panting with its mouth open, and vomited. Twitching appeared at thirty-two minutes, and the first convulsion occurred at fifty-five minutes. Convulsions were severe and frequently repeated, and it was thought that the cat would die. It had a severe convulsion at 6.5 p.m., and it was not seen again till 7.15 p.m. It then appeared rather tremulous, and was easily startled, but presented no further symptoms, and was quite well next day. It would seem that 0·375 mlgm. per kilo is very near the minimum lethal dose.

In the last three cats the constant symptoms were defæcation, rapid breathing, salivation, twitching, and general convulsions, and these generally made their appearance in the order named. The first cat did not defæcate voluntarily, and neither of the first two vomited. The vomiting in the last two occurred only once in each case. In the first convulsion in each case the tonic stage was the more pronounced, and was invariably of the opisthotonic type. Later, clonic spasms were more in evidence, and with lethal doses, when the case was making towards a termination, movement was hardly absent for a moment. With the larger doses the effect upon the mental activities of the animals was very marked. From the first they seemed dazed, and once general convulsions had set in they were oblivious of everything. With the smaller doses the cerebrum was little affected, and often after the most severe and prolonged convulsions, in the case of the cat that recovered, the animal would rise and behave as if little had happened, answering when spoken to, and even purring.

(*b.*) *Action on Rabbits.*

Rabbits are less readily affected by the poison. The largest hypodermic dose recovered from was 2 mlgm. per kilo (Exp. 5), (in a cat, 0·75 mlgm. per kilo proved fatal). A dose of 2·5 mlgm. per kilo was fatal in two hours and a half (Exp. 6), and doses larger than this killed rather rapidly (Exps. 7, 139). By oral administration a much larger dose than this is required to kill—*e.g.*, in Exp. 8, 7·5 mlgm. per kilo proved fatal in two hours; in Exp. 9, 6 mlgm. per kilo was fatal in twelve hours: while in Exp. 10, 5 mlgm. per kilo was recovered from. In one case (Exp. 161) death preceded by typical symptoms followed the instillation of four drops of a 0·5-per-cent. solution into the conjunctival sac.

Attempts to poison rabbits with fresh tutu-leaves failed, for the animals, though deprived of all other food for several days, steadfastly refused to eat.

Symptoms.—No important symptoms appear that have not been mentioned as occurring in cats. After a lethal dose the animal at first appears dazed, tends to assume unnatural attitudes—*e.g.*, lies on the abdomen, with the legs projecting in front and behind—and the gait is altered. Respiration soon becomes very rapid, and there may be salivation, though it is not so marked a symptom as it is in cats. Alteration in the size of the pupil is not so noticeable. Twitching of the eyelids, lips, ears, and fore-paws occurs, and is followed by general convulsions. In the convulsion the tonic spasms are not so evident as they are in cats, but they do occur, and are of the opisthotonic type. As a rule, after the first violent convulsive movements are over, the animal continues lying on its side, and shows almost constant movement, either clonic spasms or running-movements, chiefly of the fore paws, until exhausted. Urination occurs during the convulsions, but, of course, vomiting was not observed. The animal utters no cry, and indicates in no way that it suffers pain. In the later stages it is comatose, and usually dies from exhaustion.

(c.) *Action on Guinea-pigs.*

No series of experiments was made to determine the minimum lethal dose in these animals, but it would appear to be rather smaller than in rabbits. A dose of 2 mlgm. per kilo caused symptoms in thirty minutes and death in seventy minutes in one case (Exp. 11), while a dose of 1 mlgm. per kilo caused convulsions, but the animal recovered (Exp. 167).

A young guinea-pig was killed by a dose of 1 mlgm. per kilo, while another of the same age (five days) showed symptoms with 0·75 mlgm. per kilo, but recovered. It would appear from this that the young guinea-pig is more easily affected than the adult.

By oral administration a dose of 1·5 mlgm. per kilo was insufficient to produce obvious symptoms, but a dose of 2 mlgm. per kilo repeated in forty-eight hours caused death (Exp. 13).

The symptoms are very like those shown by rabbits—viz., unnatural attitudes, rapid breathing, twitching, general convulsions, and running movements of the limbs. The spasms are more clonic than tonic. When convulsions first appear, the animal tumbles and tosses about in every direction, but soon takes up a position on its side, and then continues in constant movement until exhausted (Exps. 14, 167).

2. ACTION ON BIRDS.

It is the common opinion that birds are immune to the tutu-poison. It were not strange did a relative immunity exist, for the plump, sweet, attractive-looking berries seem to have been designed by nature for the especial purpose of inducing birds to eat; and that they do eat them freely and without injurious effect is certain. Mr. Maning, author of "Old New Zealand," quoted by Lauder Lindsay (3), says, "Many kinds of birds live entirely on the tutu-berries when in season. . . . The tui (*Prosthemadera novæ-zealandiæ*) I have kept tame and fed for months on nothing else."

Again, birds differ from mammals in having a higher rate of oxidation, a higher temperature, and a peculiar metabolism, which results in the excretion of urates instead of urea in the urine—features which might conceivably have an important bearing on the question of their possible immunity.

Christie (11), as the result of experiment, inclined to the general opinion that birds are immune. He injected in all 40 minims of an ethereal solution of "oil of tutu" into the "chest cavity" of a young rooster. Beyond some slight symptoms which were attributed to the ether, and a marked increase in the frequency of defæcation, no characteristic effect was noted. He observes that "there was no twitching, although the dose (40 m.) is twice as much as is necessary to convulse a cat"; and concluded that the bowels are chiefly affected in birds, and that, therefore, they are saved by rapid excretion by this channel. When the above statement is more closely examined it is found that Christie administered probably not more than 1 mlgm. of pure tutin per kilo. The symptoms were wanting because the dose was inadequate.

Experiments that have been made by the present writer on pigeons prove that birds are not immune to tutin. The minimum lethal dose by mouth, however, was found to be high, and this probably accounts for the apparent immunity, the ingestion of very large quantities of berries being necessary to produce toxic symptoms.

In the first experiment (Exp. 15) it unfortunately happened that the pigeon used displayed a peculiar tolerance to the poison. This misled to the belief that the minimum lethal dose was much higher than it really is. The bird, weighing 314 grams, was subjected to successive doses, equivalent to 2, 4, 6, 8, 10, 12, 16, 20 mlgm. per kilo of body-weight. The solution of tutin was given by the mouth, and the experiment extended over a period of ten days. The smaller doses had little effect. For a few hours after each dose the bird was dull, apathetic, and disinclined to eat or move about. It stood in a corner of the cage, with its feathers puffed out, blinking heavily, and presented the appearance of a bird that had overeaten itself, and was trying hard to go to sleep, but was too uncomfortable to succeed completely. The last dose (20 mlgm. per kilo) was given on an empty crop, and as no ill effect was anticipated—it being thought at this time that in all probability birds really were immune—it was not closely watched. But forty-five minutes later attention was attracted by the flapping of its wings, and it was found lying on its back in convulsions. One hour after the administration of the poison it was dead. Its weight at death was 345 grams—a gain of 31 grams in ten days, which would seem to indicate that tutin has no injurious influence on general metabolism. That the bird actually received the doses stated is quite certain. The solution was very carefully measured in a hypodermic syringe having a running-nut on the piston-rod, and dropped into the beak, which was held open by the finger. There was no difficulty in the administration, and every particle of the fluid was swallowed.

As 20 mlgm. per kilo was obviously too great a dose, it was decided to give to the next bird 1 mlgm. per kilo in excess of the largest ineffective dose on the first bird. To this end a dose equivalent to 17 mlgm. per kilo was administered by mouth to a fasting pigeon weighing 319 grams (Exp. 16). In this case toxic symptoms—viz., twitching and tremulousness of the head and wings, and attempts to vomit—made their appearance within two minutes, violent convulsions appeared in four minutes, and death occurred sixteen minutes after the administration.

In contrasting these two experiments, it will be noticed that the "time to kill" was greater in the first case by forty-four minutes, although the dose exceeded the dose in the second case by 3 mlgm. per kilo. This observation, taken in conjunction with the fact that symptoms did not appear in the first case with a dose of 16 mlgm. per kilo, suggested the possibility of the first pigeon having acquired some degree of immunity or tolerance by the poison having been administered in gradually increasing doses over a lengthened period. To test the validity of this supposition, another pigeon was treated in the same way (Exp. 17). The experiment extended over a period of three weeks, and a maximum of 10 mlgm. per kilo was reached without the appearance of any marked symptoms, but 12 mlgm. per kilo proved fatal.

The rapidity with which symptoms ensued after a dose of 17 mlgm. per kilo, and the speed with which a fatal termination was reached, pointed to the dose being well above the lethal minimum. A dose equivalent to 15 mlgm. per kilo was therefore given by mouth to a pigeon weighing

357 grams (Exp. 18). No symptoms followed beyond those that generally appeared in the first experiment after a non-lethal dose had been administered. One hour and three-quarters later the bird was apparently normal, and on the day following the experiment was quite well. Here a dose of 15 mlgm. per kilo was without effect. It was noted that the crop in this bird was full, but, though this was recognised as probably influencing the result in some degree, the fact that the first bird was unaffected by a dose of 16 mlgm. per kilo was so striking that it was thought likely that 15 mlgm. per kilo was below the lethal minimum. It was therefore decided to give a dose equivalent to 16 mlgm. per kilo to another pigeon (Exp. 19). In administering the poison to this bird, by an accident a few drops of the solution were lost, and the deficiency was made good by an allowance of 5 extra minims (Exp. 15). In three minutes the bird was in convulsions, and in nine minutes was dead. As no satisfactory conclusion could be drawn from this experiment it was repeated (Exp. 20), but the subject became convulsed within a minute and a half, and died five minutes after the administration.

It was then decided to repeat the dose of 15 mlgm. per kilo, using the bird that had previously withstood this dose, but taking care that its crop should be empty (Exp. 21). At 5.14 the dose was given. No symptoms appeared till seven minutes had elapsed, when it began to retch. In twenty minutes convulsions appeared, and in thirty-five minutes it was dead. It was noted that the onset of symptoms was slower and the time to kill longer in this case than in the case where 16 mlgm. per kilo were given (thirty-five minutes as against five minutes). It was therefore thought worth while to repeat the dose of 15 mlgm. per kilo, using a bird that had not been starved. This was done (Exp. 22), with the result that the bird died in twelve minutes.

It being now clear that the minimum lethal dose was much exceeded, two pigeons were taken (Exps. 5, 23, 24), and to one was given a dose equivalent to 13 mlgm. per kilo, to the other 12 mlgm. per kilo. In the case of the bird with the larger dose, death resulted in nineteen minutes; but the bird that had received 12 mlgm. per kilo showed a very gradual onset of symptoms, and did not die till two hours and sixteen minutes after the administration. This bird was a young one (still squeaking), though it weighed 363 grams. It was thought that the age in this case may have influenced the result, so a dose of 12 mlgm. per kilo was given to an adult bird. Death occurred, however, in forty-six minutes—a hundred minutes earlier than in the case of the young bird (Exp. 25).

A drop in dosage was now made to 9 mlgm. per kilo, and the bird that received this dose was not affected (Exp. 26). The same result was noted in a bird receiving 9·5 mlgm. per kilo (Exp. 27); but the next bird, which received a dose of 10 mlgm. per kilo, died in forty-five minutes (Exp. 28). This was a young bird (squeaking), weighing 330 grams. The same dose (10 mlgm. per kilo) was therefore given to an adult bird (Exp. 29), which recovered after exhibiting symptoms such as vomiting and slight convulsive movements of the wings.

Of the four birds that had received 10 mlgm. per kilo, one only (a young bird) had died. A dose of 10·25 mlgm. per kilo was therefore given to an adult bird, with the result that it died in seventy-five minutes (Exp. 30).

The results of these experiments are tabulated on the following page (Table 1).

Table I.

Pigeons.—Minimum Lethal Dose.

Exp.	No.	Weight.	Mlgm. per Kilo.	Crop.	Age.	Result.	Time to kill.
		Grams.					Minutes.
15	1	314	2, 4, 6, 8, 10, 12, 16, 20	Half-full ..	Adult ..	Died ..	60
16	2	319	17	Empty ..	" ..	" ..	16
19	3	374	16	Half-full ..	" ..	" ..	9
20	4	319	16	Full ..	" ..	" ..	5
18	5	357	15	" ..	" ..	Recovered	..
21	6	345	15	Empty ..	" ..	Died (same bird as No. 5)	35½
22	7	203	15	Half-full ..	" ..	Died ..	12
23	8	375	13	Full .	Young ..	" ..	19
24	9	363	12	" ..	" ..	" ..	136
25	10	386	12	" ..	Adult ..	" ..	46
17	11	370	1·5, 2, 4, 7, 9, 9·5, 10, 12	Half-full ..	" ..	" ..	(?)
30	12	315	10·25	"	" ..	" ..	75
28	13	330	10	Full ..	Young ..	" ..	45
29	14	368	10	" ..	Adult ..	Recovered	..
27	15	365	9·5	" ..	" ..	" ..	..
26	16	305	9	Empty ..	" ..	" ..	..

It will be seen that the highest dose recovered from was 10 mlgm. per kilo, and the lowest dose that killed was 10·25 mlgm. per kilo. It may be taken as proved, then, that birds are not really immune, as has been supposed, but they are able to withstand a very high dose of the poison by oral administration.

In noting the current opinion that birds are immune, Easterfield and Aston state (7) that cases have come under their notice in which domestic fowls have been poisoned by eating tutu-berries. This seems barely credible. The lethal dose by the mouth in birds is so high, the percentage of tutin in the seeds so low, the size of the berry in proportion to the size and number of the seeds it contains so great, that it may be doubted if the crop of the ordinary fowl could comfortably accommodate the large number of berries that would be required to provide a lethal dose of tutin. For example, Easterfield and Aston found (7) that the dried seeds of *C. ruscifolia* contained 22·8 per cent. of a green oil, of which 0·18 gram administered to a small kitten produced only very mild symptoms of poisoning. Assuming that this 0·18 gram contained 0·0003 gram tutin—a dose which the present writer has found to be feebly toxic to a cat (Exp. 4)—the amount of tutin in the dried seed must be about 0·038 gram in 100 grams. The minimum lethal dose by the mouth in birds is just over 10 mlgm. per kilo, so that in order to get a fatal result, a bird weighing 0·3 kilo (the average weight of a pigeon) would require to eat a little more than 8 grams dried seed, or 150 grams—over 5 oz.—of the fresh fruit. (This statement is based on the relative weights of seeds and berries.) An average-sized domestic fowl would require about 1 lb. of the fruit, and that, of course, assuming that all the tutin would be extracted from all the seeds. To throw light on this point, 5 grams (all that was at hand) of cleaned dried seeds bound with a little moist flour were fed into the crop of a pigeon weighing 314 grams (Exp. 31). It displayed no symptoms, was quite well the next day, and continued well. Apparently unchanged seeds were recovered from the fæces.

An attempt was made to induce a domestic fowl to eat some of the fresh fruit (Exp. 32). After being deprived of food for two full days, it was offered a heaped plateful (5 oz.) of berries. After eating about 1 oz. to 1½ oz. it desisted, and ate no more, although it had no other food given it for two days longer. It displayed no symptoms.

The immunity of birds from poisoning by the seeds under natural conditions may be explained perhaps by—(1) The large number of seeds that must be ingested in order to provide a lethal dose; (2) the seeds being small and hard, and probably passing through the animal unchanged, as was noted to be the case in Exp. 31. Their relative immunity may possibly be accounted for in some measure by—(1) The higher rate of oxidation; (2) the fact that the kidneys in birds are able to secrete substances in a semi-solid condition, certain normal constituents of the urine—urates and uric acid—having been observed by Bowman (25) in the cells of the tubules. This would suggest that the excretory power of the tubule cell for insoluble substances is greater in birds than in mammals. If this suggestion be applied to the case of a poison that is with difficulty soluble in water circulating in the blood, it may be conceived that this special power of the tubule cell in birds will allow of a more rapid elimination of the toxic body, and so confer a relative immunity. This, of course, applies where the poison is gradually received into the blood, as when absorbed from the alimentary tract. Where, on the other hand, the toxic body is rapidly introduced into the blood, as when given hypodermically, the cells of the tubules have not an opportunity of exercising their special power, and so the relative immunity is not so marked, or does not obtain. This may be illustrated by Exp. 53, where a dose of 5 mlgm. per kilo was given hypodermically to a pigeon weighing 335 grams, with the result that convulsions appeared in twenty minutes, and continued without intermission till death occurred, forty-two minutes after the injection.

The question of the relation of the liver to a glucoside like tutin is an interesting one, and especially so in this connection. In birds the veins from the crop are branches of the jugulars, and therefore a toxic body absorbed from the crop, as must have been the case in the experiments cited, enters the circulation direct. In mammals, on the other hand, the gastric vein discharges the blood from the stomach—which, so far as the absorption of poisons is concerned, corresponds to the avian crop—into the portal vein, and therefore the toxic body must pass through the liver before it enters the general circulation. Has the liver-substance any power to increase or decrease the toxicity of tutin? To determine this, experiments were made on fish. The result was doubtful, but the indications are that the liver-substance does increase the toxic power, possibly by separating the glucose part of the compound from the poisonous part, and so freeing the latter of an innocuous encumbrance.

Symptoms in Birds.—With a massive dose the animal is almost immediately, with hardly any premonitory symptoms, seized with general convulsions. The wings are rigidly extended to the full, and are flapped violently. The head is retracted till it lies firmly pressed against the back between the wings, and the bird is thrown over backwards. It turns over and over, and flops about in every direction until exhausted. This period of violent movement does not last more than a few minutes. A final somersault lands the bird on its back, and it lies, with its head drawn back beneath its body.

in continuous movement—flapping its wings and clawing at space with its feet. Respiration is spasmodic, and the forcible expulsion of air from the lungs is distinctly audible. The pupils are widely dilated—no iris being visible—and the bird is in a state of coma, oblivious to everything, and apparently suffering no pain. In the later stages the head is brought forward, the eyes are kept closed, and the movements, which have continued without intermission from the onset, gradually become more and more feeble, and finally cease at death almost imperceptibly. The legs continue in movement longer than the wings.

With a smaller though still lethal dose the first change is a heaviness and drowsiness, giving the bird a peculiar sleepy, stupid look. The eyes are blinked heavily, and seem to be kept open only with the greatest difficulty. This is succeeded by attempts to vomit, and, if the crop contains anything, by actual vomiting. Then follow tremulousness of the head and wings and sharp spasmodic blinking of the eyes. The head is frequently drawn back sharply, and one or other or both wings are involuntarily extended for a moment. These seizures of the head and wings recur at frequent intervals, and gradually become more severe, making it difficult for the bird to keep its feet. In the more severe seizures it is thrown back on to its tail, and sits there for a moment until the clonic movements of the extended wings have ceased. At last the bird is thrown over on to its back, and, with continuous convulsive movement, the case hastens to a termination.

With non-lethal doses little is to be observed beyond the initial drowsiness and tremulousness, and perhaps vomiting and slight convulsive movements of the wings. In none of the experiments did any of the birds recover that reached the stage of being thrown over on to the back.

In none of the birds experimented upon was Christie's observation repeated that there is increased frequency of defæcation.

3. Action on Reptiles.

The only animals of this class available for experiment were three small lizards of the species *Lygosoma moco*, the common lizard of New Zealand. They are very small animals, these specimens weighing 4, 5, and 7 grams, and are not very suitable for experiment.

(Exp. 33.) The first lizard (4 grams) was given a dose 5 mlgm. per kilo by hypodermic injection, and it became convulsed, and died in about two hours.

The second lizard (7 grams) (Exp. 34) received 4 mlgm. per kilo hypodermically, and died four hours and three-quarters later, after showing severe and oft-repeated convulsions. Opisthotonos was well marked, the animal bending backwards till head and tail met. There were also very definite clonic spasms of the limbs. For over an hour the animal was in almost constant movement, contorting itself and twisting in every direction.

(Exp. 35.) To the third lizard was given a dose of 3 mlgm. per kilo, but beyond exaggerated respiratory movements it displayed no symptoms, and was quite normal on the day following the injection.

Lizards are therefore affected in the same way as other animals. The lethal dose is between 3 and 4 mlgm. per kilogram.

4. Action on Amphibia.

The frogs experimented upon belong to the species *Hyla aurea*. This is not the native frog of New Zealand, but has been introduced from Australia, and is now the common frog. They were kept till wanted in a large wooden box, in a cool, dark cellar, and supplied with water and fresh grass-sods, but no special provision was made for feeding them. Under these conditions they lived well, and remained healthy.

Symptoms (Exps. 54 to 58 inclusive).—With a lethal dose, the first symptom usually noticed was increased frequency of the respiratory movements. To this succeeded lethargy and muscular enfeeblement, the animal crawling in a laboured way, and trailing its hind limbs. If touched now it would attempt to hop, but made little progress from inability to draw the hind limbs completely beneath the body. If left alone it would lie prone on the belly with the limbs extended, and make no effort to move. When convulsions occur, as they usually do, though they are not such a marked feature as in mammals, tonic spasms are as a rule more apparent than clonic, and the hind limbs more affected than the fore limbs. Often the animal raises itself rigidly to the full extent of the fore limbs, and opens its mouth spasmodically two or three times in succession. If handled much, or compelled to undergo severe muscular exertion, such as struggling violently to recover the normal position when placed on the back, convulsions appear at once. This recalls the fact that a "tooted" sheep often displays no very obvious symptoms until it is "worked."

A series of experiments was made to determine the minimum lethal dose (Exps. 36 to 52 inclusive), and the results are presented in tabular form below (Table II). In the early experiments the animals, after receiving the injection, were placed under bell-jars on the laboratory-table. Here they were deprived of moisture, and exposed to a strong light. Under these experimental conditions the results were confusing, frogs with larger doses displaying no symptoms, while animals with lesser doses died. The method was therefore improved upon. Each frog after receiving its injection was placed in a small box containing a moist grass-sod in a cool, dark cellar, and a striking uniformity in result was at once obtained.

TABLE II.

Frogs.—Minimum Lethal Dose.

Exp. No.	Weight.	Dose.	Result.	Remarks.
36	27·5 grams	1 mlgm. per kilo	Died ..	Unfavourable surroundings.
39	17·3 „	1 „	Recovered	„
37	28·4 „	2 „	Died ..	„
40	25·1 „	2 „	„ ..	„
38	33·7 „	3 „	Recovered	„
41	32 „	3 „	„	„
42	31 „	4 „	„	Under improved conditions.
43	41 „	5 „	„	„
44	40 „	7 „	„	„
45	18 „	9 „	„	„
47	36 „	9 „	„	„
49	23 „	9 „	„	„
46	38 „	10 „	Died ..	„
48	31 „	10 „	Recovered	„
50	39 „	10 „	„	„
52	40 „	10·25 „	Died ..	„
51	30 „	11 „	„ ..	„

Table II shows that the highest non-lethal dose attained was 10 mlgm. per kilo. Doses of 10·25 mlgm. and over were invariably fatal. Of the frogs that received 10 mlgm. per kilo, one died, and both the others showed convulsions and were very ill for more than twenty-four hours. Severe symptoms were also present with 9 mlgm. per kilo. It was noticed that frogs experimented upon in the winter were more susceptible to the poison than those used in the summer.

The relatively high lethal dose of tutin in frogs may have some connection with their mode of respiration. To a large extent this is cutaneous, and therefore a drug such as tutin, which owes its lethal power largely to its influence on the respiratory centre, might *a priori* be expected to be less lethal to these animals than to those that have only a lung-respiration. The fact that lizards, which have a dry skin and presumably only a slight cutaneous respiration, succumb to about one-third the lethal dose for frogs points in this direction.

Even with large doses the course of events in frogs is comparatively slow. For example, in Exp. 54, where about 60 mlgm. per kilo was given, the animal lived for an hour and a half.

5. Action on Fishes.

(*a.*) *General Action.*

There is an advantage in using small fishes to test the pharmacological action of drugs, because large numbers can be dealt with, and thus the factor of idiosyncrasy, which so often confuses results, is in great measure eliminated. Moreover, fishes can be placed in a watery solution of the drug, and the symptoms and time taken to kill easily noted. Recently Sollmann (26) has used funduli and sticklebacks in this way, and suggests that the method might be used to study the antagonism of drugs.

In the first experiments of this kind undertaken by the present writer young trout procured from a fish-hatchery were used. The fry were kept till required in a trough with an overflow, placed beneath a running tap, and were fed on fresh minced liver. The experiments were carried out in the following way: 60 or 100 c.c. of tap-water, to which a solution of tutin had been added in definite quantity, were placed in a small wide beaker, and the fish transferred to it. Several beakers containing various strengths of tutin, and one beaker containing tap-water only, as a control, were set on together, and watched at intervals during the day.

Symptoms.—The young trout were about 1 in. to 1½ in. long, and in good condition. When first placed in the test-beakers they became very excited if the tutin solution were strong. After a period of excitement, during which rotatory movements on the long axis of the body were frequently seen, they became quieter, and then it was noted that the gill-movements were much exaggerated. After a time they lost their power of maintaining equilibrium, and lay on one side gasping. From this position they would frequently spring up and swim round the vessel, still on the side, and then resume their position on the bottom. Shortly before death they often turned belly upwards.

Minimum Lethal Dose.—In order to determine the minimum lethal dose, solutions of different strength were tried, and the results are given in the next table (Table III).

In these experiments the quantity of fluid used was small. Death frequently occurred in the control when the experiment lasted over twelve hours. But the results show that the fatal effects begin when the percentage is about 0·001, and are very definite at 0·004 per cent. This corresponds to a dose of 10 to 40 mlgm. per kilo. For example, if we consider that a dose of tutin—say, 10 mlgm. per kilo—injected under the skin of a mammal becomes rapidly and equally diffused through all parts of the body, its concentration at any point would be 0·01 gram (10 mlgm.) per thousand. In the case of a fish floating in a solution of tutin, the amount of the fluid is so much larger than the fish that the diffusion of the tutin into its body will not materially reduce the concentration of the poison in the fluid, and so the tissues of the fish will be subjected to the action of 0·001 per cent., or 10 mlgm. per kilo. The fatal dose in fish may therefore be said to be about 40 mlgm. per kilo under these experimental conditions.

TABLE III.

Fishes (Trout-fry).—Minimum Lethal Dose.

Exp. No.	Percentage of Tutin in Water.	Volume.	Number of Fish.	Time necessary to kill.
		C.c.		
59	10 drops of saturated solution in 100 c.c. (about 0·1 per cent.)	100	One ..	About 43 minutes.
60	0·125 per cent.	60	" ..	19 minutes.
61	0·0625 "	60	" ..	27 "
62	0·03125 "	60	" ..	50 "
63	0·0156 "	60	" ..	40 "
64	0·0078 "	60	" ..	56 "
65	0·004 "	60	" ..	111 "
66	0·001 "	50	" ..	$4\frac{1}{2}$–19 hours.
67	0·00075 "	50	" ..	$4\frac{1}{2}$–19 "
68	0·0005 "	50	" ..	Alive 15 hours 48 min. later.
69	0·00025 "	50	" ..	" "
70	0·03125 "	50	" ..	50 minutes.
71	0·004 "	50	" ..	About $8\frac{1}{2}$ hours.
72	0·003 "	50	" ..	"
73	0·002 "	50	" ..	Between $8\frac{1}{2}$ and $18\frac{1}{3}$ hours.
74	0·001 "	50	" ..	$19\frac{3}{4}$ hours.
75	0·00075 "	50	" ..	About 30 minutes.
76	0·0005 "	50	Two ..	One died between $8\frac{1}{2}$ and $18\frac{1}{3}$ hours; the other lived, and was alive and well four days later.

It was intended to use trout-fry in experiments that were made to compare the action of tutin with that of other members of the same group, and to test the effect of remedies; but the supply suddenly failed, so recourse was had to another small fish, known locally as the minnow, which abounds at certain seasons of the year in the waters of the Otago Harbour and Lake Logan. This fish (*Galaxias attenuatus*) is peculiar to the South Island of New Zealand, Tasmania, and Tierra del Fuego (33). It measures 1–$3\frac{1}{2}$ in. long, is equally at home in brackish and fresh water, and will live in a trough in the laboratory for weeks if fed on liver and supplied with fresh running water. It is semi-transparent, and the heart can be seen beating. After a great many experiments it was found that the best results were obtained when three fish were used, and placed in a fairly wide (7-in.-diameter) enamelled bowl, containing 1,000 c.c. fluid. It was found necessary to almost completely cover the top of the bowl with a piece of wood, for if left uncovered the fish were apt to leap out. This happened several times, and was often more aggravating to the experimenter than disastrous to the fish, for if discovered within an hour or so, wiped clean, and returned to the water it would recover completely. Three of these fish will live in 1,000 c.c. of water from thirty-six to forty-eight hours or more, and are apparently quite comfortable, even when the water is much fouled with their own excreta.

Sollmann states that 0·001 per cent. picrotoxin is fatal to fundulus in five to nine hours. His specimens (5 cm.) were not much smaller than the minnows used in the experiments recorded here. He used only 150 c.c. of water to each fish, and admits that occasionally one of the controls would die. It is probable that the amount of water used by Sollman was too small, for in the experiments made by the present writer to compare the effects of tutin and picrotoxin, it appeared that in the early experiments, where a small quantity of water (200 c.c.) was used, death occurred in four hours when the concentration was 0·001; whereas in the later experiments, with three fish in 1,000 c.c. fluid, 0·001 was fatal to only one fish of the three in twenty-four hours. This shows the importance, when using fish in this way, of allowing a sufficient quantity of water.

Symptoms.—The symptoms shown by the minnows when three were put together in 1,000 c.c. of a lethal percentage (0·005) of tutin were as follows: After two to four hours, with no symptoms, the fish began to swim near the surface of the fluid, and became excited in their movements, swimming vigorously about, and even leaping repeatedly out of the water. At this stage they were frequently observed to emit bubbles of gas from the mouth. This discharge of gas, and the inability to sink, point to a derangement of the function of the swim-bladder. Later they lose their power of maintaining the normal position, and swim about near the surface, turned on the side. Now and again they recover the upright position, and swim excitedly about for a minute or two, and then fall back on the side. Later on they lie at an angle with the surface of the fluid, often with the head down, and swim about feebly in this position; and later still they lie on the side on the bottom of the dish, and the gill-movements are laboured. At intervals they spring up from this position, and swim round on the side, while appearances suggesting convulsions are seen—viz., bending of the trunk, accompanied by shuddering movements. At death it was invariably noticed that the gill-movements ceased before the heart stopped beating. (For protocol of symptoms, see Exp. 108.)

Table IV shows that under the above-mentioned experimental conditions a percentage of 0·001 was necessary to cause symptoms to appear, but was not necessarily fatal unless other deleterious conditions, such as too small an amount of fluid, were present (*e.g.*, Exps. 77, 78, 79 in Table IV show fatal results within six hours, but under improved conditions 0·0035 was fatal to only one fish out of three); while a percentage of 0·005 caused symptoms within a few hours, and was generally fatal to all three fish within twenty-four hours. Between these limits various results were obtained: thus in 0·0035 per cent. two of the three fish recovered and one died, while in 0·003 per cent. and in 0·004 per cent. two of the three died and one recovered. But in these experiments, Nos. 89, 91, and 95, tin dishes were used, and the water became rusty before the end of the experiments.

In order to insure a lethal effect, the dose was therefore raised to 0·005 per cent., and experiments were made to test the effect of various reagents in increasing or diminishing the toxic power of tutin. The effect of tutin was also compared with that of picrotoxin.

TABLE IV.

Effect of Tutin Solutions on Galaxias attenuatus.—*Minimum Lethal Dose.*

Exp. No.	Percentage of Tutin used.	Volume of Fluid.	Number of Fishes.	Time of Onset of Symptoms.	Result.	Time of Death.
		C.c.				Hours.
79	0·0005	200	One ..	$5\frac{1}{4}$ hours	Fatal ..	6
78	0·00075	200	" ..	5 "	" ..	$6\frac{1}{3}$
77	0·001	200	" ..	Not observed ..	" ..	4
83	0·001	1,000	Three—(*a*) ..	Slight symptoms at $9\frac{1}{2}$ hours	Not fatal	..
			(*b*) and (*c*)	No symptoms ..	Not fatal	..
87	0·00125	1,000	Three ..	" ..	"	
86	0·0015	1,000	Three—(*a*) ..	1 hour	Fatal ..	$1\frac{5}{6}$
			(*b*) and (*c*)	No symptoms ..	Not fatal	..
88	0·00175	1,000	Three—(*a*) ..	$4\frac{1}{2}$ hours	Fatal ..	$4\frac{5}{6}$
			(*b*) and (*c*)	No symptoms ..	Not fatal	..
90	0·002	1,000	Three ..	" ..	"	
89	0·003	1,000	Three (*a*) ..	$2\frac{3}{4}$ hours	Fatal to all	7
			(*b*) ..	$9\frac{1}{2}$ "		12
			(*c*) ..	10 "		11–23
91	0·0035	1,000	Three (*a*) ..	4 "	Fatal ..	$4\frac{1}{2}$
			(*b*) ..	Slight symptoms from 7 to 10 hours	Not fatal	..
			(*c*) ..	No symptoms ..	"	
95	0·004	1,000	Three (*a*) ..	$3\frac{3}{11}$ hours	Fatal ..	12
			(*b*) ..	8 "	" ..	$8\frac{1}{2}$
			(*c*) ..	Slight symptoms at 12 hours	Not fatal	..
106	0·005	1,000	Three (*a*) ..	$7\frac{1}{2}$ hours	Fatal to all	12–22
			(*b*) ..	$7\frac{1}{2}$ "		12–22
			(*c*) ..	$6\frac{1}{2}$ "		24
108	0·005 (106 used a second time)	1,000	Three (*a*) ..	$2\frac{4}{5}$ hours	Fatal ..	$12\frac{1}{2}$–25
			(*b*) ..	$4\frac{1}{3}$ "	" ..	12
			(*c*) ..	$5\frac{1}{2}$ "	Not fatal	..

(*b*.) *Comparison of Action of Tutin and Picrotoxin.*

Sollmann's statement that 0·001 per cent. picrotoxin causes death in four to nine hours was tested by the improved method (see Table V, No. 85). Three fish were put into 1,000 c.c. of 0·001 picrotoxin at 11 a.m. Up to 8.30 p.m. no symptoms were seen, though the fish were under observation all day. At 8.30 they began to swim more frequently near the surface, and when seen next day one was dead, but the others were unaffected, and were returned to the trough at the end of twenty-four hours. A 0·001 per cent. of tutin (Exp. 83) showed almost similar results. Previous to this an experiment where 0.00075 per cent. and 0·0005 per cent. picrotoxin and the same strengths of tutin were tested gave doubtful results, because the amount of fluid was too small (Table V, Nos. 81, 82, 78, 79).

In other experiments picrotoxin was compared with tutin in a strength of 0·004 per cent. All the picrotoxin fish died—two at twelve hours and one at $29\frac{1}{2}$ hours (Exp. 100); while of the tutin fish two died—at twelve hours and at eight hours and a half—and one recovered (Exp. 95). With a 0·005-per-cent. solution of picrotoxin all three fish died—viz., at $3\frac{1}{2}$ hours, at $11\frac{3}{4}$ hours, and at $12\frac{2}{3}$ hours (Exp. 107); while tutin of the same strength caused death to all at $22\frac{1}{4}$ hours and at twenty-three hours (Exp. 106): so it would appear that picrotoxin is more lethal than tutin in equal percentages.

TABLE V.

Picrotoxin and Tutin compared.

Exp. No.	Percentage of Drug.	Volume of Fluid.	Number of Fishes.	Time of Onset of Symptoms.	Result.	Time of Death.
		C.c.				Hours.
80	Picrotoxin, 0·001 ..	200	One ..	Not observed	Fatal ..	4
81	Picrotoxin, 0·00075	200	" ..	5 hours ..	" ..	6
82	Picrotoxin ..	200	" ..	$1\frac{1}{4}$ " ..	" ..	4
77	Tutin, 0·001 ..	200	" ..	Not observed	" ..	$4\frac{1}{2}$
78	Tutin, 0·00075 ..	200	" ..	5 hours ..	" ..	$6\frac{1}{3}$
79	Tutin, 0·0005 ..	200	" ..	5 " ..	" ..	6

Control to the above fishes under the same conditions (200 c.c. fluid) showed symptoms of asphyxiation in four hours.

Exp. No.	Percentage of Drug.	Volume of Fluid.	Number of Fishes.	Time of Onset of Symptoms.	Result.	Time of Death.
		C.c.				Hours.
85	Picrotoxin, 0·001 ..	1,000	Three	$9\frac{1}{2}$ hours ..	Fatal to one	22 (about).
83	Tutin, 0·001 ..	1,000	"	$9\frac{1}{2}$ " ..	All recovered	..
100	Picrotoxin, 0·004 ..	1,000	Three—			
			(*a*) ..	$3\frac{1}{2}$ " ..	Fatal to all	$29\frac{1}{2}$
			(*b*) ..	$3\frac{1}{2}$ " ..		12
			(*c*) ..	$6\frac{1}{2}$ " ..		12
95	Tutin, 0·004 ..	1,000	Three—			
			(*a*) ..	$3\frac{3}{4}$ " ..	Fatal ..	12
			(*b*) ..	8 " ..	" ..	$8\frac{1}{2}$
			(*c*) ..	Slight symptoms at 12 hours	Recovered ..	..
107	Picrotoxin, 0·005 ..	1,000	Three—			
			(*a*) ..	$1\frac{2}{3}$ hours ..	Fatal to all	$3\frac{1}{2}$
			(*b*) ..			$11\frac{3}{4}$
			(*c*) ..			$12\frac{2}{3}$
106	Tutin, 0·005 ..	1,000	Three—			
			(*a*) ..	$7\frac{1}{2}$ hours ..	Fatal to all	$22\frac{1}{4}$
			(*b*) ..	$6\frac{1}{2}$ " ..		23
			(*c*) ..	$7\frac{1}{2}$ " ..		$22\frac{1}{4}$
105	Picrotoxin, 0·0132	1,000	Three—			
			(*a*) ..	$1\frac{1}{2}$ " ..	Fatal to all	3
			(*b*) ..	$1\frac{1}{12}$ " ..		$6\frac{1}{2}$
			(*c*) ..	$\frac{5}{6}$ " ..		$2\frac{1}{4}$

It was then resolved to compare picrotoxin with tutin in equimolecular solutions. The molecular weight of tutin ($C_{17}H_{20}O_7$) is 336, and that of picrotoxin ($C_{15}H_{50}O_{19}$) is 887; hence equal weights of tutin and picrotoxin contain by no means the same number of molecules. Accordingly two solutions were prepared, one of 0·005 per cent. tutin and one of 0·0132 per cent. picrotoxin $\left(0{\cdot}005 \times \frac{887}{336}\right)$, and the experiment was carried out as before, three fish (one large, one medium, and one small) being added to each bowl (Exps. 105, 106). The fish in the picrotoxin solution began to show symptoms first. The small fish came to the surface after fifty minutes, and in sixty-five minutes it was on its side. The medium fish also was much excited. In an hour and a half the large fish was found swimming near the surface and emitting air-bells, while at this time the other two fish showed quivering movements of the trunk. In two hours and three-quarters the small fish was dead. In three hours the larger one was dead, and the medium-sized one died in five hours. So that 0·0132 per cent. picrotoxin killed all the fish in five hours. Meanwhile the fish in the equimolecular solution of tutin began to show symptoms at the end of three hours and three-quarters, which continued till late at night—twelve hours after the experiment was begun. The next morning two were found dead (between twelve and twenty-two hours after the experiment was begun), and the last one (medium-sized) died at twenty-four hours (Exp. 106). So the result shows that in equimolecular solutions picrotoxin is more lethal than tutin.

One must be cautious, however, in applying these results to the case of mammals. In fishes the swim-bladder regulation is disturbed both by picrotoxin and by tutin, and of the two, picrotoxin seems to have the greater influence, for air-bells are more frequently seen to be emitted by fish subjected to the action of this drug. The swim-bladder—of such paramount importance in the case of fishes—has no analogue in mammals, and it is therefore quite probable that the lethal power of these poisons may be reversed in this class of animals. Indeed, the experiments on cats (Exps. 4, 168, 169, 171) justify this statement.

(c.) *Effect on Fishes of Tutin Solution that has been hydrolysed.*

It has been a constant observation in the case of both lower animals and of human beings that tutu poisoning is more lethal when the stomach is empty. This suggested the possibility of the toxicity of the tutin being increased by the action of the hydrochloric acid in the stomach. Experiments on fishes were therefore undertaken to test this. To 8 or 10 c.c. of a 0·5-per-cent. solution of tutin an equal amount of 0·4 per cent. hydrochloric acid was added, and the mixed fluid kept at a temperature of 37° C. for different lengths of time in different experiments. It was then exactly neutralised with a solution of soda of corresponding strength, and made up to 1,000 c.c.

In the first experiment (Exp. 92) of this kind 7 c.c. of tutin solution was so treated (0·0035 per cent. tutin), and a control (Exp. 91) of a solution of untreated tutin in corresponding strength was used. In the hydrolysed tutin solution one fish showed symptoms at three hours and three-quarters, which continued till it died, at seven hours and a half. Another began to show symptoms at eight hours and one-third, and died between ten and twenty-two hours; while the third showed symptoms at nine hours, and died at $22\frac{1}{2}$ hours. In the control of untreated solution one fish showed symptoms at four hours and died at four hours and a half, and the other two, of which one showed symptoms from the seventh to the tenth hour, recovered.

Another experiment of the same kind was then made, a slightly higher percentage of tutin being used—viz., 0·004 instead of 0·0035. Two test-tubes were taken, each containing 8 c.c. of a 0·5 per cent. solution of tutin. To one, A (Exp. 94), 8 c.c. of 0·4 per cent. HCl were added; so that the total percentage of HCl in the fluid was 0·2. This mixture was kept at 37° C. for one hour, then neutralised and made up to 1,000 c.c. To the 8 c.c. tutin solution in the other test-tube B (Exp. 95) the same amount of HCl was added, but it was immediately neutralised, and then kept at 37° C. for one hour, and made up to 1,000 c.c. In each of these two solutions three fish were placed, and they were observed at frequent intervals during the day. In B (control), symptoms began in three hours and three-quarters in a fish which died in twelve hours; and at eight hours in a fish which died in eight hours and a half. The third fish showed slight symptoms when last seen at night, twelve hours after the experiment was begun, and was apparently quite well the next day. After thirty hours this fish was removed, the fluid filtered, and three other fish placed in the solution. This second group of fishes was affected as follows: When last seen at night, two hours after the experiment was begun, they seemed unduly excited, and next morning all three were dead—*i.e.*, within sixteen hours of the commencement of the experiment (Exp. 98). (In order to test whether a second use of the solution would influence the result, a control of 1,000 c.c. water that had been used the day before was also filtered, and three fishes placed in it. These fish were quite unaffected at the end of the experiment, so that one may disregard the fact that the control solntion mentioned above was used twice.)

TABLE VI.

Effect of Hydrolysis by 0·2 per Cent. HCl on the Toxicity of Tutin.

Exp. No.	Strength of Tutin.	Hydrolysed or not.	Volume of Fluid.	Number of Fishes.	Onset of Symptoms.	Result.	Time of Death.
	Per Cent.		C.c				Hours.
92	0·0035	Hydrolysed 30 min. at 37° C.	1,000	Three—			
				(*a*) ..	$3\frac{3}{4}$ hours ..	Fatal to all	$7\frac{1}{2}$
				(*b*) ..	$8\frac{1}{3}$ " ..		10–22
				(*c*) ..	9 " ..		$22\frac{1}{2}$
93	0·0035	Not hydrolysed (control to 92)	1,000	Three—			
				(*a*) ..	4 " ..	Fatal ..	$4\frac{1}{2}$
				(*b*) ..	Slight symptoms, 7–10 hours	Recovered	..
				(*c*) ..	No symptoms	Not fatal	..
94	0·004	Hydrolysed 1 hour at 37° C.	1,000	Three—			
				(*a*) ..	5 hours ..	Died ..	$25\frac{1}{3}$
				(*b*) ..	$6\frac{1}{4}$ " ..	" ..	28
				(*c*) ..	8 " ..	Recovered	..
97	0·004	Same fluid as 94, filtered	1,000	Three—			
				(*a*) ..	3 " ..	Died ..	16
				(*b*) ..	16 " ..	" ..	$22\frac{1}{2}$
				(*c*) ..	No symptoms	..	..
95	0·004	Control to above	1,000	Three—			
				(*a*) ..	$3\frac{3}{11}$ hours ..	Died ..	12
				(*b*) ..	8 " ..	" ..	$8\frac{1}{2}$
				(*c*) ..	12 " ..	Recovered	..
98	0·004	Same fluid as 95, filtered	1,000	Three	2 " ..	Fatal to all	16
111	0·005	Hydrolysed 1 hour at 37° C.	1,000	Three—			
				(*a*) ..	$6\frac{2}{3}$ " ..	Fatal to all	$13\frac{5}{6}$
				(*b*) ..	$5\frac{1}{3}$ " ..		$8\frac{1}{6}$
				(*c*) ..	$5\frac{1}{3}$ " ..		$9\frac{1}{6}$
106	0·005	Untreated	1,000	Three—			
				(*a*) ..	$7\frac{1}{2}$ " ..	Fatal to all	$22\frac{1}{4}$
				(*b*) ..	$6\frac{1}{2}$ " ..		23
				(*c*) ..	$7\frac{1}{2}$ " ..		24

Now, with regard to the hydrolysed tutin (Exp. 94), to which the foregoing served as control experiments: In the first set of three fishes, one showed symptoms at the end of five hours, and died in $25\frac{1}{3}$ hours; a second showed symptoms at the end of six hours and a quarter, and died at twenty-eight hours; and the third showed slight symptoms at the end of eight hours, and recovered. The fluid was filtered, and three fresh fishes introduced, and of these one died within sixteen hours, one at $22\frac{1}{2}$ hours, and one recovered (Exp. 97).

A third experiment (Exp. 111) was made with 0·005 per cent. tutin in the same way. Symptoms appeared in two of the fish at five hours and a third: these died at eight hours and a sixth and nine hours and a sixth respectively. The third showed symptoms at six hours and two-thirds, and died at $13\frac{5}{6}$ hours. Usually fish live in a 0·005-per-cent. solution of tutin for an average of seventeen hours.

To summarise the results of these three experiments: Twelve fish were subjected to the influence of hydrolysed tutin (0·0035 per cent. to 0·005 per cent.). Of these, ten died at an average period of fourteen hours: the other two showed symptoms, but recovered. In the corresponding control solutions, of the twelve fish, nine died at an average period of 16·9 hours; two showed symptoms, and recovered; and one showed no symptoms. It would seem to follow that hydrolysed tutin is more toxic than tutin itself; but the rise in toxicity is not great, and in marked contrast to the action which takes place in dilute alkali at corresponding strength.

(*d*.) *Action of Alkalis on Tutin.*

Attention having been arrested by the fact that animals poisoned by tutin are frequently reduced to a state of coma, which may possibly contribute towards a fatal termination, the use of alkalis as a remedial agent suggested itself. Hughes had found that lime destroyed the activity of the tutu poison, and Easterfield and Aston were unable to recover tutin after a solution treated with lime had been evaporated to dryness.

TABLE VII.

Effect of Alkali on the Toxicity of Tutin.

Exp. No.	Percentage of Tutin.	Treatment by Alkali.	Volume of Fluid.	Number of Fishes.	Time of Onset of Symptoms.	Result.	Duration of Experiment.
			C.c.				Hours.
96	0·004	Treated with 0·2 per cent. NaOH at 37° C. for 1 hour	1,000	Three	No symptoms	All lived	30
99	0·004	Ditto	1,000	"	"	"	27
101	0·005	Treated with 0·2 per cent. NaOH at 37° C. for 20 minutes	1,000	"	"	"	25
102	0·005	Ditto, for 40 minutes	1,000	"	"		25
109	0·005	Ditto, for 10 minutes	1,000	"	"	"	30
112	0·005	Ditto, for 5 minutes	1,000	"	"	"	26

The experiments were done in the same way as in the case of HCl: 10 c.c. of a 0·5-per-cent. solution of tutin was rendered alkaline with the solution used in the foregoing experiments to neutralise the weak hydrochloric acid. The alkalinity used was equivalent to 0·2 per cent. HCl. or a little over 0·2 per cent. It was found (Exps. 96, 99, 101, 102, 109, 112) that tutin solution kept at 37° C. in the presence of that amount of alkali completely lost its toxic power. In the first experiment the time allowed for the alkali to act on the tutin was one hour, and the three fish that were subjected to the action of the solution were unaffected after thirty hours. The fluid was filtered and three other fish introduced for twenty-seven hours, but without effect.

In other experiments the time allowed for the alkali to act upon the tutin was shortened successively to forty minutes, twenty minutes, ten minutes, and five minutes, but the result was the same in each case—the tutin had completely lost its toxic power.

In this connection the following experiment on a cat may be cited (Exp. 113): 8 c.c. of a 0·5-per-cent. solution tutin was treated with 1 gram of lime [$Ca(OH_2)$] for one hour at 37° C., and thereafter for one day at room-temperature. The lime was removed by passing CO_2 and filtering, and the fluid was evaporated to about 2 c.c., and injected under the skin of a cat weighing 2·4 kilograms. It displayed no symptoms, and remained well.

(*c*.) *Influence of "Surviving" Organs on Tutin.*

In considering the explanation of the relative immunity of birds to tutin poisoning by oral administration, it was suggested (*vide ante*) that the interposition of the liver in the usual path of absorption in mammals might account for some increase in the toxicity of the tutin in their case. To test the influence of the liver-substance on tutin, an experiment was carried out as follows: A rabbit was killed by chloroform, a canula was tied into the aorta, and the blood-vessels washed free of blood by a stream of warm saline. The liver and kidneys were rapidly excised, 9 grams of each weighed out, minced, and bruised rapidly in a warm mortar. To each mass 10 c.c. of a 0·5-per-cent. solution of tutin in normal saline was added. The mixtures, in small wide beakers, were placed in the oven at 37° C. for one hour. An equal volume of absolute alcohol was then added, to stop further action. The mixtures were then evaporated on a water bath, and kept there for some hours to coagulate the proteids. A watery extract of each was then made, filtered, and made up to 1,000 c.c. with tap-water. Three minnows were placed in each of these solutions, and the results were as follows:—

Liver and Tutin (Exp. 103): One fish showed symptoms at two hours and a third, and died in five hours and a half; one showed symptoms in two hours and a third, and died in six hours; and one showed symptoms in four hours and a half, and died in seven hours and three-quarters.

Kidney and Tutin (Exp. 104): One showed symptoms at an hour and a half, and died in four hours and a half; one showed symptoms at four hours and a half, and died in seven hours and three-quarters; and one showed symptoms in four hours and a half, and died in twenty-seven hours.

The course of events in the latter case is just similar to that of a 0·005-per-cent. solution of tutin, so that we may suppose that here the tissue had no effect on the tutin; but, on the other hand, it is difficult to avoid thinking that the liver-substance increased the toxicity of the tutin.

6. Action on Insects.

Insects are susceptible to the action of the poison. Weak solutions (0·1 per cent.) have no influence. A number of flies lived in perfect health for a week on a solution of cane sugar in 0·1-per-cent. solution tutin (Exp. 115); but a 0·5-per-cent. solution quickly produced symptoms, and caused death in half an hour or so (Exp. 116).

The symptoms were very like those that characterize the action of the poison in higher animals—namely, an initial lethargy, followed by isolated tonic spasms of the wings and legs, exactly resembling the appearance met with in pigeons in the early stages of poisoning, when one or other wing is extended in rigid spasm for a moment: then marked clonic spasm of the wings recurring at intervals, and finally general convulsions, in which the insect tossed and buzzed about until exhausted. In the latest stages the flies lay on their backs, showing only occasional movements of the legs. After death, distention of the abdomen was an invariable finding, and in the case of a blowfly the exudation of a considerable drop of clear fluid from the proboscis occurred.

7. Action on Larvæ.

(Exp. 117.) The effect of the poison on maggots was tested by placing some mince that had become infected by blowflies in solutions of tutin of different strength for one hour, and then draining off the fluid. The experiment was controlled by a portion of the mince being placed in normal saline for the same period. On the day following, the maggots in the control had hatched out, and were very active; but in the mince subjected to the action of a 0·5-per-cent. solution tutin no movement was seen, and only one or two larvæ were found moving in the mince that had been soaked in tutin solutions of lesser strength.

Experiments that were made on full-grown maggots showed that confinement for forty-eight hours in tutin solutions of strengths graded up to 0·05 per cent. had apparently no influence. As immersion in a 0·05-per-cent. solution is about equivalent to a dose of 500 mlgm. per kilo, or 0·5 gram, tutin is seen to be very inactive.

8. Action on Molluscs.

(Exp. 114.) Two cockles of about the same size were placed one in sea-water and the other in a 0·5-per-cent. solution of tutin in sea-water, freshly prepared. Equal volumes of fluid were allowed. The cockle that had been placed in the tutin solution, in five minutes opened its shell and extruded its body. If touched it immediately withdrew, but came out again at once. It kept opening and closing its shell, but did not withdraw its body as the valves came together. It continued like this for twenty-four hours, responding more sluggishly to a touch as time went on, and then died. The control meanwhile had displayed no symptoms, but behaved in exactly the way the other had done when it, in turn, was placed in the tutin solution, and it also died.

9. Action on Infusoria and Amœbæ.

The action on infusoria and amœbæ was examined in the following way:—

A drop of hay-infusion, containing infusoria, amœbæ, monads, and bacteria, was placed on a slide; a drop of 0·1-per-cent. solution tutin was added, and the specimen observed for an hour. A drop of the infusion to which nothing had been added was used as a control. Another drop to which a drop of normal saline had been added was used to test the influence of the saline in which the tutin was dissolved; and a fourth drop, to which a drop of a 0·1-per-cent. solution of quinine-sulphate had been added, was used for the sake of comparison (Exp. 118). In fifteen minutes no paramœcia were found moving in the quinine preparation, but monads were still in motion. In the three other specimens no change was observed. In thirty minutes all movement had ceased in the quinine preparation. In the tutin preparation paramœcia could still be seen moving, but their movements seemed to be somewhat irregular; amœbæ, bacteria, and monads were still moving. In one hour one or two paramœcia could still be seen moving in the tutin preparation; they were by no means so numerous as at first, and rather difficult to find. Many of the monads were as active as ever, and amœbæ were still throwing out pseudopods; but the preparation did not present the same appearance of general activity that it did at first. The saline preparations and the control were as active at the end of the experiment as they were at the beginning.

A further experiment (Exp. 119) was made by covering a drop of hay-infusion with a cover-glass, and then placing a drop of 0·1-per-cent. tutin solution on the edge of the cover. It was observed that such paramœcia as swam out into the drop of tutin solution remained in that drop, displayed irregular movement, and in a few minutes came to a standstill, and appeared to undergo internal disintegration, which reduced them to unrecognisable masses. The experiment was repeated with a drop of a 0·5-per-cent. solution tutin in distilled water, with similar results (Exp. 120).

It would appear, therefore, that paramœcia are injuriously affected by the poison, but not in so great a degree as they are by quinine. On amœbæ, dilute solutions (about 0·05 per cent.) have very little influence. Monads are affected in a lesser degree than paramœcia.

10. Action on Bacteria.

(Exp. 121.) This was tested by placing pieces of fresh mince in test-tubes containing solutions of tutin of different strength (0·1 to 0·5 per cent.) and a piece in a test-tube containing normal saline alone. The tubes were left open to the air for twenty-four hours, and then corked and placed in an incubator at 37° C. Two days later the tubes were examined, and it was found that the tube containing saline was very offensive, but the tubes containing tutin solution were not at all offensive, and smelt rather like stomach-contents.

When subjected to microscopic examination, it was found that all the solutions contained bacteria, but in the slide prepared from the normal saline the bacteria were very much more numerous, and showed a greater variety of form and size. It would appear, therefore, that tutin has a deleterious action on certain forms of bacteria, but not on all.

That some forms of bacteria are certainly not affected by tutin is shown by the following observation: A 0·5-per-cent. solution of tutin in normal saline which had been allowed to stand for six months in the laboratory was examined microscopically, and found to contain fairly numerous large motile bacilli resembling *B. subtilis*. A green growth that had developed and formed a layer at the bottom of the bottle was found to consist of small rounded yeast-like cells tinged with chlorophyl.

11. Action on Yeast.

The action of tutin on the fermentation of glucose by yeast was studied in a few experiments (Exps. 122, 123, 124). It was found that fermentation proceeded vigorously in the presence of even 0·4 per cent. tutin. Some slight differences in the rate of fermentation that were noted were probably due to differences in the amount of yeast added. (For details of experiments, see protocols, Exps. 122, 123, 124.)

12. GERMINATION OF SEEDS.

The action of tutin on the germination of seeds was tested by soaking mustard-seeds in solutions (in normal saline) of various strengths (0·1, 0·2, 0·3, 0·4, and 0·5 per cent.) for twenty-four hours (Exp. 125). The seeds were then sown on pieces of felt in separate tin boxes, appropriately labelled, and kept moist with water. An equal number of seeds was sown on each piece of felt, and the experiment was controlled by seeds that had been soaked for the same length of time in normal saline. The day following, all the seeds had germinated, and they were therefore replaced in their respective tutin solutions for a further period of twenty-four hours, and then sown again. During the next week the progress made by the seedlings was observed, and the effect of the tutin on their development noted.

It was found that the seeds progressed more or less in order of the weakness of the solutions in which they had been soaked: thus, the growth of those that had been soaked in normal saline, in 0·1 per cent., and in 0·2 per cent. tutin was the most vigorous, while those that had been soaked in 0·3, 0·4, and 0·5 per cent. made slow progress, and all the seedlings in these lots did not continue to grow. In a fortnight, however, little difference was to be noted in any of the seedlings that had developed at all, one or two of the 0·5-per-cent. seedlings that were growing being as well developed as those that had been soaked in saline.

This result may possibly be due to the effect previously noted on bacteria, certain forms of bacteria being necessary to the growth of plants. From experiments on invertebrates, bacteria, &c., it may be inferred that tutin is toxic to any given form of life in proportion to its complexity of organization. Wherever a nervous system is sufficiently developed, the toxic action is greatest; but that it has some injurious influence on primitive protoplasm may also be seen from its effects on paramœcia, bacteria, &c.

13. ACTION OF TUTIN ON TISSUES.

From the symptoms observed when studying the general action of the poison on mammals, it seemed very evident that the nervous system was the part chiefly affected. Nervous tissue will be considered later, and the action of tutin on other tissues will be recorded first.

(*a.*) *Action on Primitive Protoplasm.*

As is shown in Exp. 118, tutin, as compared with quinine, is not a strong protoplasmic poison. That it has some deleterious action on living protoplasm is shown by the experiments on putrefactive bacteria, on the germination of seeds, and on paramœcia (Exps. 121, 125, 119), though it is doubtful if the action here is more than might be exerted by any foreign substance.

(*b.*) *Ciliated Epithelium.*

The action on cilia was tested in the following way: A few bars from the gill of a cockle were placed on a slide in a drop of sea-water, and examined with a power of 80 diameters. In the first experiment, the preparation was covered with a cover-glass, but in the later experiments coverglasses were not used, in order to allow of ready interchange of O_2 and CO_2. The results are shown in Table VIII (Exps. 126 to 134 inclusive).

TABLE VIII.

Action of Tutin on Cilia.

Exp. No.	Source of Material.	Strength of Tutin.	Effect.	Time.	Remarks.
		Per Cent.			
126	Cockle-gill ..	0·1 in saline	No change	7 min.	Control specimens in normal saline continued active.
	Same preparation	0·2 "	Retarded (?)	4 "	
	"	0·3 "	Slowing ..	1 "	
			Ceased ..	8 "	
127	Cockle-gill ..	0·3 "	Slower ..	1 "	
			Ceased ..	5 "	
128	" ..	0·2 "	Practically ceased	7 "	Movements restored by 1 in 1,000 KOH.
129	" ..	0·2 "	No change	9 "	
	Same preparation	0·3 "	Less active	10 "	
	"	0·5 "	Still moving	15 "	
130	Cockle-gill ..	0·2 "	Slowing ..	7 "	Accelerated by infusion with sea-water.
131	Rock-oyster gill ..	0·5 "	Slight retardation (?)	5 "	
			Still active	1½ hours.	
132	Cockle-gill ..	0·5 "	Exaggerated (?)	2 min.	
			Still active	1⅓ hours.	
133	Ciliated epithelium of frog's gullet	0·1 "	No change	1 hour.	
		0·5 "	"	1 "	

(Exp. 134.) The rate of progress of a small fragment of cork along the surface of the gullet was noted before and after applying tutin (0·3 per cent. in saline). Average rate before = 50·4″ for 1 cm. travelled; average rate after = 34·8″ for 1 cm. travelled. The method presented many difficulties, as it is impossible to keep the fragment moving on the same line each time, and the mucus secreted clogs its movements.

From these results it is impossible to draw a definite conclusion, for although in some specimens taken from sea-water animals the ciliary action ceased on the application of tutin, in other specimens from the frog's gullet tutin had little or no action.

(*c*.) *Action of Tutin on Striped Muscle and Nerve-terminations.*

This was tested by determining the strength of stimulus just sufficient to cause contraction of a nerve-muscle preparation before and after the application of tutin. The preparation (gastrocnemius-sciatic) was made from the frog. An induction-coil with one Daniell cell and mercury-key was used. The muscle in each case was placed first in normal saline (0·75 per cent.) and the strength of the minimal stimulus determined. The tutin solution was then substituted for the saline, and the excitability tested from time to time.

Four experiments were made (Exps. 135 to 138 inclusive). In three of these the one muscle was placed in 0·025, 0·05, and in 0·5 per cent. tutin solution, while the other muscle was placed in normal saline. In another experiment the muscle of one preparation was placed in 0·5-per-cent. solution tutin, and the nerve of the other in 0·5-per-cent. tutin. (Exp. 136).

In the first experiment (Exp. 135)—0·025 per cent. tutin—there was a diminution in excitability: thus, the muscle in saline contracted with the coil at 18 cm., three hours after the experiment began, while the corresponding muscle in tutin contracted only at 15 cm.

Where 0·05-per-cent. solution tutin was used (Exp. 137) the muscles were equally excitable after two hours, but the muscle in the tutin had been the more excitable of the two before immersion in the tutin. Thus, before tutin was applied it contracted at 30·5 cm., and two hours after the application of tutin at 25·5 cm., while the control contracted at 25·5 cm. and at 25 cm.

Another experiment where the muscle was placed in 0·05-per-cent. solution tutin gave the following results (Exp. 138): Before immersion in tutin solution—A contracted at 36 cm.; B (control) contracted at 32 cm. Two hours after immersion in tutin solution—A contracted at 21; B contracted at 23.

In the experiment with 0·5-per-cent. solution tutin (Exp. 136) the minimal stimulus before the application of tutin for A was 28 cm., for B 34 cm. The muscle of B (control) and the nerve of A were then placed in the tutin solution, and an hour and a quarter afterwards A contracted at 33 cm. and B contracted at 27·5 cm.

(For details of these experiments, see protocols.)

The inference to be drawn from these few experiments is that tutin has no striking action on nerve or muscle fibre; but there seems to be a diminution in the excitability in the muscle placed in tutin solution, due either to an action on the nerve-terminations or to an action on the muscle fibre. This would help to explain the weakness and loss of tone seen in the later stages of tutin poisoning, especially well seen in frogs.

It is possible that the action is one on the nerve-endings, for instances are known of a poison (*e.g.*, strychnine) acting as an irritant to nerve-cells, and having at the same time a paralysing action on motor-nerve endings. Nussbaum (27) states that picrotoxin in small doses stimulates, and with slightly higher doses depresses, the activity of the peripheral nerve-terminations. The same may be the case with tutin.

14. ACTION ON THE DIFFERENT SYSTEMS.

(*a.*) *Alimentary System.*

Salivation is a marked feature in animals poisoned by tutin. It is an early symptom, and usually precedes the vomiting, though it may be present when vomiting is absent, as in Exps. 1 and 2. It is most profuse where the dose is large, and in these cases is a source of danger in the later stages by obstructing the respiratory passages. As a rule, it diminishes when vomiting has occurred, and is not a marked feature in those animals (rabbits and guinea-pigs) that do not vomit. Probably, therefore, it may be an exaggeration of the salivation which usually precedes the act of vomiting. The saliva is thick and ropy, and hangs from the mouth in long tenacious strings. Saliva of this consistence suggests stimulation of the sympathetic.

Vomiting is also an early symptom. It is not an invariable symptom, being present in only two of the cats and in three or four of the pigeons experimented upon. It is more likely to occur if the dose be small.

The salivation and the vomiting could both be explained as due to stimulation of the vomiting-centre in the pons. That it is due to stimulation of the centre is shown by the fact that it occurs when the poison is given hypodermically. But in ordinary cases of poisoning by the tutu plant there may be irritation of the gastric mucosa as well. Christie's assertion (11) that tutin is excreted by the stomach, and so causes vomiting by local irritation, is unsupported. No tutin could be extracted from the gastric and small-intestine contents of a rabbit which had been killed by intravenous injections of large doses of tutin during a blood-pressure experiment.

Stomach.—In cases of herbivora poisoned by tutu, accumulation of gas in the stomach is a marked feature. This is probably due to the rapid fermentation of the leaves ingested, though possibly it may be due, in part, to air swallowed during the convulsions.

To test the fermentability of tutu-leaves, a mash of minced leaves with a little water was placed in an incubator at 40° C., and examined after the lapse of an hour. On stirring the mixture it was seen to be permeated with bubbles of gas, but it was not determined how far this was due to the expansion of imprisoned air.

In the experiments with the pure substance, distension by gas was not observed. Pure tutin and artificial gastric juice when incubated in a fermentation-tube gave no appearance of gas-development.

The action of hydrochloric acid in hydrolysing tutin has already been referred to under "Fishes." It was found that the toxicity was slightly increased.

Intestines.—The action on peristaltic movement was not investigated experimentally, but from observations made on animals killed by tutin, where the abdomen was opened immediately, it was clear that there was no diminution of peristaltic movement. That it was even increased was inferred from the frequency with which defæcation occurred. The stools were often loose, and were expelled with some violence.

(*b.*) *Hæmopoietic System.*

In one experiment, where a rabbit received a fatal dose of tutin and died in one hour, blood-films were taken before the injection of tutin and just before death (Exp. 139). The only point of difference seemed to be that the leucocytes appeared fewer in number after tutin. They seemed to be quite normal in regard to granules and staining-power.

(*c.*) *Circulatory and Respiratory Systems.*

Previous observers have noticed that the tutu poison has no depressing influence upon the circulation. Christie (11) found that the heart continued beating after the respiration had ceased. In one of his experiments (on a cat) he opened the thorax immediately on the cessation of all movement, and observed the heart to beat for twenty-two minutes after the last respiratory gasp. In his own case, where he took 9 grains of an extract made from the leaves, the pulse-rate rose to 102, and this observation led him to conclude that the action of the poison was to accelerate the beat of the heart. In attempting to bleed poisoned animals by opening veins and by slitting the ears he found that the blood did not run readily, and concluded that the arterioles were contracted. He noticed, also, what had been observed previously in cases of accidental poisoning—that at first the respirations were increased in frequency and in force, and that later they became feeble and irregular, and finally ceased before the heart stopped beating.

Marshall (24) found that tutin diminished the number of heart-beats and increased the frequency of respiration.

As coriamyrtin belongs, pharmacologically, to the picrotoxin group, and is therefore closely allied to some of the decomposition-products of digitalin—*e.g.*, digitaliresin (30)—it was expected that tutin, which is so closely related to coriamyrtin, might show the tonic action on the heart that is characteristic of the digitalis bodies. In frogs and in mammals, where the heart was examined after the breathing had ceased, it was found invariably to be still beating. In one experiment on a cat (Exp. 153) the heart-beat was distinctly audible with the stethoscope for two minutes and a half after respiration had ceased.

As it had been observed that tutin has apparently no action on striped muscle (Exps. 135 to 138), and as no proof was forthcoming that it has any action on unstriped muscle, it was not considered likely that it would manifest any direct action upon cardiac muscle. As it might, however, have some action on the extrinsic and intrinsic nervous mechanism of the heart, it seemed best to begin the study of its action upon the circulation by observing its effect upon the heart of a pithed frog, where one has to consider muscle and intrinsic ganglia only. A number of experiments were undertaken to determine this. Tracings* of the frog's heart-beat were taken in the usual way with a lever arranged to write against a blackened revolving cylinder. In some cases the tutin solution was painted on the surface of the heart; in others it was injected into a vein or into the heart itself. The results obtained show that the rate of the beat was slightly diminished: thus, in Exp. 140 the rate fell from 37 to 35 beats per minute: in Exp. 141 from 32 to 30·8, then to 28·8, and then to 26·4 per minute; and in other experiments from 20 to 14 and from 20 to 16.

After injection of tutin the force of the heart-beat was increased, and the beat was not impaired even with a concentration of tutin solution greater than could possibly be reached by absorption of the poison from the stomach in cases where the plant has been eaten.

An irregularly beating heart was generally improved, the beat becoming regular. So that it may be concluded that tutin has a purely beneficent influence on the heart's contraction.

Action on Mammalian Circulation.—This was studied by taking tracings of the blood-pressure from one or other carotid artery, and noting the effect of injections of tutin solution into the jugular vein. The animal was anæsthetised (chloroform and paraldehyde) during the experiment, and was not allowed to regain consciousness. It was found that injections of tutin solution (0·5 per cent.) caused a rise of pressure: thus in Exp. 143 the initial pressure was 3 in.: in the course of an hour, during which the animal received nearly 10 mlgm. tutin, the pressure rose gradually to $4\frac{1}{2}$ in.* In some cases the vagi were divided before the drug was injected, but without affecting the result. The rate with which the blood-pressure rises is proportional to the size of the dose given. In one experiment (Exp. 145), where the abdomen had been opened and its contents handled, a reflex cardiac inhibition seemed to be set up, for the tutin injection in this case caused a marked fall in pressure, which was followed by a rise on division of the vagi. It appears, therefore, that tutin increases the

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* As the tracings had to be sent to Edinburgh with the original thesis, it is impossible to reproduce them here, and this portion of the work has therefore been summarised, and technical details have been omitted.

excitability of the medullary centres, and the stronger reflex effects from these usually lead to a rise of blood-pressure; but in cases where some reflex cardiac inhibition already obtains, this is increased by tutin, and a fall in pressure results. That tutin acts specially on the centres in the medulla was also shown in several experiments where Traube-Hering curves and Cheyne-Stokes type of respiration occurred simultaneously. When twitching and general convulsions set in, the blood-pressure curve became markedly irregular, due probably to mechanical obstruction to the flow through the vessels.

The action of tutin on the vagus-endings in the heart was investigated. The strength of stimulus just necessary to inhibit the heart slightly and cause a fall of blood-pressure was determined both before and after the injection of tutin. No marked difference was obtained, so it was concluded that tutin has no influence on the excitability of the nerve-ending in the heart.

In some of the later experiments a spring manometer was used to measure the blood-pressure instead of the ordinary mercurial manometer. This, by recording each heart-beat on the tracing, enabled the rate to be accurately determined. It was found that there was no increase, but in rabbits the rate is already so high that one could hardly expect much change.

A curious periodicity in the heart's action was observed in some cases towards the end of the experiment when the animal was dying, one or two beats being missed at each inspiration. The explanation of this was not at first clear, but in a subsequent experiment on a cat (Exp. 153), where the heart was auscultated as the animal was dying and breathing in the way shown in the tracing, it was noticed that towards the end of each inspiration the heart missed two or three beats. The explanation of this seemed to be that as the respirations were infrequent and deep, and the respiratory passages obstructed by quantities of mucus and saliva, the deep forcible inspiration created so much negative pressure in the thorax that the heart was unable to beat until the pressure was relieved by expiration. That the variation was due to respiratory influence, and not to any action of the drug upon the circulation, was shown in the case of this cat by the fact that when respiration had ceased the heart continued to beat regularly for two minutes and a quarter.

With regard to Christie's statement that the arterioles are contracted, no direct experiments were made, but some perfusion experiments on frogs showed that there was no marked or constant change. Further, the action on the heart is sufficient to account for the rise in blood-pressure. Were the arterioles also constricted, one would expect a much higher rise than occurs. Any influence that tutin does exert on the calibre of vessels is exerted through the vaso-motor centre in the medulla, as seen in the Traube-Hering curve already mentioned.

Action on the Respiratory System.—The rate and amplitude of the respiratory movement is markedly increased by tutin. After the first injection in the anæsthetised animal the rate may be doubled. During convulsive seizures the spasm of the respiratory muscles is very marked, and respiration appears to be brought to a complete standstill—*e.g.*, in a cat (Exp. 3), during an interval of four minutes and a half, no visible or audible sign of breathing could be noticed. Doubtless this is a frequent cause of death in animals poisoned by a large absorption of tutin.

That respiration ceases before the heart was a constant observation. It was seen in fishes and in all animals where such an observation could be made.

Breathing of the Cheyne-Stokes type occurred in some experiments, the climax of the period of respiratory activity corresponding to the highest point of the Traube-Hering curve, which appears simultaneously.

(*d.*) *Urinary System.*

Micturition was a marked feature in cats poisoned by tutin. It occurred voluntarily several times before convulsions occurred, and during the convulsions (and this is true also of rabbits and guinea-pigs) involuntary discharges of urine occurred. In the majority of cases the bladder was found distended after death, even where a free discharge of urine had taken place during the convulsions. This points to an increased secretion of urine. Attempts were made to estimate the rate of flow in anaesthetised animals (Exps. 144, 145), but without satisfactory results.

This increased secretion pointed to the possibility of tutin being eliminated in the urine, and so an attempt was made to recover tutin from the urine of poisoned animals. The urine was collected by incising the bladder after death. It was evaporated to dryness and exhausted with ether, but no crystals of tutin could be detected on evaporating off the ether. The residue from the ethereal solution was in one case dissolved in saline and injected under the skin of a frog (Exp. 151), but with negative results. The urine was in several cases examined for abnormal constituents, but none was found.

(*e.*) *Genital System.*

Many of the animals experimented upon were pregnant females in different stages of pregnancy, but in no case was abortion observed, although the animal was under the action of the poison long enough for it to occur.

(*f.*) *Nervous System.*

The symptoms that appear in animals poisoned by tutin point clearly to the central nervous system as the part of the body that is specially affected by the action of the poison. The two cardinal symptoms are convulsions and a dulling or blunting of the mental faculties that in the early stage makes the animal appear dazed and stupid, and in the later stages passes into actual coma.

Convulsions.—The convulsions are obviously of central origin. They bear a close resemblance to an ordinary epileptic fit, which is generally held to originate in the cortex. Whether the tutin convulsions originate in the cortex or not, it is certain that the nerve-cells in the basal ganglia, pons, medulla, and cord are profoundly affected. This is shown by the action on the vomiting centre, respiratory centre, and cells of the cord. Among the first symptoms to appear are twitching of the ears, blinking of the eyes, and movements of the lips. These are followed by jerking of the head and movements of the fore and hind limbs. These movements may be attributed to irritation of the cells of either the upper or the lower motor neurones. In order to determine more accurately the site of action the following experiment was made:—

(Exp. 152.) The right cerebral hemisphere was exposed in a cat and a large dose of tutin injected hypodermically. When general convulsive movements had developed, the right cerebral hemisphere was removed. Now, had the convulsions been cortical in origin, one would expect them to have ceased on the left side of the body; but they continued as before, affecting both sides equally. The left hemisphere was then removed, but the movements were unaffected, and continued on both sides equally. So it may be concluded that the convulsions may originate in the cells of the lower neurones, or, at any rate, that the upper neurone is not necessary for their development. Further observations made in this experiment lend support to this suggestion. After the cerebrum had been removed, the cord was divided at the level of the fifth dorsal vertebra. Four minutes afterwards tonic and clonic spasms of the hind limbs were observed, and continued intermittently for a quarter of an hour. As the cells of the cord were now completely cut off from the higher centres, these movements must have originated in the neurones of the spinal cord itself.

Post Mortem.—The chest was opened just after all respiratory movement had ceased, and the heart was seen to be still beating. The bladder was full. The cerebral hemispheres were found to be entirely removed. The cord at the seat of section was examined, and it was found that division was complete, but there had been some crushing of the tissue on either side of the section, and the dura mater was still intact. Although satisfied that division was complete, it was thought that the crushing of the cord may have caused irritation, which might possibly be held to account for the movements observed in the hinder part of the body. It was resolved, therefore, to repeat the experiment. This was done as follows:—

(Exp. 153.) A cat was chloroformed, the cord exposed, and completely and cleanly divided in the mid-dorsal region. Five mlgm. of tutin were then injected into the peritoneum, and chloroform anæsthesia discontinued. Ten minutes later no reflex could be elicited from the left hind foot, while the left fore foot responded normally. Fifteen minutes after the injection of tutin twitching of the ears and jerking of the head began, and became very distinct at twenty-four minutes. Two minutes later a convulsive movement of the fore part of the body occurred, and was *accompanied by a movement of the tail.* These convulsive movements of the fore part of the body continued for nearly an hour, and the animal died an hour and seventeen minutes after the injection of tutin. About half an hour after the cord had been divided and tutin injected, reflexes could be obtained from the hind limbs; and ten minutes later a stimulus applied to one hind limb caused movements of both. During the last half-hour of life the movements of the tail became more and more marked. They generally appeared just at the beginning of each convulsive seizure of the fore part of the body, but they also occurred independently. Sometimes the whole tail was moved from the root, at other times there was only a slight movement of the tip. One hour after section of the cord convulsive movements (tonic and clonic spasms) of *the hind limbs* occurred, and were accompanied by defæcation and erection of the hairs of the tail. These convulsive movements were frequently repeated. By this time the fore part of the body had become almost quiescent, but the spasms of the hind limbs increased in severity until death. It was in this experiment that the heart was observed to beat intermittently during the long-drawn, obstructed inspirations. When respiration had ceased, it continued to beat regularly for two minutes and a quarter.

The conclusion to be drawn from these two experiments is that the convulsions that occur in tutin poisoning may originate in the lower centres of the pons, medulla, and cord. The action on the cord is a late appearance, and this corresponds to the finding of Gottlieb (28) that picrotoxin can elicit convulsions below a section of the spinal cord, and that these appear later in the hinder part of the body. This result does not agree with the statement made by Marshall (24) that the spasms in tutin poisoning are not produced below a section of the cord.

Like other convulsants, tutin raises the excitability of the reflex arc. This is shown in the last experiment, where crossed reflexes could be obtained soon after section of the cord. This rise in excitability might explain the severity and frequent repetition of convulsive seizures when once they begin, for it is known that in strychnine poisoning, where the reflex excitability is raised, the afferent, probably painful, impulses coming from the convulsed muscles originate further convulsions, and thus a sort of vicious cycle is set up. In this connection it may be noted that it has long been known to farmers that if "tooted" sheep are left undisturbed no symptoms may appear; but once the symptoms are initiated—say, by the bark of a dog—they continue, and are from the outset severe. The explanation given above would account for the apparently sudden onset of severe symptoms.

It seemed of interest to determine whether the reflex time was shortened. Florence Buchanan (29) and others found that strychnine in small doses did not perceptibly shorten the reflex time. It was impossible in this case to use the same elaborate method, so recourse was had to the simple but less accurate method of Turck. The results of the experiments, with details of the method, are given in the protocols, but they may be shortly summarised here.

Six experiments were made. In three of these (Exps. 154, 156, 157) the reflex time was shortened from 6 to 4, from 6 to 5, and from 6·1 to 3 respectively; while in three others (Exps. 155, 158, 159) the time was lengthened from 8 to 12·2, from 8·3 to 22, and from 8·5 to 44. From these results it will be seen that no definite conclusion could be drawn. The one thing that did appear in these experiments was that the amount of movement was increased after the injection of tutin, the stimulus as a rule now causing general movements of the body. Thus, though the effect of tutin upon the reflex time remained doubtful, its effect in increasing reflex excitability seemed to be clear.

In frog 157 the injection of tutin caused a typical convulsion, and in this case it was found that the optic lobes had not been pithed. In cases where the pithing destroyed all parts but the cord no convulsions occurred. Although this differs from what was found in mammals where tutin produced spasms below a section of the cord, it agrees with Gottlieb's (28) finding that in picrotoxin poisoning *in frogs* convulsions did not occur below a section of the cord.

The second important symptom of tutin poisoning is the comatose condition that is so invariable an accompaniment. This occurs in various degrees according to the dose, and it deepens as the case advances. In the recorded cases of poisoning of human beings, referred to above, complete loss of consciousness and subsequent loss of memory was frequently observed. Loss of memory appears to occur also in lower animals, for shepherds have observed that a "tooted" lamb which has recovered does not know its own mother, and the ewe may be seen following her lamb and striving to excite recognition.

Another proof that abrogation of sense-perception obtains is the marked absence of any evidence of pain. The animals utter no cry of pain, although the convulsions are very severe, and would, were this condition not present, be most painful.

From the examination of sections of the cerebrum, medulla, and cord there is evidence of great congestion of these parts in tutin poisoning. The central nervous system was examined in several cases after death, and congestion of the membranes was found in all. In one case the grey matter of the cord when seen on section was distinctly reddish. Pieces of cord, medulla, and cerebrum were fixed in 8 per cent. formol, and sections were made and stained by Nissl's method, and also by Muir's eosin and methyline-blue method. On microscopic examination the Nissl granules showed no obvious change, but there was very evident congestion, shown especially well by Muir's method. The capillaries and small vessels seemed more numerous than normal, because they were rendered visible by being crowded with red blood-corpuscles. At several places there were collections of corpuscles, pointing to small extravasations of blood. These changes were present in the grey matter of the cord, medulla, and cerebral cortex. The appearance at once suggested that more or less permanent damage would have resulted had the animal lived. It has been observed in cases of tutu poisoning that sometimes the victim does not completely recover, a permanent mental alienation remaining as an after-effect.

Lauder Lindsay (3), in one case of poisoning he records, in which convulsions were a prominent symptom, notes that the subject never completely recovered, "there remaining to this day a peculiar form of nervous irritability not observable prior to this toot-poisoning." The present writer has knowledge of another case, although, unfortunately, no authentic details are available, where two children were poisoned by tutu. They were both very seriously ill, and one died. The other recovered, but incompletely, mental enfeeblement and a squint remaining as after-effects. Sequelæ of these kinds may possibly be explained as resulting from permanent damage done to the nervous tissue by the extreme congestion and the small hæmorrhages which occur in the cerebral cortex as well as throughout the whole grey matter of the central nervous system.

Sympathetic Nervous System.—This was not specially examined by experimental methods, but that the nerve-cells here were also affected was shown by the viscid character of the saliva secreted by cats, by the dilatation of the pupil that occurred during convulsions, and by the erection of the hairs of the tail.

In short, it is probable that tutin affects every kind of nerve-cell: the fact that the medulla is seen to be specially affected being due to the sensitiveness of the cells in that region.

Effect on the Pupil and Conjunctiva.—When dropped into the eye of a rabbit, tutin solutions cause no local irritation and no change in the size of the pupil (Exps. 160, 161). The same holds good for the cat (Exp. 162) and for the excised eye of the frog (Exp. 163). During convulsions in the cat and in pigeons dilatation is well marked.

The action of coriamyrtin was studied in the same way, because it is said by Riban (15) to cause contraction of the pupil in rabbits when applied locally. It was found to cause contraction in the excised eye-ball of the frog, but the results of applying it to the eye of a rabbit and of a cat were negative (Exps. 164, 165).

(*g.*) *Action of Tutin on General Nutrition.*

It is not an uncommon opinion among farmers that animals that eat the plant in moderation thrive well on land where tutu abounds. To test whether tutin had any injurious influence on general nutrition, a young rabbit (Exp. 166) was given small doses of tutin by the mouth every third or fourth day for nearly two months, the dose being gradually increased up to 7 mlgm. per kilo (6 mlgm. per kilo is a fatal dose by the mouth in rabbits). During this time the animal grew and developed normally, and it increased in weight from 777 grams to 1,154 grams. This shows that tutin does not retard growth.

Another experiment was made on a guinea-pig (Exp. 167), the animal being treated like the rabbit. A second guinea-pig, as a control, was kept in the same hutch, and abundance of food was supplied. In thirteen days the animal subjected to the influence of tutin gained 16 grams, and the control in the same time gained 38 grams. The animals, however, were not of the same age: the control, being younger, apparently gained more.

From these data it looks as if tutin had no injurious influence on general metabolism (*cf.* Exp. 15, on a pigeon).

15. Fate of Tutin in the Body.

It is impossible to trace in the body the fate of a substance which, like tutin, contains only C, H, and O; but that the tutin is not rapidly destroyed or eliminated was shown by the following experiment (Exp. 13): A guinea-pig was given by mouth on alternate days a dose of tutin which was near the minimum lethal dose; thus, 1·5 mlgm. per kilo was given on the 17th, on the 19th, and on the 22nd February. No symptoms appeared, so the animal was able either to oxidize or to excrete this amount (1·5 mlgm. per kilo) in two days. On the 24th it received 2 mlgm. per kilo, and a similar dose was given on the 26th. On the 27th it was found dead. From this it appears that a guinea-pig is unable to dispose of 2 mlgm. per kilo within two days. Enough tutin must have been still present in the body on the afternoon of the 26th, when the second dose of 2 mlgm. per kilo was given, to raise the total amount present to the lethal dose.

16. Immunity or Tolerance.

Several experiments were made with the object of determining whether tolerance of the effects of the poison can be established.

A pigeon (Exp. 15) that had been subjected to gradually increasing doses by mouth over a period of ten days withstood 16 mlgm. per kilo. The minimum lethal dose in pigeons by oral administration is about 10·25 mlgm. per kilo. A second pigeon (Exp. 17), treated in the same way for over three weeks, succumbed to 12 mlgm. per kilo. A guinea-pig (Exp. 167), which was being treated in the same way, and had received several small doses, was killed by a dose of 7·5 mlgm. per kilo given by mistake, so that no great degree of tolerance had been established. A rabbit, already referred to above when considering the effects on general metabolism, received small doses, gradually increasing to 7 mlgm. per kilo, over a period of two months. A dose of 8 mlgm. per kilo then caused severe symptoms: so that it would appear that a slight degree of tolerance had developed, for the lethal dose, by oral administration, in rabbits is about 7 mlgm. per kilo. Five days later this rabbit succumbed to a dose of 11·6 mlgm. per kilo per os.

The general conclusion reached was that tolerance can be established only in a very slight degree, if at all.

17. Pharmacological Relationship of Tutin.

Schmiedeberg (30) placed coriamyrtin in the picrotoxin group of nerve and muscle poisons. This group is closely allied to the camphor and digitalin groups, which include a number of the strongest non-nitrogenous poisons found in the vegetable kingdom. Other members of the group are cicutoxin, a resinous substance derived from the water-hemlock; œnanthotoxin, from the water-dropwort; digitaliresin and toxiresin, decomposition products of digitalin and digitalein respectively; and oleandresin, from oleandrin. These substances, by their action on the medulla oblongata, all cause general and respiratory convulsions, slowing of the pulse, and a rise in blood-pressure.

Tutin, as has been shown, possesses these actions common to the group. Some experiments were made to determine its toxic power as compared with picrotoxin and coriamyrtin (a very small quantity of the latter—11 mlgm.—dissolved in absolute alcohol was kindly supplied by Mr. Aston, of the Agricultural Department of the New Zealand Government; he, in turn, had obtained it from its discoverer, Monsieur Riban).

Tutin compared with Picrotoxin.—In the experiments on fishes already cited it was found that picrotoxin was more lethal than tutin when equal percentages of the two were used, and in equimolecular solutions it proved much more lethal. In mammals, on the other hand, tutin was found to be more fatal than picrotoxin. In Exp. 4 a cat received 0·375 mlgm. per kilo of tutin: it developed severe symptoms, but recovered. Two days later it received exactly the same weight of picrotoxin (Exp. 168) without the development of any symptoms. The solution of picrotoxin used had been made seven months previously, and, lest it had deteriorated, a fresh solution was made and the same dose repeated five days later (Ex. 169); beyond defæcation and occasional swallowing-movements, no symptoms appeared. It was therefore concluded that tutin was more poisonous to mammals than picrotoxin. Following the procedure adopted in the case of fishes, the two were then compared in equimolecular strengths, and $0{\cdot}375 \times \frac{883}{336}$ mlgm. per kilo given hypodermically to the same cat (Exp. 170). It developed twitching, vomiting, and other symptoms resembling those seen with tutin. Only one general convulsion occurred, however, whereas the dose of tutin had caused very numerous convulsions. It recovered in a shorter time, and the whole effect was much less severe; so that, in contradistinction to fishes, mammals may be said to be more susceptible to poisoning by tutin than by picrotoxin.

Tutin and Coriamyrtin.—The quantity of coriamyrtin mentioned above was insufficient for an extended series of experiments, and only one cat was subjected to its influence (Exp. 171). The symptoms were very similar to those of tutin poisoning; twitching and convulsions were very marked. In the convulsions the tonic spasms were not so prolonged as in the case of tutin, the clonic element being more in evidence; emprosthotonos appeared instead of the opisthotonos, which is so invariable a feature of tutin convulsions. Salivation, vomiting, respiration, erection of hairs of tail, and dilatation of the pupil were all present, as in tutin poisoning. A strict comparison of its toxic power can hardly be drawn from one case; but if the time taken to kill be proportional to the toxic power, tutin is the more lethal of the two, for 3 mlgm. per kilo of tutin killed a cat (Exp. 1) in thirty-one minutes, while this cat with the same dose of coriamyrtin died in forty-two minutes.

(Exp. 172.) Twelve mlgm. per kilo proved fatal to a frog. It displayed the symptoms seen in tutin poisoning. The time of death could not be noted, so no strict comparison can be made with tutin. The minimum lethal dose of tutin in frogs is between 10 and 11 mlgm.

On the whole, the impression left on one's mind is that there is comparatively little difference in the toxic power of the two substances; but the mental effects seemed more marked in the case of the cat poisoned by tutin.

18. ACTION OF REMEDIES.

Although not strictly within the scope of the title of this paper, notes of some experiments made to show the influence of remedial measures will be included here. These experiments were made from time to time while the physiological action of tutin was being examined, and before the experiments on the action of alkalis on tutin had been undertaken. They are necessarily, therefore, incomplete; but some points have been investigated and some observations made which it is hoped may prove of value in the treatment of cases of poisoning.

In tutu poisoning various remedies have been suggested from time to time, and the rationale of some of these is difficult to understand. With shepherds, bleeding is a favourite method of treatment. It is usually done by slashing the ears or tail, or by incising the roof of the mouth. It is said to be of special advantage in young sheep, but in older sheep it is regarded by some as being dangerous, and as tending rather to hasten the end than to promote recovery. Carbonate of ammonia is also used, a lump about the size of a walnut being dissolved in water and poured down the animal's throat.

In 1870 Hughes advocated the use of lime as an antidote. He was led to do this from the observation he had made that lime destroyed the activity of the poison. Cases in human beings have been treated with lime, and, it is said, successfully.

The Maoris depended largely upon partial asphyxiation as a means of treatment. This was effected either by holding the patient under water till he was nearly drowned, and repeating the immersion as soon as he showed signs of returning life, or by suspending him head downwards over the smoke of a fire. Another method (31) was to bury the patient in the ground up to the neck, apparently with the object of restraining the convulsive movements.

Professor Marshall (32), in a report made to the Agricultural Department of the New Zealand Government, recommends bleeding and the intravenous injection of chloral-hydrate. In connection with the use of chloral-hydrate it may be noted that Crichton Brown (34) states that he was able, by the administration of chloral-hydrate, to prevent death in a rabbit which had received five times the minimum lethal dose of picrotoxin.

It will be noticed that in a rabbit (Exp. 174) which received a lethal dose (3 mlgm. per kilo hypodermically) death was prevented by 0·6 gram of chloral-hydrate. It should be stated that the chloral was given first by the rectum, and the tutin administered hypodermically as soon as the anæsthetic effect of the chloral was established, so that every chance was given to the action of the chloral. In two rabbits where 4 mlgm. of tutin per kilo was given (Exps. 173, 175) death occurred. The one received 1 gram of chloral per rectum in one dose, and the tutin hypodermically immediately afterwards; it died in six hours, in tutin convulsions. The other received 0·6 gram chloral per rectum, and while asleep, ten minutes later, the tutin was given hypodermically: symptoms of tutin poisoning came on in less than two hours, and continued for an hour and a half: as the animal seemed likely to succumb, a further dose of 0·6 gram chloral was given, and in about a quarter of an hour the symptoms subsided, and the animal apparently recovered: next day it was suffering from diarrhœa, and the following day was found dead; possibly it died more from the after-effects of the chloral than from tutin, and it looked as if a little careful nursing would have led to its recovery.

The results of some experiments made with chloral as a remedy in tutin poisoning are given in Table IX.

TABLE IX.

Action of Chloral in antagonizing Tutin.

Exp. No.	Animal.	Dose of Tutin in Mlgm. per Kilo.	Usual Result.	Remedy used.	Result.	Remarks.
				Chloral.		
167	Guinea-pig	7·5 ..	Death within 1 hour	0·5 grm. ..	Died in 45 hours	Died apparently from chloral.
173	Rabbit ..	4 ..	Death within 2½ hours	0·6 grm., followed by a second dose of 0·6 grm.	Died between 24 and 48 hours.	
174	" ..	3 ..	Death within 3 hours	0·6 grm. ..	Recovered completely.	
175	" ..	4 ..	Death within 2½ hours	1 grm. given simultaneously	Died in 6 hours	Tutin symptoms.
177	Frog ..	12 ..	Death ..	0·012 grm.	Died.	
178	" ..	11 ..	" ..	"	"	
179	" ..	12 ..	" ..	"	"	
176	" ..	No tutin	..	"	Lived.	

A guinea-pig (Exp. 167) which had received 7·5 mlgm. tutin per kilo by mistake, and was then given chloral per rectum, died in a somewhat similar manner. It recovered fully from the tutin convulsions, but became paralysed in its hind quarters, and died on the second day after the tutin was given. It also had diarrhœa.

Frogs (Exps. 177, 178, 179) which were given just over the lethal dose of tutin (11 and 12 mlgm. per kilo) were not saved by chloral in moderate doses given hypodermically at the same time. Control Exp. 176.

On the whole, the use of chloral seems to be justified, and in cases of poisoning in man, where the symptoms can be more accurately observed and interpreted, and dangers more easily circumvented, it should prove of great value. The beneficent action of tutin on the heart would allow of the use of larger doses of chloral than are usually employed.

Paraldehyde and Chloroform.—In the experiments on blood-pressure, where the animal was under a large dose (1·2 to 1·5 c.c.) of paraldehyde, convulsions nevertheless appeared, and the mode of death was that of tutin poisoning. From such a dose of paraldehyde a rabbit may recover (Exp. 181), but the dose is a massive one, and is apparently unable to prevent the development of tutin symptoms. In these experiments, when it was desired to keep the animal quiet it was found that chloroform-inhalation was sufficient for this purpose. The amount required seemed to be great, but there was no available means of accurately gauging the quantity. It was noted in some cases that the convulsions did not cease until the blood-pressure began to fall, and this, taken in conjunction with the fact that reflex excitability of the nervous system is raised, and that tutin therefore increases the effect of any reflex cardiac inhibition which may be present, points to the need of caution in its administration in cases of tutin poisoning; in fact, in one case of tutin poisoning in a rabbit, when urethane and sodium-carbonate had had no effect in easing the symptoms (Exp. 180), the administration of chloroform caused sudden cessation of the breathing, which could not be restored, although the heart continued beating and artificial respiration was carried out.

Urethane, tried in one case (Exp. 180) just mentioned, was ineffectual. A dose of 1·5 grams was given to a rabbit weighing 1·4 kilograms, and 4 mlgm. tutin was then administered. The ordinary tutin symptoms developed, though a little later than is usual with so large a dose.

Morphine.—$\frac{1}{4}$ grain injected intravenously at (25) on tracing of Exp. 148 had no effect on the convulsions of a rabbit under paraldehyde. A severe convulsion followed very shortly after the injection.

Atropine.—$\frac{1}{50}$ grain given in the same way at (23) on tracing of Exp. 148 had no effect.

Hyoscine hydrobromate (Exp. 182) was found to be curiously inactive as regards rabbits. $\frac{1}{100}$ grain in all was given to a rabbit weighing 1·5 kilograms, but apparently it had no effect at all, so its influence on tutin symptoms can be disregarded.

Bleeding is frequently used in cases of tutin poisoning, and is said to do good; but it is very difficult to judge of the value of the evidence. In the experiments on blood-pressure the animals were frequently bled to death slowly, but no cessation of the tutin spasms was observed in any case.

Restraint of the movements was tried in one experiment on a pigeon, but without influencing the result in any way.

Suspension of a rabbit under the influence of tutin by the ears or hind legs had no effect on the spasms.

Partial asphyxiation, by blocking the nostrils with a damp cloth—(26) on tracing of Exp. 148—had no effect on the convulsions; but a stream of CO_2 directed against the nostrils seemed to render the breathing more regular (27).

Alkalis (Lime, &c.).—Hughes's discovery of the action of lime on tutin, although generally discredited at the time and since, may possibly be utilised to some extent in a modified form. Alkalis in general have been shown in the foregoing pages to have a very distinct action on the toxicity of tutin: thus 0·2 per cent. NaOH in five minutes at 37° to 40° C. completely destroyed the toxicity of a 0·5-per-cent. solution of tutin, and possibly the same result would follow in a shorter time and with a weaker alkali.

Since this is so, the treatment of stock poisoned by the tutu plant may be greatly improved. It is impossible to fully wash out the stomach in herbivora, so there is no way of getting rid of the leaves, &c., swallowed by the animal; but the introduction of a quantity of weak sodium-hydrate, or lime-water, or a watery suspension of magnesia simply poured down the throat, or, better, introduced by a stomach-tube, would lead to the neutralisation of the tutin present in the stomach, and so give the animal a better chance of recovery. The accumulation of gas would at the same time be diminished by the absorption of the CO_2, which no doubt forms part of the mixture of gases present, so the distension that so frequently occurs in these cases would be diminished.

The comatose condition which forms part of the symptoms of tutin poisoning suggested the possibility of some form of acid poisoning being present, and, if this be so, the injection of alkalis should prove of benefit. Sodium-carbonate was tried intravenously in one of the blood-pressure experiments, but no apparent effect was observed. In another case sodium-carbonate was injected into the rectum of a rabbit that seemed likely to die of tutin poisoning, but here also it was ineffective. So that for the present one can only say that alkali would render unabsorbed tutin non-toxic.

19. General Summary.

1. Investigations made on the action of the pure principle tutin ($C_{17}H_{20}O_7$) confirmed the results of previous observers that it is in itself sufficient to account for the main bulk, if not the whole, of the symptoms of poisoning by the tutu plant.

2. These symptoms, as they occur in cats, have been fully described, and the differences which appear in other animals noted.

3. Tutin, or its metabolic products, acts mainly on nerve-cells, producing first increased excitability and then exhaustion. It specially affects the cells of the respiratory centre, causing increased rate and depth of respiration.

4. Death may occur during the phase of increased excitability (asphyxia during convulsions) or in the phase of exhaustion. Various reflex acts—vomiting, defæcation, micturition—may occur during the stage of increased excitability. A comatose condition, possibly due to exhaustion of the cells of the cerebral cortex, is a marked feature in proportion to the strength of the dose. It deepens as death approaches. Small hæmorrhages into and congestion of the grey matter of the brain and cord are marked features in fatal cases. The Nissl granules seem unchanged when death occurs in a short time.

5. In strong solutions tutin has a slight deleterious action on tissues less highly specialised than nerve tissue—*e.g.*, ciliated epithelium and muscle. It retards the growth of some forms of bacteria, and injuriously affects paramœcia and other low forms of life in relatively strong solutions.

6. The symptoms of poisoning by tutin are in a general way similar in widely different forms of life (flies, pigeons, cats, &c.), and can all be referred to an action on nerve-cells.

7. The minimum lethal dose in milligrams per kilo of body-weight for different classes of animals is as follows :—

	Hypodermically. Mlgm.	Per Os. Mlgm.	Immersion in. Mlgm.
Cats ..	About 0·75	..	..
Rabbits ..	,, 2·5	About 6	..
Guinea-pigs ..	,, 2	..	..
Birds ..	Less than 5	Between 10 and 10·25	..
Lizards ..	Between 3 and 4	..	..
Frogs ..	,, 10 and 10·25	..	..
Fishes ..	..	..	About 50

8. The effects on the various systems can all be referred to the influence on their nerve mechanisms—*e.g.* : Alimentary system, salivation, vomiting (on hypodermic injection). The circulatory system is not injuriously affected

by tutin. Cardiac inhibition does not occur, and the heart beats forcibly up to the time of death. Respiration is quickened and deepened. The pupil is not affected by local application, but dilates during the tutin fit. General metabolism is not affected.

9. From experiments on birds and rabbits, some slight degree of tolerance seems to be acquired. The natural relative immunity of birds is discussed.

10. Accumulation of the drug, or of its effects, may occur. Thus a guinea-pig was found to be unable to dispose of 2 mlgm. per kilo per os administered every second day.

11. The toxic action of tutin was compared with that of other members of the picrotoxin group. It was found to be more toxic than the sample of picrotoxin employed. The action of coriamyrtin was found to be very similar to that of tutin.

12. Attempts were made to antagonize the action of tutin with chloral-hydrate and other drugs, with a slight degree of success.

Attention is drawn to the powerful action of weak alkalis on tutin. The toxic power of tutin is completely destroyed by 0·2 per cent. sodium-hydrate acting upon it for five minutes at 37° C., and possibly the action of weaker alkalis—*e.g.*, lime and magnesia—would be equally destructive.

The suggestion is made that weak alkali should be used to destroy the tutin in the stomach in the case of stock poisoned by eating the tutu plant.

I may state here that the bulk of the work was done in the physiological laboratory of the Otago University, and I gladly take the opportunity of acknowledging my great indebtedness to Professor Malcolm, both for this privilege and for the essential aid he has afforded me by advice and criticism. I wish also to acknowledge my obligation to Mr. Aston for supplies of tutin and coriamyrtin, and for several references; to Dr. Hocken, for the use of his invaluable library; to Professor Benham, for the identification of specimens; to Mr. Deans, of the Acclimatisation Society, for supplies of trout-fry; and to Nurse Stronach, of the Infectious Diseases Hospital, Lake Logan, for supplies of minnows.

PROTOCOLS.

EXP. 1.

P.M. Cat (female). Weight, 3·28 kilograms.

5.25. Gave 33·4 minims of a 0·5-per-cent. solution of tutin in 0·75 per cent. saline (3 mlgm. per kilo body-weight), under skin of back.

5.29. Respiration rapid (48 to the quarter-minute); hypersalivation; keeps mouth agape; panting vigorously.

5.32. Lying on bottom of cage panting, respirations audible; mouth open; thick ropy saliva pouring from mouth; whole body shaking with respiratory effort; pupils moderate.

5.35. Becoming restless; walks cautiously about cage.

5.35½. Suddenly seized with violent convulsion; tonic spasm affecting all muscles, lasting 30 seconds, succeeded by clonic spasms; pupils widely dilated; defæcation; micturition; nose cyanosed; unconscious, conjunctival and ear reflex absent.

5.44. Almost constant convulsion since last note; now becoming exhausted; respiration slow, irregular, spasmodic; pupils dilate during convulsions, contract in intervals.

5.45. Respiration infrequent and jerky; fits in abeyance; lies full stretched on side; twitching of individual muscles.

5.47. Fit after three minutes' interval; tonic spasm not succeeded by clonic.

5.49. Occasional gasping respirations; writhing-movements of body.

5.51. Clonic spasm, with a few involuntary cries.

5.53½. Clonic spasm.

P.M.

5.54. Mistaken for dead, but still respiring feebly, and at rare intervals.

5.56. Respiration ceased; heart inaudible with stethoscope; pupils dilated; dead. Temperature in rectum, 102° Fahr.

P.M.—Rigor mortis extremely well marked; no sign of fluid at point of injection; blood very dark and fluid.

Abdomen: Right horn of uterus contains one fœtus nearly full size, which looks as if it had died in spasm; one hind leg twisted over the other; right paw behind right ear; claws extruded.

Gall-bladder contained bile. No obvious abnormalities.

Thorax: Great veins and right side of heart distended with blood; left side contained some dark blood; lungs showed small hæmorrhages, as also did the thymus.

Brain and cord: The membranes seemed somewhat injected; grey matter of cord appeared distinctly pinkish to the naked eye.

Microscopic: The cord and medulla were hardened in 8 per cent. formol, and carried through into paraffin, and sections cut. The sections were stained by Nissl's method with toluidin blue. On examination the granules were found to be present and normal in appearance. A marked feature was the congestion of the grey matter. Capillaries can be seen close up to the nerve-cells quite full of corpuscles. At other places the collections of corpuscles suggest that minute hæmorrhages had occurred. The cord, medulla, and cerebrum show these appearances, but the congestion of the medulla is the most marked.

EXP. 2.

Cat (female). Weight, 3·50 kilograms.

P.M.

5.0. Gave 23·8 minims of a 0·5-per-cent. solution of tutin in 0·75 per cent. saline (2 mlgm. per kilo body-weight), under skin of back.

5.1. Gave a deep sigh.

5.6. Lying in a normal attitude on bottom of cage; looks sleepy; respirations, 21 to the half-minute; pupils moderate.

5.10. Still lying down; looks sleepy, and is tremulous.

5.14. Opening mouth wide; cries loudly; respirations panting, 56 to the quarter-minute; has got up; salivating.

5.19. Lying down; mouth wide open; panting; salivating.

5.21. Slight twitching of muscles of face; cries at intervals; pupils moderate.

5.22. Twitching of head.

5.23. Twitching of head, followed by loud cries, as if alarmed, without knowing at what.

5.24. Defæcation, large quantity of solid fæces; twitching of head.

5.25. More marked twitching of head, extending to shoulders and fore paws; twitching is now almost without interval, and rapidly becoming more severe; pupils dilated, but not full; respirations irregular, suggestive of Cheyne-Stokes.

5.29. General convulsion, pupils widely dilated, tonic stage lasting 30 seconds.

5.40. Has continued lying on side since first convulsion; is unable to see; conjunctival reflex sluggish; convulsions have continued with intervals of only two or three seconds since last note; seems unconscious; pupils contract in intervals.

5.45. Becoming exhausted, convulsions becoming feebler and rarer; respirations slow, irregular, gasping.

5.51. With a final spasm and choking involuntary cry, died.

EXP. 3.

Cat (female). Weight, 2·394 kilograms.

P.M.

2.32. Gave 5·9 minims of a 0·5-per-cent. solution tutin in normal saline (0·75 mlgm. per kilo body-weight), under skin of back.

2.55. Sitting purring; pupils moderate; keeps swallowing, as if swallowing saliva; respiration, 48 per minute; "miauing" plaintively; made water; defæcated (diarrhœa and flatulence), did not finish act, but walked away with discharge still pouring from anus; looks sick.

3.0. Keeps mouth open; panting respiration; salivation; vomited, vomit shot out without retching.

3.3. Straining at stool and "miauing"; looks ill and miserable, and disinterested in its surroundings.

3.5. Begun to purr; has laid down curled up, as if to sleep.

3.7. Has got up; sitting on haunches purring; twitching of muscles of face; still swallowing saliva.

P.M.

3.9. Lies down again; twitching of face getting more marked, and extending to shoulders; each attack of twitching followed by loud "miauing," and, as it gets more marked, by growling; pupils dilate with each attack.

3.13. General convulsion lasting one minute; saliva pouring from mouth; loud voluntary crying after convulsion; conjunctival reflex present, pupils widely dilated; can see; respiration laboured; keeps lying on side.

3.19. Stands up and looks round cage; breathing easier; pupils not so large.

3.21. Walked to another corner of the cage, and sat down; looks frightened and uneasy; has been no twitching for some time; breathing quite easy, and only a little hurried; salivation seems to have ceased; constant loud crying; pupils moderate.

3.32. Has been quiet since last note; looks as if it might recover.

3.34. Now crying loudly, and showing slight twitching of head.

3.35. Twitching getting more severe; loud prolonged plaintive cries; sitting up on haunches, looking round.

3.36. Walks across cage with cautious unsteady steps.

3.40. Twitching getting much more marked and more extensive, as if another general convulsion were about to occur; loud crying; whole body tremulous; respiration hurried and exaggerated, panting with mouth open; put its head into the drinking-bowl, but did not lap; is restless.

3.42. Most severe general convulsion, lasting 4½ minutes, then a long-drawn inspiration.

3.50. Convulsions have continued almost without interval, but now becoming less severe; much frothing at mouth; gave a cry in an interval.

3.51. Choky cries occur in the intervals between the convulsions; respirations irregular and gasping.

3.55. A longer interval, with loud crying; respirations in the interval, 14 to the quarter-minute.

4.2. Has been in almost continuous convulsive movement, with comparatively quiescent intervals of only a few seconds, since 3.43; in a longer interval than usual attempted to rise, but knocked down again by a convulsion.

4.4. Seizures shorter; intervals longer, about 20 seconds to 5 seconds.

4.6. After a more severe convulsion than usual respirations are now very slow, irregular, and gasping.

4.9. No convulsions since last note; respirations more rapid; running or swimming movement of limbs; attempts to rise, but knocked down by a convulsion.

4.15. Gave a voluntary cry.

4.20. Continues in constant more or less voluntary movement. Has been no convulsive seizure since 4.9 till now.

4.21. No respiratory or other movement since last fit. Is dead.

EXP. 4.

Cat. Weight, 2·686 kilograms.

P.M.

3.46. 3·4 minims of a 0·5-per-cent. solution tutin (0·375 mlgm. per kilo), injected under skin of back.

3.58. Defæcated, hard motion, covered it up; beginning to swallow; does not look so bright as it did; is quiet; no change in pupils; breathing more marked; beginning to look sleepy.

4.2. Swallowing repeatedly; looks very sleepy.

4.10. Opening mouth and panting; vomited freely and forcibly, a large quantity of stomach-contents being ejected; micturated.

4.20. Twitching of eyelids and ears.

4.30. Has shown twitching of face, head, and neck at short intervals; "mians" occasionally.

4.40. Twitching becoming exaggerated, involving shoulders, fore limbs, and back.

4.43. General convulsions, severe.

4.47. Gets up after convulsive movements have gradually subsided.

4.50. Looks very ill; sitting on haunches; tremulous breathing exaggerated; answers when spoken to; twitching beginning again; salivating.

4.56. Respirations 48 to the quarter-minute; lying quiet.

5.15. Twitching getting more marked; cries after each attack.

5.19. Still twitching.

5.21. Twitching involving more muscles.

5.30. Twitching getting very marked; at each attack animal almost springs into the air; loud crying; breathing very exaggerated; opens mouth occasionally, and pants for a few seconds.

P.M.
5.34. General convulsion.
5.36. Up again; takes no notice when called; lying panting, with mouth open.
6.0. Has continued twitching every few minutes since last note; now getting very marked.
6.5. Severe general convulsion, lasting 1 minute.
6.6. Rose again; pupils widely dilated when convulsed, diminish in size in the intervals.
7.15. The cat has not been seen since last note till now; it is sitting on its haunches, tremulous, "miaus" when approached.
7.40. Same.
8.30. Sitting quietly; easily startled.
9.30. Apparently recovered; no symptoms noticed.
Next day, 9 a.m. Seems quite well.

Exp. 5.

A.M. Rabbit. Weight, 0·729 kilograms.
10.43. Gave 5 minims of a 0·5-per-cent. solution tutin (2 mlgm. per kilo), hypodermically.
11.15. No apparent change.
12.0. Standing in middle of cage; does not appear at ease.
P.M.
12.10. Animal near front of cage; semi-dazed; starts when disturbed.
1.10. Much the same, quiet and dazed-looking.
2.10. Seems normal.
3.0. Gave some food.
5.0. Food untouched, but no obvious symptoms.
Next day. Quite well.

Exp. 6.

A.M. Rabbit. Weight, 962 grams.
9.56. Gave 8·2 minims of a 0·5-per-cent. solution of tutin in normal saline (2·5 mlgm. per kilo).
11.0. Noticed to be in convulsions; last seen about 10.30, was then quiescent.
11.10. Sitting up; dazed-looking.
11.11. Another convulsion began, fell on side, clonic spasms; head bent back, ears twitching.
11.17. Still in convulsions.
11.32. Convulsions.
11.52. Lying on side, head bent back; running-movements.
12.22. Died.

Exp. 7.

A.M. Rabbit. Weight, 788 grams.
10.4. Gave 8 minims of a 0·5-per-cent. solution tutin (3 mlgm. per kilo).
10.50. Slow, deliberate winking.
10.55. Lying on right side; breathing laboured.
11.4. In clonic convulsions, with movements of jaw and exposure of teeth.
11.15. Still in almost constant convulsion.
11.20. Dead.

Exp. 8.

P.M. Rabbit. Weight, 1·507 kilograms.
5.12. Gave 38·4 minims of a 0·5-per-cent. solution tutin (7·5 mlgm. per kilo), per os. Was not watched constantly, but at—
5.45. Was found to show great rapidity of respirations; alteration in gait—*e.g.*, moved forward with difficulty, with body elongated, and abdomen trailing on floor; then lay on abdomen, with hind legs projecting behind, twitching of eyes and ears.
6.5. Was found in severe general convulsions, head retracted, tonic spasms well marked; running-movement of legs between fits; was held up by the ears, but this did not influence the convulsions, and no influence when suspended by hind legs.
6.25. Constant movements, either convulsive seizures in which the head is always firmly retracted, or running-movements; is quite unconscious; eyes wide open, and, as it lies on its side, rubs the open lower eye into the sawdust during seizures.
6.45. Dead.

EXP. 9.

Rabbit. Weight, 1·16 kilograms.

P.M.
6.0. Gave 6 mlgm. per kilo, by mouth.
7.25. Respirations seem more rapid than usual.
Next day, 9 a.m. Dead. Rigid, in oposthotonic posture. Has evidently died from tutin.

EXP. 10.

Rabbit. Weight, 1·069 kilograms.

P.M.
3.6. Gave 17·5 minims of a 0·5-per-cent. solution tutin (5 mlgm. per kilo), per os.
3.45. Has displayed no symptoms.
Next day. Quite normal.

EXPS. 11, 12.

Two guinea-pigs, A and B. Weight of A, 624 grams (Exp. 11); weight of B, 684 grams (Exp. 12). To A, gave 2 mlgm. per kilo body-weight; to B, gave 3 mlgm. per kilo body-weight.

P.M.
3.20. Gave to A 4·2 minims of a 0·5-per-cent. solution tutin, under skin of back.
3.40. Gave to B 7 minims of a 0·5-per-cent. solution tutin, under skin of back. Both pigs were placed in the same cage, but B attacked A so viciously that it was necessary to separate them.
3.50. A seems tremulous.
3.55. A obviously affected, twitching and starting.
4.0. B affected in the same way.
4.5. Both in violent and continuous convulsions.
4.10. B removed from cage, and 17 minims of a 0·05-per-cent. solution of chloral-hydrate injected (equal to 0·011 grams per kilo).
4.15. B dead; killed in 35 minutes. Mouth and nostrils found blocked with sawdust from the bottom of the cage.
4.15. A still in constant convulsions; becoming feebler.
4.30. A dead; has continued in constant movement since convulsions appeared; killed in 70 minutes.

Result.—A killed in 70 minutes by 2 mlgm. per kilo; B in 35 minutes by 3 mlgm. per kilo.

EXP. 13.

Guinea-pig. Weight, 751 grams.

Feb. 13. Gave 4 minims of 0·5-per-cent. solution tutin (1·5 mlgm. per kilo), per os.
,, 17. Weight, 768 grams. Gave 4 minims of 0·5-per-cent. solution, per os.
,, 19. ,, 824 grams. Gave 4 minims of 0·5-per-cent. solution, per os.
,, 20. Has displayed no symptoms.
,, 22. Weight, 809 grams. Gave 4 minims of 0·5-per-cent. solution, per os.
,, 24. ,, 823 grams. Gave 5·5 minims of 0·5-per-cent. solution tutin (2 mlgm. per kilo), per os.
,, 25. No symptoms.
,, 26. Weight, 767 grams. Gave 5·2 minims of a 0·5-per-cent. solution (2 mlgm. per kilo), per os.
,, 27. Found dead in the morning.

Result.—Was able to eliminate 1·5 mlgm. per kilo given every second day, but unable to eliminate 2 mlgm. per kilo in two days.

In this experiment the influence of the prolonged administration of tutin on the weight of the animal was tested by keeping a second guinea-pig under similar conditions as a control. The weights of the two animals as taken during the course of the experiment were as follows:—

	A (Control). Grams.	B. Grams.
Feb. 13	..	751
,, 17	595	768
,, 19	589	824
,, 22	607	809
,, 24	627	823
,, 26	633	767

Result.—Control gained 38 grams; tutin animal gained 16 grams.

Exp. 14.

Guinea-pig. Weight, 1 lb. Fed up to this morning.

A.M.
10.53. Gave 5 minims of 0·5-per-cent. tutin; injected into mouth, and fluid was readily swallowed.
10.55. Animal seems quite as usual, though easily frightened.
11.0. Same.
11.10. Still same; trying to chew straw in cage.
11.20. Gave it some wet green grass, which it ate greedily.
11.45. Quiescent; has not eaten much grass; apparently normal.
P.M.
12.5. Seems still quite normal. Gave other 5 minims in same way (about 3·5 mlgm. per kilo).
12.20. Stretching-movements (? normal).
12.30. Normal.
12.33. Sudden onset of symptoms; convulsive movements; stood on hind legs till fell over backwards; rushed several times round cage; then tonic spasm, lying on side; respiratory movement increased; twitching of ears and fore part of body. Then became quiescent, lying still on right side.
12.40. Resumed usual sitting-position.
12.48. Still quiescent.
12.50. Moved slowly round several times against direction of a clock.
1.3. Another fit began, with twitching of head backwards and upwards; then running-movements of limbs. It ran to front of cage, got its nose into one of the meshes, and tried, as it were, to run forward rapidly; then ran towards another corner, but fell on its side, and went into a clonic spasm, moving its fore and hind legs vigorously; then came a more tonic spasm of whole body; fine tremors; swallowing and gasping movements; mouth open. By 1.7 it became quiescent again.
1.10. Another fit; lying on side and working its fore and hind legs; head bent back on body, but whole body not rigid.
1.15. Still same, but movements slower.
1.40. Same condition.
1.50. Movements continue practically without cessation.
1.55. Same.
2.0. Same, slight cries.
2.5. Same.
2.15. Movements less frequent.
2.17. Quiescent; dead.
2.30. Rigor mortis seems to be setting in already.
2.45. Rigor distinct.

P.M. (3.30).—Rigor well marked; abdomen opened; some grass observed in stomach and intestines, but no great accumulation of gas.

Exp. 15.

Pigeon. Weight, 314 grams.

Jan. 14. Gave 2 mlgm. tutin per kilo body-weight, per os.
" 15. No effect, so gave 4 mlgm. per kilo, per os.
" 18. No effect, so gave 6 mlgm. per kilo, per os.
" 19. Bird seemed dull and heavy for a few hours after the dose; took no food, and moped in a corner, with feathers puffed out. Is quite well to-day.
" 20. Reweighed; same weight. Gave 8 mlgm. per kilo, per os.
" 21. A repetition of symptoms noted previously. Is quite well to-day, so gave 10 mlgm. per kilo, per os.
" 22. Same symptoms as before. Quite well to-day, so gave 12 mlgm. per kilo, per os.
" 23. Same symptoms as before. Quite well to-day, so gave 16 mlgm. per kilo, per os.
" 24. Same symptoms as before, but quite well to-day; so at 12 noon gave 20 mlgm. per kilo, per os, on an empty crop. At 12.45 p.m. bird found lying on back in convulsions; marked retraction of head, and constant movements of feet and flapping of wings. At 12.50 p.m. movements becoming feebler and slower. At 1 p.m. dead; weight, 345 grams, an increase of 31 grams.

P.M.—Crop noted to be empty; nothing abnormal detected.

Result.—16 mlgm. per kilo non-lethal; 20 mlgm. per kilo killed in one hour.

EXP. 16.

A.M. Pigeon. Weight, 319 grams.

10.6. Gave 18·3 minims of 0·5-per-cent. solution tutin in normal saline (17 mlgm. per kilo body-weight), per os.

10.8. First appearance of symptoms, tremulousness and jerking of head; sudden slight expansive movements of the wings.

10.10. General convulsions; marked opisthotonus; bird turning over and over, head firmly retracted on back, wings widely extended, general convulsive movements.

10.13. Has been no cessation of convulsive movements since onset; now becoming more feeble.

10.21. Movements very feeble; bird apparently been unconscious since onset.

10.22. All movements ceased.

P.M.—Crop opened; found empty, except for a small amount of grumous fluid containing small yellow particles. Sour smell, and distinct acid reaction. No abnormality observed.

Result.—Death in 16 minutes from 17 mlgm. per kilo.

EXP. 17.

Pigeon.

Feb. 7. At 6 p.m. gave 2 mlgm. of a 0·5-per-cent. solution tutin (about 1·5 mlgm. per kilo), per os. At 7.5 p.m., apparently normal. At 10.45 p.m., same.

" 8. Quite normal. Gave 3 mlgm. of a 0·5-per-cent. solution tutin (about 2 mlgm. per kilo), per os.

" 10. At 6 p.m. pigeon weighed 396 grams. Gave 5·3 minims of a 0·5-per-cent. solution tutin (4 mlgm. per kilo), per os.

" 11. Normal.

" 14. Weight, 408 grams. Gave 9·7 minims of a 0·5-per-cent. solution (9 mlgm. per kilo), per os.

" 15. Normal.

" 17. At 6.3 p.m. weighed 388 grams. Gave 11·8 minims of 0·5-per-cent. solution tutin (9 mlgm. per kilo), per os.

" 18. Normal.

" 19. Weight, 342 grams. Gave 10·8 minims of 0·5-per-cent. solution tutin (9·5 mlgm. per kilo), per os.

" 20. Normal.

" 24. Weight, 343 grams. Gave 11·6 minims of 0·5-per-cent. solution tutin (10 mlgm. per kilo), per os.

" 25. Normal.

" 26. At 6 p.m. weighed 370 grams. Gave 15·4 minims of a 0·5-per-cent. solution tutin (12 mlgm. per kilo), per os. At 6.20 p.m. squatting on floor of cage; very tremulous about head and neck; blinking repeatedly.

" 27. Found dead in the morning.

Result.—No tolerance developed. Death from a dose of 12 mlgm. per kilo.

EXP. 18.

Jan. 28. Pigeon. Weight, 357 grams.

P.M.

5.45. Gave 18·2 minims of a 0·5-per-cent. solution tutin in normal saline (15 mlgm. per kilo body-weight), per os.

7.30. Beyond some dullness and heaviness, no symptoms.

Next day. Quite normal.

Result.—Recovery from 15 mlgm. per kilo.

EXP. 19.

P.M. Pigeon. Weight, 374 grams.

6.7. Intended to give 20·3 minims of a 0·5-per-cent. solution tutin (16 mlgm. per kilo body-weight), but a few drops were lost, so gave 5 minims more.

6.10. General convulsions; marked extension of wings and bending-backwards of the body, so that the bird rests on its tail.

6.12. Lying on back, in constant convulsive movement.

6.16. Dead.

P.M.—Crop half-full. No abnormality detected.

Result.—Death in 9 minutes from a dose of about 16 mlgm. per kilo.

Exp. 20.

P.M. Pigeon. Weight, 319 grams.

5.6. Gave 17·3 minims of a 0·5-per-cent. solution tutin (16 mlgm. per kilo body-weight), per os.
5.7. Appearance of symptoms.
5.7½. Clonic convulsions began.
5.11. Movements ceased; pupils dilated; dead.

P.M.—Crop full of half-digested food. No abnormalities observed.

Result.—Death in 5 minutes from a dose of 16 mlgm. per kilo.

Exp. 21.

P.M. Pigeon. Same as used in Exp. 14. Weight, 345 grams.

5.14. Gave 16·8 minims of a 0·5-per-cent. solution tutin (15 mlgm. per kilo body-weight), per os. Had received no food since the day before.
5.20. Seems quite normal; is preening its feathers.
5.21. Attempting to vomit.
5.22. Retching.
5.23. Retching.
5.24. Retching; drowsy-looking; tremulous about head.
5.24½. Retching.
5.25. Squatted down on bottom of cage.
5.25½. Retching.
5.26. Very tremulous about head and neck; dazed and sleepy looking; retching every half-minute or so.
5.29. Twitching of muscles of neck; head being drawn back with sharp jerks.
5.36. Slight convulsions affecting the fore part of the body; wings rigidly extended, and marked clonic movements of tail and neck; remains standing between the attacks; blinks its eyes heavily, as though only keeping awake with the greatest effort; pupils contracted.
5.40. A more severe convulsion; bird thrown over on to its back, but recovered its position again.
5.43. A most severe convulsion, bird thrown over backwards; lies on back, with head bent back beneath body; all muscles in continuous clonic spasm.
5.49. Convulsions have continued without intermission since last note; movements now becoming feeble.
5.50. All movements ceased; dead.

P.M.—Crop empty. No abnormality observed.

Result.—Killed in 35 minutes by a dose of 15 mlgm. per kilo.

Exp. 22.

P.M. Pigeon. Weight, 203 grams.

5.13. Gave 10·3 minims of a 0·5-per-cent. solution tutin (15 mlgm. per kilo), per os.
5.20. Lying on back, in continuous convulsive movement.
5.25. Gave 10 minims of a 1-in-1 solution chloral-hydrate, equal to 0·6 gram chloral, per os.
6.25. Dead.

P.M.—Crop half-full. No abnormality observed.

Result.—Death in 72 minutes from 15 mlgm. per kilo. Life evidently prolonged by the chloral.

Exp. 23.

P.M. Pigeon (young). Weight, 375 grams. (Fed at 1 p.m.)

3.49. Gave 15·5 minims of 0·5-per-cent. solution tutin (13 mlgm. per kilo body-weight), per os.
3.52. Slight attempts at vomiting.
4.0. Lying on back, in convulsions; convulsive movements continued till death.
4·8. Death.

Result.—Death in 19 minutes from 13 mlgm. per kilo.

Exp. 24.

P.M. Pigeon (young). Weight, 363 grams.

3.46. Gave 14·8 minims of 0·5-per-cent. solution tutin (12 mlgm. per kilo body-weight), per os.
3.50. Vomiting repeatedly, bringing up quantities of grain.

P.M.
4.8. Is tremulous and unsteady.
4.14. Slight convulsive movements, affecting the wings and head; vomiting.
4.20. Vomiting.
4.25. Defæcated; a more severe convulsion; body bent forward till breast touches ground, head bent back, wings rigidly extended, perhaps one more than the other. The bird was here taken out of the cage and placed on the floor of the laboratory; it did not attempt to fly away, and kept pretty much to the place where it was set down; it moved away a little if approached. On the whole, seemed more acute mentally than birds that had received a larger dose.
4.28. Convulsion, but still able to keep its feet; pupils widely dilated during convulsion.
4.33. Retching.
4.35. }
4.36. } Convulsions.
4.36½. }
4.38. Vomiting and convulsions.
4.39. Convulsion, still affecting chiefly the fore part of the body.
4.42. Vomiting and convulsions: pupil continuously dilated.
4.46. Most severe convulsive attack yet, tail involved, and clonic as well as tonic spasm present. The bird was thrown down, but recovered its feet again.
4.48. }
4.49. } Retching.
4.50. }
4.51. Convulsion.
5.10. Since last note have been frequent convulsions, affecting the neck, wings, and tail, but the bird has kept its feet. They are getting more severe, and last longer.
5.12. Most severe convulsive seizure, bird tumbling and somersaulting about the floor of the laboratory.
5.14. Lying on back; all the muscles in constant clonic spasm.
5.16. Short interval, during which voluntary squeaking.
5.20. Lying on back; convulsions continue; legs as much affected as wings.
5.42. Has been lying on back in constant movement since 5.16.
5.51. Movements becoming more feeble; they never entirely disappear, but increase in severity at intervals. In the intervals, gasping inspirations.
6.2. All movement ceased; dead.

Result.—Death in 136 minutes from a dose of 12 mlgm. per kilo.

Exp. 25.

P.M. Pigeon (adult). Weight, 386 grams.
4.45. Gave 15·7 minims of 0·5-per-cent. solution tutin (12 mlgm. per kilo), per os.
5.30. Lying on back, in continuous convulsive movement.
5.31. All movement ceased; dead.

Result.—Death in 46 minutes from a dose of 12 mlgm. per kilo.

Exp. 26.

P.M. Pigeon (adult). Weight, 305 grams.
5.52. Gave 9·3 minims of a 0·5-per-cent. solution tutin (9 mlgm. per kilo), per os.
Next day, 4 p.m. Quite normal. Displayed no marked symptoms.

Result.—Recovery from a dose of 9 mlgm. per kilo.

Exp. 27.

P.M. Pigeon (adult). Weight, 365 grams.
4.30. Gave 11·7 minims of a 0·5-per-cent. solution tutin (9·5 mlgm. per kilo), per os.
Next day, 4.30 p.m. Quite normal. Has displayed no marked symptoms.

Result.—Recovery from a dose of 9·5 mlgm. per kilo.

Exp. 28.

P.M. Pigeon (young). Weight, 330 grams.
4.45. Gave 11·2 minims of a 0·5-per-cent. solution tutin (10 mlgm. per kilo), per os.
5.10. Lying on back in convulsions.
5.30. Dead.

Result.—Death in 45 minutes from a dose of 10 mlgm. per kilo.

Exp. 29.

P.M. Pigeon (adult). Weight, 368 grams.

4.56. Gave 10·6 minims of a 5-per-cent. solution tutin (10 mlgm. per kilo), per os.
5.14. Vomiting.
5.21. Slight convulsive movements of wings.
5.45. Restless.
8.30. Apparently normal.

Result.—Recovered from a dose of 10 mlgm. per kilo.

Exp. 30.

P.M. Pigeon. Weight, 315 grams.

2.50. Gave 11·2 minims of a 0·5-per-cent. solution tutin (10·25 mlgm. per kilo), per os.
3.18. Tremulous; jerking of head; restless; blinking.
3.20. Tonic spasm of wings; paroxysms of difficult breathing, during which bird turns round and round in one place.
3.40. Retching.
3.48. General convulsion, lasting 30 seconds, in which bird tumbles about in every direction.
3.51. Lying on side, trembling and breathing very rapidly; pupils normal.
3.53. General convulsion; pupils wide.
3.54. General convulsion.
3.56. Recovered upright position, and sat for a few seconds on its tail; was then seized with severe convulsions, which continued without intermission till death.
4.5. Died.

Exps. 31, 32. (See text.)

Exp. 33.

P.M. Lizard (*Lygosoma moco*). Weight, 4 grams.

5.15. Gave 3·4 minims of a 0·01-per-cent. solution tutin (5 mlgm. per kilo), under the skin of the abdomen.
6.15. Apparently normal.
7.10. Quiet when first seen; then took fits of abnormal activity, contorting itself, holding its fore limbs wide stretched, and resting on belly.
7.55. Lying quiet, with mouth partially open.
8.5. Seems quite dead; mouth still more widely open.

Exp. 34.

P.M. Lizard. Weight, 5 grams.

3.0. Gave 2·5 minims of a 0·01-per-cent. solution (3 mlgm. per kilo), under the skin of the abdomen. The breathing became exaggerated almost immediately, and the animal puffed itself up as a frog does.
7.30. Nothing remarkable has been noticed.
Next day, 9 a.m. Apparently normal.

Exp. 35.

P.M. Lizard. Weight, 7 grams.

4.35. Gave 5 minims of a 0·01-per-cent. solution of tutin (4 mlgm. per kilo), hypodermically.
7.20. Remarkable convulsive effects, opisthotonus and twisting into a ball with tail up to mouth, then clonic spasms of limbs; after this was quiet for a time, and then movements began again; lies on back biting at its own tail and hind limbs.
7.45. Has been quiescent for last five minutes; now puffing itself up; lying in normal position.
7.58. Another severe fit coming on suddenly; animal twists rapidly into every possible attitude.
8.2. Still in constant movement, now more often on its back.
8.15. Quieter again.
8.25. Another period of restlessness.
8.35. Has quiet intervals.
8.55. Occasional movements.
9.15. Seems quite dead, but gave reflex response from limbs, and did not move after that.

EXPS. 36, 37, 38.

Jan. 15. Three frogs (*Hyla aurea*). Weights: (1) 27·5 grams (Exp. 36); (2) 28·4 grams (Exp. 37); (3) 33·7 grams (Exp. 38).

P.M.

4.25. Gave to frog (1), 4·1 minims of 0·01-per-cent. solution tutin (1 mlgm. per kilo); to frog (2), 3·4 minims 0·025-per-cent. solution tutin (2 mlgm. per kilo); to frog (3), 6·8 minims 0·025-per-cent. solution tutin (3 mlgm. per kilo). In each case the solution was injected into the abdominal cavity, and the frogs placed under bell-jars on the laboratory-table.

7.30. Frog (3) seems affected; crouches in a sitting-position, and is blown out with air. No apparent abnormality in frogs (1) and (2).

10.0. No sign of convulsion in any when stimulated. Frog (3) seems more excitable than the others.

Jan. 16.

A.M.

8.55. All three appear to be affected; are sluggish, and lying prone on their bellies, with legs extended. Frog (2) is almost dead.

10.0. Frog (2) dead (2 mlgm. per kilo); died between 9 and 10 a.m.

Jan. 18. Frog (1) found dead in the morning (1 mlgm. per kilo); weight, 18 grams, a loss of 9 grams. Frog (3) (3 mlgm. per kilo) is still alive, and seems quite normal.

No sign of convulsion noticed in these frogs. The two that died seemed extremely thin and emaciated. Frog (1) looked very much thinner on the 17th than on the two days before. The weather was cold on the 16th. On the 17th the temperature was 12° C. in the morning, but this does not explain why frog (3), with 3 mlgm. per kilo, seems unaffected. Loss of weight might be due to drying; but the air has not been dry. The weather is cold and wet.

EXPS. 39, 40, 41.

Jan. 16. Three frogs. Weights: (1) 17·3 grams (Exp. 39); (2) 25·1 grams (Exp. 40); (3) 32 grams (Exp. 41).

P.M.

4.40. Gave to frog (1), 2·6 minims of a 0·01-per-cent. solution tutin (1 mlgm. per kilo); to frog (2), 7·5 minims of a 0·01-per-cent. solution tutin (2 mlgm. per kilo); to frog (3), 5·7 minims of a 0·025-per-cent. solution tutin (3 mlgm. per kilo). In each case the solution was injected into the abdominal cavity, and the frogs placed under bell-jar on the laboratory-table.

10.0. No change observed.

Jan. 17. No change observed.

,, 18. Frog (2) was found dead in the morning: weight, 18 grams. Weather cold. Frogs (1) and (3) were apparently normal.

In the two experiments above, the number of minims in 1 c.c. was taken as 15; in the subsequent experiments as 17. The doses per kilo body-weight above are therefore smaller than as stated.

EXPS. 42, 43.

Two frogs. Weights: (1) 31 grams (Exp. 42); (2) 41 grams (Exp. 43).

Jan. 21.

P.M.

5.0. Gave to frog (1), 4 minims of a 0·05-per-cent. solution tutin (4 mlgm. per kilo).

5.15. Gave to frog (2), 7 minims of a 0·05-per-cent. solution tutin (5 mlgm. per kilo).

In each case the solution was injected under the skin of the back, and the frogs were placed under bell-jars, with moist grass and earth, in a cool dark cellar.

7.30. Frog (1) gave a long cry when touched; seems very excitable. Frog (2) apparently normal.

10.30. Could detect nothing abnormal in either.

Jan. 22.

A.M.

9.30. Both apparently well.

P.M.

2.30. Both quite normal.

Jan. 25. Quite normal.

Exp. 44.

Jan. 22. Frog. Weight, 40 grams.

P.M.

3.0. Gave 9·5 minims of a 0·05-per-cent. solution tutin (7 mlgm. per kilo), injected under the skin of the back. The frog was placed under a bell-jar, with wet grass, in a cool cellar.

4.45. Apparently normal.

6.30. No obvious effect.

10.30. No obvious effect.

Jan. 23.

A.M.

9.0. No obvious effect.

P.M.

4.30. No obvious effect.

Jan. 25.

A.M.

9.30. Apparently quite normal.

Exp. 45.

Jan. 28. Frog. Weight, 18 grams.

P.M.

3.35. Gave 5·5 minims of a 0·05-per-cent. solution tutin (9 mlgm. per kilo), injected under the skin of the back. It was placed in a cellar, with moist grass and earth.

6.10. Not normal; squats flat on belly; muscular weakness of hind legs; respiration exaggerated.

7.30. Hind limbs show spastic spasms; unable to progress; lies sprawling on belly.

Jan. 29.

A.M.

10.45. Seems much improved; sits in normal position; hops away unsteadily when touched.

Jan. 30. Seems weak, but in other respects is quite normal.

Exp. 46.

Jan. 29. Frog. Weight, 38 grams.

P.M.

5.33. Gave 13 minims of a 0·05-per-cent. solution tutin (10 mlgm. per kilo), injected under the skin of the back. It was placed in a cool cellar, with moist grass.

6.10. No change.

7.0. Apparently unaffected.

9.40. Frog found in severe spasm, chiefly affecting the hind limbs, which are fully extended: is very excitable; gave cries when touched, and climbed to the top of the bell-jar; no muscular weakness manifest.

Jan. 30.

A.M.

9.0. Very lively and excitable; no distinct convulsions when touched; is still noisy.

P.M.

2.30. Just dying; mouth open; could not obtain reflexes.

3.15. Dead.

Exp. 47.

Frog. Weight, 36 grams.

Jan. 31. Gave 11 minims of a 0·05-per-cent. solution tutin (9 mlgm. per kilo), injected under the skin of the back. It was placed in a cool cellar, with moist grass.

Feb. 3. Quite normal.

Exp. 48.

Feb. 3. Frog. Weight, 31 grams.

P.M.

6.15. Gave 10·5 minims of a 0·05-per-cent. solution tutin (10 mlgm. per kilo), injected under the skin of the back. As before, it was placed in favourable surroundings.

Feb. 4.

P.M.

3.45. Seems weak, but shows no marked symptoms.

Feb. 5. Apparently quite normal.

Exps. 49, 50, 51.

Three frogs. Weights: (1), 23 grams (Exp. 49); (2) 39 grams (Exp. 50); (3), 30 grams (Exp. 51).

Feb. 18.

P.M.

6.20. To frog (1) was given 7 minims of a 0·05-per-cent. solution tutin (9 mlgm. per kilo).

6.24. To frog (2) was given 13·2 minims of a 0·05-per-cent. solution tutin (10 mlgm. per kilo).

6.31. To frog (3) was given 11·2 minims of a 0·05-per-cent. solution tutin (11 mlgm. per kilo).

In each case the solution was injected under the skin of the back, and the frogs were placed in favourable surroundings.

Feb. 19.

P.M.

4.0. Frog (1) affected; lying prone on belly, with legs extended; great muscular weakness. Frog (2) presented the same appearance. Frog (3) was found dead at 9 a.m.

Feb. 20. Frogs (1) and (2) apparently normal.

" 21. Both frogs quite well.

Exp. 52.

Feb. 20. Frog. Weight, 40 grams.

P.M.

5.0. Gave 14 minims of a 0·05-per-cent. solution tutin (10·25 mlgm. per kilo). The solution was injected under the skin of the back, and the frog placed in a cool cellar, with moist grass and earth.

Feb. 21.

P.M.

2.0. Sprawling on belly; hind legs extended; abdomen distended; twitching of toes; fibriliary twitching of muscles of thighs. On being handled, was seized with a convulsion, affecting chiefly the hind legs; the mouth was opened wide and kept open, the animal croaking loudly.

4.25. Dead.

Exp. 53.

P.M. Pigeon. Weight, 335 grams.

5.30. Gave 5·6 minims of a 0·5-per-cent. solution tutin (5 mlgm. per kilo). The injection was made under the right wing.

5.45. Very sleepy-looking; narcotic effect is most marked; tremulous about head; retching.

5.50. General convulsions.

6.5. General convulsive movements have continued since last note; are now becoming feebler; bird on its back.

6.12. All movement ceased; dead.

Result.—Death in 42 minutes from a hypodermic dose of 5 mlgm. per kilo.

Exp. 54.

P.M. Frog. Weight, 20 grams.

4.55. Gave 6·8 minims of a 0·1-per-cent. solution tutin (20 mlgm. per kilo), under the skin of back.

5.0. Breathing exaggerated; keeps opening mouth wide.

5.15. No further symptoms; gave other 7 minims.

5.16. Rapid breathing; mouth-opening movements.

5.26. Gave other 7 minims.

6.0. Lying prone on belly; shows occasional slight twitchings, chiefly of hind legs; if touched, is seized with convulsions, and pupils dilate; respirations irregular and exaggerated; makes a sucking noise occasionally.

6.9. Turned on back; cannot recover, and struggles violently and continuously in its efforts to do so.

6.11. Most severe convulsions; mouth spasmodically opened to fullest extent; cries loudly; spasms occur every 4 or 5 seconds. (This change has occurred since, and apparently as a result of, violent voluntary efforts to recover position when placed on back.) Heart can be seen beating through abdominal wall; rate, 44 per minute.

P.M.
6.15. Respirations ceased.
6.20. Heart-movement not so visible; rate, 32 per minute. Muscles still show occasional twitches and spasms.
6.30. Seems quite dead; no reflexes.

This frog received about 60 mlgm. per kilo.

Exp. 55.

P.M. Frog (female). Weight of frog, 38 grams; ovaries, 57 grams.
4.12. Gave 1 minim saturated solution tutin, injected under skin of back.
4.30. Remains crouching; if turned on back, recovers position slowly.
4.35. Turned on back; recovers position with difficulty; convulsive movements fore and hind limbs; lies prone on belly; if legs extended, does not retract them; respiration feeble and irregular; convulsive movements of limbs if turned on back.
4.40. Attempted to crawl, but unable to advance; pricking skin of limb, no response.
4.45. Respiration imperceptible; if turned on back, recovers position with difficulty, then tonic spasm in extension and a few vigorous respirations.
4.55. When turned on back, quickly recovered, and made three or four vigorous hops; crying loudly, with jaws spasmodically opened, then lay on belly, and at intervals of 10 to 15 seconds opened jaws widely and extended limbs in tonic spasm.
5.15. When turned on back, lay so, occasional tonic spasm of fore limbs, irregular feeble movement of hind limbs; respiration at rare and irregular intervals—two or three respirations, and then a more or less prolonged pause; helpless, lying on belly, reflexes still present; makes no attempt to swim when placed in water; unable to rectify position in water; lying on back at bottom of basin.
6.7. Under bell-jar, makes occasional kicking-out movements; still on belly, and swollen-looking.
7.40. Very similar; makes less movement than before; lies in practically any position if gently handled, but reflex action still marked; pupils dilated.
10.15. No spontaneous movement, and no reflexes (some movements, got on turning over or letting fall, seem due to direct stimulation of muscles); pupils dilated; no respiration seen.

Next day, 9 a.m. Dead; stiff in position it was in for greater time after injection.

Exp. 56.

P.M. Frog (small).
3.0. Gave 1 minim semi-saturated solution tutin, injected under skin.
3.3. Attempting to jump, but movements already enfeebled.
3.15. Respiratory movement exaggerated; abdomen distended.
3.20. Slowly extended hind legs and advanced fore legs, and lay on belly; respiration quickened and exaggerated; occasionally raises fore part of body in spasm to full extent of fore arms, and respiration ceases.
3.25. Twitching of toes.
3.35. Attempting to crawl flat on belly; unable to make progress; conjunctival reflex active; skin reflex sluggish; pupils dilated.
3.40. Spasm of all four limbs; restless; raises body stiffly, with hind limbs extended.
3.45. Continuous struggling-movements; twice turned on back, and slowly and with difficulty recovered position.
3.50. Placed on back, unable to recover; twitching of muscles and successive tonic spasms; respiration rare and convulsive; has opened mouth spasmodically once.
4.10. Reflex action abolished, except conjunctival, which is sluggish.
4.15. Repeated spasmodic opening of mouth.
4.30. Can still see; lies on back; occasional movements of fore limbs.
5.5. On letting fall, slight reflex in fore limbs; conjunctival reflex still present.

Exp. 57.

P.M. Frog (small).
4.30. One drop of a semi-saturated solution tutin in conjunctival sac.
4.45. Movements of fore limbs to eyes; conjunctival irritation; restlessness; exaggerated respiration.
5.0. Opisthotonic movements; weakness of hind limbs; crawls slowly; hops with difficulty.

P.M.
7.5. When light turned on, was found to be in a state closely resembling clonic stage of epileptic fit; this soon subsided, but could be initiated to a lesser degree by pulling animal about by hind leg. Pupils wide; respiratory movement excited and irregular.
10.30. Dead.

EXP. 58.

P.M. Frog (small). Weight, 12·5 grams.
12.35. Gave 1 minim of a 0·05-per-cent. tutin solution in 0·76 per cent. saline, injected under skin. Motionless, on belly.
12.42. First movement, lifted head.
12.45. Sprang forward; increased respiratory rate.
12.50. Attempted to spring, but moved sluggishly, and did not advance; emptying of cloaca, urine, and fæces.
12.55. Raised on all four limbs, and sank slowly back on belly.
1.0. Raised himself on all-fours, and remained sitting up with fore limbs extended; irregular crawling-movements, chiefly in fore limbs; feeble attempts to spring; hind limbs seem weak; pupils dilated.
1.10. Restless; attempting to crawl up side of bell-jar; movements incoordinate and feeble.
1.43. Sitting motionless; pupils more dilated than at beginning of experiment; can leap fairly well when toe pinched, but seems feebler, and does not resent interference so much as in a normal frog.
2.3. Leaning up against side of bell-jar; left hand partially closed, as if grasping a twig; right extended against glass.
2.43. Lying quiet; recovers position fairly quickly when turned on back; also shows occasional voluntary movements.
3.13. Same; pupils wider than previously.
4.13. As before, but respirations (taken from movement of floor of mouth) 40 for one half-minute, 30 for another half-minute, and rather irregular.
4.50. Lying prone on belly, with legs extended from sides; if turned on back, recovers with difficulty; able to advance across table by short halting leaps; hind legs drawn up slowly to jumping-position after each effort; no convulsive movements noted so far; seems to be a general muscular enfeeblement, most marked in hind legs.
5.0. Makes continued efforts to jump, but fails to advance, as cannot flex legs sufficiently beneath body.
6.0. Lying prone on belly; turns over when placed on back, though with difficulty.
7.35. Lying sprawling on belly; limbs extended; moves feebly when disturbed; pupils dilated (? due to darkness); while being observed it had something like a weak convulsive fit. It lay on belly and kicked out repeatedly but feebly with hind legs, and moved fore limbs as if attempting to swim.
9.35. Sprawling on belly as before, and motionless till disturbed. Weakness more marked; cannot turn over when placed on back; makes several efforts, accompanied by deep breathing, and then lies still.
Next day, 9 a.m. Found dead, in same position as left in last night; pupils firmly contracted; lower limbs extended; fore limbs flexed, and digits closed, as if grasping twig; no swelling of abdomen.

P.M.—Gall-bladder distended; intestines distended; cloaca full; intestine, some dark grumous liquid; stomach empty, except for mucus; kidneys apparently normal; no abnormality at seat of injection; central nervous system nothing abnormal, except seems too pale; no ecchymosis; blood seems fluid, and animal as a whole seems more bloodless than normal; blood-film squeezed out of heart and tissues presents many leucocytes, possibly due to mode of obtaining it.

EXP. 59.

P.M.
5.45. Small trout, in 100 c.c. water, with 10 drops saturated solution of tutin (about 0·1 per cent.).
5.49. Movement very excited; breathing exaggerated.
6.18. Breathing more laboured.
6.28. Swimming on side, near surface.
6.30. Shuddering-movements; spasmodic movements of gills, which then ceased.
Control, in same amount of water, showed no change.

EXPS. 60 to 76.

These experiments were very like the above (see Table III).

Table of Experiments on Fishes.

Exp. No.	Drug.	Percentage of Drug.	Modification of Drug.	Volume of Fluid.	Number of Fishes.	Time of Onset of Symptoms.	Result.	Time of Death.
				C.c.				
77	Tutin ..	0·001	..	200	1	..	Died ..	4 hours.
78	,, ..	0·00075	..	200	1	5 hours ..	,, ..	$6\frac{1}{3}$,,
79	,, ..	0·005	..	200	1	5 ,, ..	,, ..	6 ,,
80	Picrotoxin	0·001	..	200	1	..	,, ..	4 ,,
81	,,	0·00075	..	200	1	5 hours ..	,, ..	6 ,,
82	,,	0·005	..	200	1	$1\frac{1}{4}$,, ..	,, ..	4 ,,

Control to the above fishes under the same conditions (200 c.c. fluid) showed symptoms of asphyxiation in 4 hours, and the fishes in tutin and picrotoxin died practically in order of their weights.

Exp. No.	Drug.	Percentage of Drug.	Modification of Drug.	Volume of Fluid.	Number of Fishes.	Time of Onset of Symptoms.	Result.	Time of Death.
				C.c.				
83	Tutin ..	0·001	..	1,000	3	$9\frac{1}{2}$ hours ..	Recovered	..
84	Tutin and chloral	0·001 0·128	..	1,000	3	Not observed..	1 died ..	About 22 hours.
85	Picrotoxin	0·001	..	1,000	3	$9\frac{1}{2}$ hours ..	,, ..	,,
86	Tutin ..	0·0015	..	1,000	3	1 hour ..	,, ..	$1\frac{5}{8}$ hours.
87	,, ..	0·00125	..	1,000	3	No symptoms	All lived	..
88	,, ..	0·00175	..	1,000	3	$4\frac{1}{2}$ hours ..	1 died ..	$4\frac{5}{8}$ hours.
89	,, ..	0·003	..	1,000	3	(l.) $2\frac{3}{4}$ hours.. (m.) $9\frac{1}{2}$,, .. (s.) 10 ,, ..	Died .. ,, .. ,, ..	7 hours. 12 ,, 11–23 ,,
90	,, ..	0·002	..	1,000	3	No symptoms	All lived	..
91	,, ..	0·0035	..	1,000	3	(l.) 4 hours .. (m.) Slight symptoms from 7–10 hours (s.) No symptoms	Died .. Recovered ..	$4\frac{1}{2}$ hours. .. ..
92	,, ..	0·0035	Digested with HCl 30 min. and then neutralised	1,000	3	(l.) $3\frac{3}{4}$ hours .. (m.) $8\frac{1}{3}$,, .. (s.) 9 ,, ..	Fatal to all	(l.) $7\frac{1}{2}$ hours. (m.) 10–22 ,, (s.) $22\frac{1}{2}$,,
93	,, ..	0·003	Already once used, filtered	1,000	1*	$4\frac{2}{3}$ hours ..	Died ..	$6\frac{2}{3}$ hours.
94 (A)	,, ..	0·004	Hydrolysed with HCl 1 hour at 37° C.	1,000	3	(l.) 5 hours .. (m.) $6\frac{1}{4}$,, .. (s.) 8 ,, ..	Died .. ,, .. Recovered	$25\frac{1}{3}$,, 28 ,, ..
95 (B)	,, ..	0·004	Control to 94; HCl added, and immediately neutralised	1,000	3	(l.) $3\frac{3}{4}$,, .. (m.) 8 ,, .. (s.) Slight symptoms at 12 hours	Died .. ,, .. Recovered	12 hours. $8\frac{1}{2}$,, ..
96 (C)	,, ..	0·004	Treated with 0·2 per cent. NaOH for 1 hour at 37° C.	1,000	3	No symptoms	All lived	..
97 (A)	,, ..	0·004	Hydrolysed with HCl 1 hour at 37° C.	1,000	3	(l.) 3 hours .. (m.) Symptoms at 16 hours (s.) No symptoms	Died .. ,, .. Lived ..	About 16 hours. ,, $22\frac{1}{2}$,, ..
98 (B)	,, ..	0·004	Control to A. HCl immediately neutralised	1,000	3	2 hours ..	All died	About 16 hours.
99 (C)	,, ..	0·004	Treated with 0·2 per cent. NaOH for 1 hour at 37° C.	1,000	3	No symptoms	All lived	..
100	Picrotoxin	0·004	..	1,000	3	(l.) $3\frac{1}{2}$ hours .. (m.) $3\frac{1}{2}$,, .. (s.) $6\frac{1}{2}$,, ..	Died .. ,, .. ,, ..	$29\frac{1}{2}$ hours. 12 ,, 12 ,,

* Fish used in this experiment was *Cheimarrichthys fosteri*. Tutin solution, 0·003 per cent., was not fatal to three minnows.

Table of Experiments on Fishes—continued.

Exp. No.	Drug.	Percentage of Drug.	Modification of Drug.	Volume of Fluid.	Number of Fishes.	Time of Onset of Symptoms.	Result.	Time of Death.
				C.c.				
101	Tutin ..	0·005	Treated with 0·2 per cent. NaOH for 20 min.	1,000	3	No symptoms	All lived 25 hours	..
102	,,	0·005	Treated with 0·2 per cent. NaOH for 40 min.	1,000	3	No symptoms	All lived 25 hours	..
103	,,	0·005	Acted on by living liver-cells for 1 hour at 37° C.	1,000	3	(l.) $2\frac{1}{3}$ hours .. (m.) $2\frac{1}{3}$,, .. (s.) $4\frac{1}{2}$,, ..	All died	$5\frac{1}{2}$ hours. 6 ,, $7\frac{1}{4}$,,
104	,, ..	0·005	Acted on by living kidney-cells for 1 hour at 37° C.	1,000	3	(l.) $1\frac{1}{3}$ hours .. (m.) $2\frac{1}{3}$,, .. (s.) $4\frac{1}{2}$,, ..	Ditto	$4\frac{1}{5}$ hours. $7\frac{3}{4}$,, 27 ,,
105	Picrotoxin	0·0132	..	1,000	3	(l.) $1\frac{1}{2}$,, .. (m.) $1\frac{1}{12}$,, .. (s.) $\frac{5}{6}$,, ..	,,	3 ,, $6\frac{1}{2}$,, $2\frac{1}{4}$,,
106	Tutin ..	0·005	..	1,000	3	(l.) $7\frac{1}{2}$,, .. (m.) $6\frac{1}{2}$,, .. (s.) $7\frac{1}{2}$,, ..	,,	**About $22\frac{1}{4}$ hrs.** 23 hours. **About $22\frac{1}{4}$ hrs.**
107	Picrotoxin	0·005	..	1,000	3	(l.) $1\frac{2}{3}$,, .. (m.) $1\frac{2}{3}$,, .. (s.) $1\frac{2}{3}$,, ..	,,	$3\frac{1}{5}$ hours. $11\frac{3}{4}$,, $12\frac{2}{3}$,,
108	Tutin ..	0·005	Had been used once before	1,000	3	(l.) $2\frac{4}{5}$,, .. (m.) $4\frac{1}{3}$,, .. (s.) $5\frac{1}{2}$,, ..	Recovered Died .. ,, ..	.. $12\frac{1}{2}$ hours. $12\frac{1}{2}$–25 hours.
109	,, ..	0·005	Treated with 0·2 per cent. NaOH for 10 minutes	1,000	3	No symptoms	All lived 30 hours	..
110	,, ..	0·005	Ditto ..	1,000	3	,,	Ditto ..	..
111	,, ..	0·005	Treated with 0·2 per cent. HCl for 1 hour at 37° C.	1,000	3	(l.) $6\frac{2}{3}$ hours .. (m.) $5\frac{1}{3}$,, .. (s.) $5\frac{1}{3}$,, ..	All died	$13\frac{5}{6}$ hours. $8\frac{1}{6}$,, $9\frac{1}{6}$,,
112	,, ..	0·005	Treated with 0·2 per cent. NaOH for 5 minutes at 37° C.	1,000	3	No symptoms	All lived 26 hours	..

Fluids 94 (A), 95 (B), and 96 (C) filtered and tried over again.
(l.), (m.), (s.) = large, medium, small.

EXP. 108.

A.M. Three minnows (large, medium, and small).

8.43. Placed in 1,000 c.c. fluid of 0·005-per-cent. solution.
9.40. No symptoms.
11.30. Large fish on side, emitting air-bells.
11.50. Large fish now upright, but keeping near surface.

P.M.

12.10. Large fish on its side; movements feeble. As yet the other two fish are unaffected.
12.49. Large fish upright again; near surface.
1.5. Large fish on side near surface. Medium fish in excited movement near surface, emitting air-bells. Small fish excited.
2.15. Large fish same; medium and small both on the side near the surface.
3.10. } Same.
3.22. }
4.0. All markedly affected, and keep more or less on side, near the surface.
5.0. Same.
6.20. All swim near surface, excitable, but feeble; now swimming upright.
7.20. All keep close to surface, and emit air-bells.

P.M.

8.20. Gill-movements have ceased in medium-sized fish; heart-movement still visible. Large and small fish both deeply affected.

9.15. Large fish dead. Small fish deeply affected; swimming upright, but very feebly, near surface.

Next day. Small fish apparently well.

Exp. 114.

P.M.

3.55. Two cockles, of about the same size, were placed—one in sea-water, the other in a 0·5-per-cent. solution of tutin in sea-water. Equal volumes of fluid were used.

4.0. The cockle in tutin solution has opened its shell.

4.10. The cockle in sea-water has not moved. The one in tutin solution keeps opening and closing its shell at intervals of a minute or two.

4.15. Portion of the one in tutin solution is now extruded from its shell; the shell every now and then shuts down sharply, but without the extruded portion being drawn back; when touched with a needle the extruded portion is withdrawn, but is pushed out again after a short interval.

4.25. The one in tutin solution continues extruded, but withdraws when the glass container is tapped with a pencil.

Next day, 9 p.m. The one in tutin solution is dead; throughout the day it has remained with shell open and body extruded; at noon to-day was alive, and withdrew sluggishly when touched with a needle. The one in sea-water is still alive, with the shell firmly closed; it has not been observed to open the shell throughout the experiment; on being placed in the tutin solution it opened its shell in a few minutes, and behaved as the other had done.

Exp. 115.

Jan. 21. At 8 p.m. two flies—a large blowfly and an ordinary house-fly—were placed in a cage with a watch-glass containing a solution of sugar in a 0·1-per-cent. solution tutin. Both were observed to partake freely of the solution on several occasions.

„ 22. At 8.30 p.m. both flies are active, and apparently quite normal; they frequently feed from the watch-glass.

„ 23. At 12.15 p.m. the house-fly is dead. The blowfly is active, and apparently normal.

„ 24. Blowfly quite well; allowed to escape.

Exp. 116.

Mar. 1. About twenty house-flies were placed in each of two cages. Into one cage was put a solution of sugar in a 0·1-per-cent. solution tutin in normal saline; into the other a solution of sugar in normal saline. The flies, being thirsty, at once crowded round both watch-glasses, and partook freely.

„ 4. All the flies are alive, and quite healthy. The flies with the tutin solution do not feed so readily as those with the normal saline; they frequently approach the watch-glass, merely taste the solution, and retire; now and again one will remain feeding.

„ 7. Flies still all alive, and quite healthy; during the week the solution has dried up once or twice, and more 0·1-per-cent. solution tutin has been added. Despite the concentration by evaporation, they have displayed no symptoms.

P.M.

6.40. A few drops of 0·5-per-cent. solution tutin in distilled water added to the watch-glass, which had become dry.

7.0. On returning, found four flies on their backs, but not dead; moving their legs occasionally. Three other flies were affected. Every now and then wings violently buzzed for a second or two, lifting flies on to tip-toes. They walk rather incoordinately.

7.5. One of the affected flies spinning round and round on its back, wings buzzing continuously; movement ceases for a short interval, and is then repeated.

7.8. Both the other flies similarly affected.

7.15. All three are now lying quiescent on backs, with occasional movements of legs.

Mar. 8.

A.M.

10.0. Ten flies dead; several others seem unaffected. A large blowfly introduced into the cage, and observed to drink the solution for 15 minutes.

10.30. Blowfly not so active; does not fly away when probed; shows what seem to be involuntary movements of the legs.

A.M.
10.40. Blowfly very lethargic; walks heavily; can be pushed along without offering to fly; every now and then one or other wing extended to full extent, and held there a moment; this is not a voluntary movement; does not seem to have proper control of legs when walking—one or more legs move irregularly, and not in a suitable direction.

11.0. Blowfly allowed to escape from cage; remained in one position on table till touched, and then flew heavily on to window, crawled into a corner, and was subsequently lost sight of. Two other blowflies introduced into cage; one immediately fed from the watch-glass, and in 15 minutes showed symptoms; lethargic, and disinclined to move.

P.M.
12.0. Second blowfly has been observed to drink but sparingly. First blowfly showing more marked symptoms; tonic spasms of wings and uncontrolled movement of legs; allowed to escape, but on attempting to fly seized with a general convulsion, buzzing round and round on back; was attacked with seizures of this kind until exhausted.

1.0. Lying on side, dead. Quite a considerable drop of clear fluid has exuded from proboscis.

Mar. 10. All the house-flies are dead, and all show marked distention of abdomen. Blowfly apparently unaffected, so allowed to escape; flew about on window for few minutes, and was then seized with convulsions and died, as the others had done.

EXP. 117.

Jan. 30. At 4.30 p.m. some mince was allowed to become infected by blowflies. A small portion of the meat containing the larvæ was placed in each of four watch-glasses, and covered with a 0·01-per-cent., a 0·025-per-cent., and a 0·05-per-cent. solution tutin, and with normal saline respectively. In each case the larvæ began to wander and coil up in the fluid. After one hour these fluids were poured off, and each watch-glass covered with another, to prevent evaporation.

,, 31. At 4.45 p.m. the watch-glasses were examined. In the one treated with normal saline only the larvæ are numerous, have grown, and are very active, crawling all over the surfaces of both watch-glasses. In the 0·01-per-cent. and 0.025-per-cent. solution only one or two larvæ are to be seen in movement; they are very small, and have not wandered from the mince. In the 0·05-per-cent. solution no movement is to be seen.

EXP. 118.

A drop of hay-infusion, containing paramœcia, amœbæ, monads, and bacteria, was placed on each of four slides, labelled A, B, C, D.

P.M.
5.49. One drop normal saline added to B.

5.50. One drop of a 0·1-per-cent. solution tutin in saline added to C.

5.51. One drop of a 0·1-per-cent. solution quinine hydrobromate in normal saline added to D.

6.5. B: No change. C: No change. D: No paramœcia to be seen, but monads and bacteria still moving.

6.30. B: No change. C: Paramœcia may still be seen moving, but their movements are irregular; the monads are collecting at the surface and edge of the drop; this may also be seen in A and B. Another drop of a 0·1-per-cent. solution added to C. D: No movement.

6.50. A and B: No change. C: Still one or two paramœcia moving; are not so easy to find; many monads still active, others stationary; amœbæ still moving; field does not look so lively as it did.

EXP. 119.

7.30. A drop of hay-infusion placed on a slide, and covered with a cover-glass, and a drop of a 0·1-per-cent. solution tutin normal saline placed at edge of cover.

7.35. Some paramœcia have swum out into drop of tutin solution; at once display irregular movements; remain in the drop of tutin solution.

7.40. Movement of paramœcia in drop of tutin solution, which at first were excited, now becoming slower and very irregular; they roll over and over like rotifers.

7.45. Paramœcia at a standstill in tutin solution; they appear to disintegrate internally, and are no longer recognisable; paramœcia under the cover-glass quite normal.

Experiment repeated, using a 0·5-per-cent. solution tutin in distilled water, with similar results.

Exp. 120.

This experiment was essentially similar to Exp. 119.

Exp. 121.

Jan. 28. Six test-tubes were taken and labelled—"0·5 per cent. tutin," "0·4 per cent. tutin," "0·3 per cent. tutin," "0·2 per cent. tutin," "0·1 per cent. tutin," and "normal saline." The volume of fluid in each tube was the same.

P.M.

5.0. A small piece of fresh mince was added to each tube, and the tubes left open to the air.

Jan. 29. At 5·45 p.m. the tubes were corked, and placed in an incubator at 40° C.

,, 31. Tubes opened and examined. The tube containing normal saline was very offensive. None of the other tubes had the offensive smell of putrefaction; the smell was rather like that of stomach-contents.

Feb. 1. Contents of tubes examined under microscope; all show moving bacteria, but the drop taken from the tube containing normal saline was much more crowded, and the bacteria in it showed a greater variety of form and size.

Exp. 122.

Four fermentation-tubes were filled—(1) with glucose solution and tutin (0·25 per cent. of the latter); (2) glucose solution, with 0·1 per cent. tutin; (3) glucose solution alone; (4) water. A few drops of a yeast emulsion were added to each.

P.M.

5.45. Tubes placed in incubator.

7.10. Fermentation in (1) and (3).

7.45. Fermentation in (2) as well, but only half as much gas developed as in (1).

9.30. (1), (2), and (3) fully fermented.

Exp. 123.

4.40. Two fermentation-tubes set on—(1) with glucose alone; (2) with 0·05 per cent. tutin.

5.10. No change.

6.10. Both equally fermented.

8.30. Both fully and equally fermented.

Exp. 124.

Four fermentation-tubes filled with the following:—A: Water (16 c.c.), 25 per cent. glucose (4 c.c.); B: Water (20 c.c.); C: Water (8 c.c.), plus 0·5 per cent. tutin solution (8 c.c.) plus 25 per cent. glucose (4 c.c.) (equals 0·2 per cent. tutin in mixed fluid); D: 0·5 per cent. tutin (16 c.c.), plus glucose (4 c.c.) (equals 0·4 per cent. tutin in mixed fluid). A few drops of freshly procured emulsion of brewers' yeast added to each; D received rather more than the others.

P.M.

3.30. Tubes placed in incubator.

4.40. Small bubbles forming in A, C, and D.

5.10. Same.

6.0. Fermentation most distinct in D.

7.10. Most fermentation in D; slight in C; little or none in A and B.

7.30. Added another drop of yeast emulsion to A.

8.0. Fermentation now as great in A as in D.

This shows that the amount of yeast added exerts a greater influence on the amount of fermentation that occurs than does the presence of tutin.

Exp. 125.

Five test-tubes were taken, containing a 0·1-per-cent., a 0·2-per-cent., a 0·3-per-cent., a 0·4-per-cent., and a 0·5-per-cent. solution tutin in normal saline; and one test-tube containing normal saline alone. Equal volumes of fluid in each test-tube.

Jan. 23. At 4.30 p.m. twelve mustard-seeds were placed to soak in each test-tube.

,, 23. At 4.30 p.m. the seeds from each test-tube were sown on moist felt placed in separate tin boxes, correctly labelled.

,, 24. All the seeds in each box have germinated.

,, 25. At 10.10 a.m. the same progress has been made in each case. All the seeds were replaced in their respective solutions.

Jan. 26. The seeds were resown in the tin boxes.

„ 30. All have grown more or less. The seeds soaked in normal saline have made most progress, and are closely followed by those soaked in 0·1 per cent. and 0·2 per cent. Those soaked in 0·4 per cent. and 0·5 per cent. are growing, but only two or three seeds in each, and the growth is not so vigorous as in the others. Since the 26th the felt in the boxes has been kept moist by the addition of water.

Feb. 3. All the seeds soaked in normal saline have grown, and are growing vigorously. In the boxes labelled "0·1 per cent." and "0·2 per cent." three or four seeds are growing vigorously, and have made nearly as much progress as in the box labelled "normal saline," but the others remain stunted, and one or two have made no progress since being resoaked in the tutin solution. In the boxes labelled "0·4 per cent." and "0·5 per cent." one or two seeds have made good progress, but most of the others are stunted, or have not grown at all.

EXP. 126.

A few bars were taken from the gill of a cockle, and mounted in sea-water, and observed under the low power.

P.M.

4.0. Normal saline perfused under cover-glass.
4.35. No appreciable difference.
4.38. 0·1-per-cent. tutin solution perfused under cover-glass.
4.45. No change.
4.46. 0·2-per-cent. solution tutin perfused under cover-glass.
4.50. Seems to be a slight retardation, but doubtful.
4.51. 0·3-per-cent. tutin solution perfused under cover-glass.
4.52. Obvious slowing; many cilia stationary, others moving feebly.
4.59. Ciliary movement practically ceased.

EXP. 127.

P.M.

5.10. Fresh specimen taken in 0·3 per cent.
5.11. Movements slower.
5.13. Very feeble movement.
5.15. Movements ceased.

Normal saline and afterwards sea-water were then perfused under cover-glass, but recovery did not take place.

EXP. 128.

P.M.

5.30. Fresh specimen taken, and a 0·2-per-cent. solution tutin perfused under cover-glass.
5.37. Movements have practically ceased, except for a few cilia here and there.
5.45. All movement apparently ceased.

A solution of $\frac{1}{1000}$ KOH in sea-water perfused under cover-glass, and ciliary movement immediately resuscitated.

EXP. 129.

P.M.

5.54. Fresh specimen taken, and a 0·2-per-cent. solution tutin applied.
6.5. Cilia still moving; movement confined to the apices of the cilia. A drop of 0·3-per-cent. solution tutin applied.
6.15. Still moving, but less actively. A drop of 0·5-per-cent. solution tutin applied.
7.30. Still moving.

As this piece of gill was rather large, a fresh specimen was taken from a mussel.

EXP. 130.

P.M.

7.45. 0·2-per-cent. solution tutin applied.
7.52. A distinct slowing has occurred, but the cilia are still able to cause a movement of particles. This only occurs in sheltered places. The cilia are at a standstill on the edges.
7.57. A drop or two of sea-water applied, and many cilia restored to action.

In every case a control mounted in sea-water was used for comparison.

EXP. 131.

Two or three gill-bars from a small rock-oyster were taken and mounted in sea-water under a cover-glass. Two preparations were made, and one used as a control. (Low power.)

P.M.
2.30. A drop or two of a 0·5-per-cent. solution in sea-water tutin perfused under cover-glass.
2.35. Appears as if there was a slight slowing of cilia in exposed situations, but doubtful.
2.40. Cilia still moving; more 0·5-per-cent. solution tutin perfused under cover-glass.
3.0. Most cilia in active movement; here and there a few are motionless, or moving feebly.
4.0. Still moving.

EXP. 132.

A fresh preparation was made from the gill of a cockle, and examined with the low power without a cover-glass. A control was used.

P.M.
3.10. A drop of a 0·5-per-cent. solution tutin applied.
3.12. If anything, movements seem exaggerated.
3.20. First drop tutin solution dried off, and a second drop added.
3.50. No effect observable.
4.30. Still in active movement.

EXP. 133.

Three preparations of ciliated epithelium from the gullet of a frog. No. 1 was mounted in normal saline without a cover-glass, and used as a control; No. 2 was mounted in a drop of a 0·1-per-cent. solution tutin, without a cover-glass; No. 3 was mounted in a drop of a 0·5-per-cent. solution tutin, without a cover-glass. Three microscopes were used, and the specimens examined under the low power, with the draw-tube out.

	1.	2.	3
5.14.	Moving.	No effect.	No change.
5.20.	..	No change.	..
5.25.	..	..	..
5.30.	..	..	..
5.35.	..	..	..
5.40.	..	..	..

6.10. The specimens had partially dried, and cilia were seen moving in preparation 3 only.

EXP. 134.

The gullet of a frog was exposed, and the rate of progress along it (by ciliary action) of a small fragment of cork was observed. A centimeter scale was arranged to lie parallel with the gullet, and the time the cork took to travel 1 cm. noted as follows:—

Normal.	Gullet bathed with a 0·3-per-cent. Solution Tutin.
52″	32″
47″	38″
51″	38″
51″	29″
51″	37″
Average, 50·4″	Average, 34·8″

EXP. 135.

Two frogs' nerve-muscle preparations made. Muscles placed in watch-glasses with normal saline. Nerve laid on frog-plate, and kept moist with saline, and stimulated with break shocks. A (in saline), minimal stimulus found to be with coil at 17 cm. B (in saline), minimal stimulus at 21·5 cm. B was then placed in a watch-glass containing a 0·025-per-cent. solution tutin in normal saline at 5.54 p.m.

P.M.		A.	B.
5.55.	Contracts at	20 cm.	20 cm.
6.8.	,,	20 cm.	18 cm.
6.17.	,,	21 cm.	19·5 cm.
7.15.	,,	19·5 cm.	18 cm.
7.35.	,,	19 cm.	17 cm.
8.10.	,,	19 cm.	16 cm.
8.52.	,,	18 cm.	15 cm.
9.35.	,,	18 cm.	12 cm.

Exp. 136.

In this experiment, the nerve of the one preparation (A) was placed in tutin solution (0·5 per cent.), and the muscle of the other (B) in the same. Before placing in tutin solution, A contracts at 28 cm., and B at 34 cm.

P.M.
6.3. Tutin solution applied as above.

		A.	B.
6.6.	Contracts at	31·5 cm.	28·5 cm.
6.17.	,,	30·5 cm.	30 cm.
7.22.	,,	33 cm.	27·5 cm.

Exp. 137.

One muscle in saline (B) and one in a 0·05-per-cent. solution tutin (A). Nerves exposed to air, and kept moist. Stimulated as before. Before tutin applied, A contracts at 30·5 cm., and B at 25·5 cm.

P.M.
6.15. Placed in tutin solution.

		A.	B.
6.20.	Contracts at	28·5 cm.	25 cm.
6.28.	,,	28·5 cm.	24 cm.
7.25.	,,	24·5 cm.	22·5 cm.
8.20.	,,	25·5 cm.	25 cm.

Exp. 138.

Same as previous experiment. Before tutin (interrupted current), A contracts at 36 cm., and B at 32 cm.; single shocks, A contracts at 27 cm., and B at 25·5 cm.

A.M.
10·56. A placed in a 0·05-per-cent. solution tutin in normal saline. B left in saline.

		A.	B.
11.2.	Contracts at	27 cm.	26 cm.
11.20.	,,	26·5 cm.	25 cm.
P.M.			
12.20.	,,	24 cm.	24·5 cm.
1.0.	,,	21·5 cm.	23 cm.

Exp. 139.

Rabbit (young). Weight, 804 grams.

Blood-films were taken, dried in the air, and fixed with Jenner's stain; and next morning at—

A.M.
11.36½. Gave 25 minims of a 0·5-per-cent. solution tutin (10 mlgm. per kilo), hypodermically.
11·56. Shaking-movements of head; pupils normal.
11.58. Shaking and rocking of whole body; lying prone on belly.
11.59. Twitching of ears.
P.M.
12.0. Twitching of hind limbs and then of fore limbs.
12.1½. Severe convulsions; kicking-movements; head drawn back; clawing-movements; convulsions lasted 2 minutes; pupils did not dilate; cornea damaged by rubbing open eye on floor in convulsion.
12.3½. Lying on side, with head bent back; hind and fore limbs show running-movements.
12.4½. Clonic convulsion.
12.6. Convulsion passed, but running-movements of legs continue.
12.8. Clonic convulsion.
12.11. Convulsion passed: running-movements continue; head bent well back.
12.13. Convulsive movements of jaw and ears, gradually merging into a general convulsion.
12.15. Momentary quiescence.
12.18. Jaw and limb movements continue. The lower jaw is pushed forwards, and then clenched so that lower incisors lie outside upper incisors, then they slip inside the upper incisors with a grating sound.
12.22. Movements still continue; no cry has been uttered by the animal as yet; respiratory movements are not much in evidence; movement of limbs, jaw, and retraction of head most prominent.

P.M.
12.32. Same; lying on left side, with occasional kicking-movements.
12.34. All movement ceased, except that heart can be seen beating by movement of hairs over precordial region.
12.36. Dead.

P.M.—Stomach not distended; contained only food; blood-film taken from the left ventricle only; heart had ceased beating; lungs not congested; bladder full.

Result.—10 mlgm. per kilo caused death in less than one hour.

Exps. 140–151.

Experiments 140 to 151 inclusive referred to the blood-pressure work, details of which are omitted.

Exp. 152.

Cat. Weight, 3·52 kilograms.

P.M.
3.6. Chloroform administered with a Skinner's mask. The skin was reflected, the cranium trephined over the right parietal region, and the bone removed with bone forceps until the greater part of the right cerebral hemisphere was exposed.
4.10. 50 minims of a 0·5-per-cent. solution tutin was injected hypodermically, and the administration of the anæsthetic discontinued.
4.24. As no symptoms had appeared, 25 minims of a 0·5-per-cent. solution tutin was injected into the peritoneum.
4.32. Slight twitching of the head and ears noticed, followed in a minute or two by convulsive movements of the paws. The right cerebral hemisphere was immediately scooped out. The convulsive movements continued as before, affecting both sides equally. The left cerebral hemisphere was then removed. The convulsive movements continued. The breathing was greatly exaggerated, and at intervals large quantities of urine were shot out with considerable force.
4.45. The spinal cord was then divided at the level of the 5th dorsal vertebra.
4.49. Spasmodic movements of the hind limbs; the limbs were rigidly flexed on the abdomen and shaken with clonic spasms.
4.54. Movements of fore paws.
4.56. Slow spasmodic movements of hind limbs, the slow rigid movement towards the abdomen ending in clonic spasms. The reflexes in the hind limbs are exaggerated, the legs being quickly drawn up, and showing clonic movements.
5.0. The fore limbs have been quiescent for some time; movements occurring in the hind limbs only.
5.3. Reflexes still markedly exaggerated (clonus) in the hind limbs, but cannot be elicited from the fore limbs.
5.9. All respiratory movements ceased, and reflexes absent.

P.M.—The chest was opened at once, and slight heart-movements found to be still present. The bladder, notwithstanding the large quantities of urine ejected during the experiment, was full. The cerebral hemispheres were found to be entirely removed; the corpora quadrigemina were intact; the cord was found to be divided within the dura mater at the level of the 5th dorsal vertebra; the cord was crushed through rather than cut through (scissors, not too sharp, having been used to divide it), but its continuity was completely destroyed.

Exp. 153.

Cat. Weight, 2·4 kilograms.

P.M.
2.50. Chloroform anæsthesia induced, and spinal cord exposed, and completely divided in the mid-dorsal region; 1 c.c. of a 0·5-per-cent. solution of tutin was then injected into the peritoneum, and chloroform discontinued.
3.0. No response to electric stimulus applied to left hind foot, but marked response when applied to left fore foot.
3.5. Slight twitching of ears and jerking of head.
3.14 Distinct tutin twitches of head and fore limbs.
3.16. Convulsion of fore part of body, accompanied by movement of tail; hairs of tail have not become erect; great salivation.
3.20 Convulsive movement of fore part of body continues; a movement of the tail near the tip; 1 c.c. of a 0·5-per-cent. tutin injected into peritoneum.
3.22. Swishing-movement of tail from side to side; reflex response to pricking left hind leg with a knife distinctly obtained during convulsion of fore part.
3.28. Movement of tail during convulsion of fore part.
3.29. Severe convulsions of fore part, accompanied by marked lashing-movement of tail.

P.M.

3.32. More convulsions, with lashing of tail; movement of tail sometimes occurs quite apart from any movement in fore part of body, but occurs also with marked regularity at the beginning of each fit of fore part.

3.42. Several movements of tail, with no convulsion of fore part; tail sometimes moved from root and sometimes only the tip; movement is mainly from side to side, but now and then the whole tail is lifted upwards. Reflexes present in the hind part; movements of both limbs on tapping one.

3.45. Movement of tail becoming more marked, while fore part more quiescent.

3.46. Defæcation occurred.

3.47. Hind limbs spasmodically drawn up to abdomen several times; then a slight fit of fore part occurred, and movements of tail, with tetanic movement of hind limbs.

3.50. Tonic and clonic spasm of hind limbs; claws extruded.

3.52. Respirations slow and gasping.

3.54. Heart-beat vigorous; as heard by stethoscope, 72 per minute. Twitches of fore paws and tonic spasm of hind limbs, with erection of hairs of tail.

4.4. Clonic movements of left hind limb.

4.5. Distinct tonic and clonic spasm of both hind limbs; limbs fully extended, with claws extruded; respiration infrequent and difficult, owing to obstruction of air-passages by saliva and mucus; heart intermittent, misses one or two beats towards the end of inspiration.

4.6. More movements of hind limbs, fore part motionless; respirations about four per minute.

4.6½. Another spasm of hind quarters.

4.7. Respirations ceased: heart audible by stethoscope, beating regularly for two minutes and a half after last respiratory gasp.

EXP. 154.

A frog (*Hyla aurea*), pithed in the ordinary way three hours previously, was suspended by the head. At intervals of a few minutes its feet (as far as the ankle) were dipped into dilute sulphuric acid, of a strength of 1 in 1,000. After each dipping the feet were carefully washed in fresh water. The time was taken by a seconds-clock, and the result was as follows:—

	Right Foot.	Left Foot.
Frog A	8″	9″
,, ...	6″	8″
,, ...	6″	4″
,, ...	6″	4″
,, ...	4″	6″
,, ...	6″	6″
,, ...	6″	6″
,, ...	6″	6″
Average	6″	6″

6·3 minims of a 0·1-per-cent. solution tutin (11 mlgm. per kilo) was then injected under the skin of the back, and after an interval of 30 minutes the feet were again dipped in the acid:—

	Right Foot.	Left Foot.
Frog A	5″	4″
,, ...	4″	4″
,, ...	6″	6″
,, ...	8″	8″
Average	5·8″	5·5″

Here a further dose of 10 minims was injected, and after an interval of 15 minutes the feet were dipped as before:—

	Right Foot.	Left Foot.
Frog A	4″	4″
,, ...	4″	4″
,, ...	4″	4″
,, ...	4″	4″
Average	4″	4″

Each time the feet were withdrawn together, and, it was thought, more actively than before the tutin was injected.

Exp. 155.

The experiment was repeated with a second frog, pithed in the same way four hours previously. The result was as follows :—

	Right Foot.	Left Foot.
Frog B	6″	7″
,,	10″	11″
,,	8″	8″
,,	8″	8″
,,	8″	8″
,,	8″	8″
,,	8″	8″
,,	8″	8″
Average	8″	8·3″

10 minims of a 0·1-per-cent. solution tutin was then injected under the skin of the back, and after an interval of half an hour the reaction-time again tested. The time when movement first took place only was noted.

Twitched at 2″; withdrawn at 4″

Frog B	6″
,,	6″
,,	6″
,,	14″
,,	14″
,,	20″
,,	16″
,,	22″
,,	14″
Average	12·2″

At 22 seconds there was a slight twitch, but no further movement took place, although 70 seconds were counted. Pinching or pricking a foot met with an immediate response, but the acid had no influence. Five minutes later no reflex movement could be elicited by any means, and the heart could no longer be seen beating through the chest-wall.

Frog A was then tested again, and found to respond as actively as before.

Exp. 156.

A third frog, pithed one hour previously, was treated in the same way.

Frog C	10″	Right leg only withdrawn. Frog removed from acid as soon as first movement took place.
,,	5″	
,,	5″	
,,	5″	
,,	5″	
,,	5″	
Average	6″	

2 minims of a 0·5-per-cent. solution was then injected under the skin of the back, and 10 minutes were allowed to elapse before the feet were dipped again.

Frog C	6″	
,,	5½″	Both legs withdrawn.
,,	5″	
,,	5½″	
,,	5″	
,,	5½″	
Average	5″	

1 minim of a 0·5-per-cent. solution tutin was then injected into the heart.

Frog C	5″
,,	5½″
,,	6″
,,	6″
,,	6″
Average	$5\frac{2}{5}$″

Exp. 157.

A fourth frog, pithed one hour previously.

Frog D	8″	Movements of lower limbs only.
,, ...	5″	
,, ...	7″	
,, ...	6″	
,, ...	5″	
,, ...	6″	
,, ...	6″	
,, ...	6″	
,, ...	6″	
,, ...	6″	
Average ..	6·1″	

5 minims of a 0·1-per-cent. solution tutin (10 mlgm. per kilo) was then injected under the skin of the back, and six minutes later the test reapplied.

Frog D ..	2″	Very extensive general movements.
,, ..	4″	Arms moved as well.
,, ..	2″	Legs and subsequent movements of arms.
,, ..	1″	Legs, spreading to arms.
,, ..	2″	Legs, arms not moved so vigorously.
,, ..	4″	Both legs only.
,, ..	5″	Legs only, response more sluggish.
,, ..	4″	Legs only.
,, ..	4″	,,
,, ..	2″	Legs and arms.
Average	3″	

Exp. 158.

The experiment was repeated a fifth time. In this case the frog had been pithed in the usual way one hour previously, but it appeared to retain some power of voluntary movement, and was so restless that it was suspected that the cerebrum had not been completely destroyed. Extensive general movement followed each application of the acid.

	Left Foot.	Right Foot.
Frog E	2″	2″
,, ...	4″	4″
,, ...	3″	4″
,, ...	12″	4″
,, ...	14″	7″
,, ...	11″	8″
,, ...	12″	9″
,, ...	9″	11″
,, ...	8″	6″
Average	8·3″	6·1″

1 minim of a 0·5 per-cent. solution tutin was then injected (about 12 mlgm. per kilo) under the skin of the back, and 15 minutes later the feet were again dipped into the acid; but before this was done a typical tutin convulsion occurred.

	Left Foot.	Right Foot.
Frog G	13″	20″
,, ...	9″	9″
,, ...	50″	70 seconds were counted, but the right foot was not withdrawn.
,, ...	38″	38″
,, ...	20″	15″
Average	22″	20″

On examination the optic lobes were found to be intact.

Exp. 159.

The experiment was repeated with a sixth frog. This was beheaded a little in front of the anterior border of the tympanic membrane, so as to sever all in front of the top of the medulla.

	Right Foot.	Left Foot.
Frog F	7″	5″
,, ...	7″	7″
,, ...	9″	9″
,, ...	8″	9″
,, ...	14″	12″
,, ...	15″	13″
Average	8·5	9·1

1 minim of a 0·5-per-cent. solution was then injected under the skin of the back, and 8 minutes later the test reapplied.

	Right Foot.	Left Foot.
Frog F	10″	10″
,, ...	38″	38″
,, ...	84″	84″
Average	44″	44″

As a result of letting the frog fall on the table, a typical tutin spasm, with croaking, occurred here. Seemed to require severe irritation to induce a spasm. A spasm occurred on striking sharply with a glass rod.

250 seconds were counted, but feet not withdrawn. Slight twitches occurred, however, at 58″, 71″, 86″, 94″, and 120″. 100 seconds more, but no effect.

Although the acid had ceased to have any influence, it was still possible to elicit reflex action on painful stimulation—*e.g.*, pinching.

Ten minutes later reflexes could not be elicited in any way. The thorax was then opened, and the heart found to be still beating. The auricles were distended. Twitching occurred as the cord was being pithed.

Exp. 160.

A few drops of a solution of tutin were introduced into the right eye of a young rabbit. Within a few minutes there seemed to be a very slight dilatation. In an hour and a quarter the right pupil was thought to be slightly the larger by an observer ignorant of which eye had been subjected to the test, but the difference was so very slight, if existing at all, that the result was regarded as doubtful.

Exp. 161.

Four small drops of a 0·5-per-cent. solution tutin were introduced into the left conjunctival sac of a rabbit. It was observed for 15 minutes, and no change in the size of the pupil was noted. No hyperæmia of the conjunctiva resulted, nor did the conjunctiva become less sensitive.

This rabbit died twenty-four hours later, after exhibiting symptoms of tutin poisoning.

Exp. 162.

P.M.

2.50. Two drops of a 0·5-per-cent. solution of tutin introduced into the right eye of a cat.
2.52. No apparent effect.
2.55. No change.
3.0. No change.
3.5. Pupils are the same size, and react equally to light.
3.10. No effect.
4.0. Pupils equal.

Exp. 164.

P.M.

3.25. 0·5 c.c. of a 0·5-per-cent. solution of coriamyrtin was instilled into the right eye of a rabbit.
3.30. No apparent effect.
3.35. Difficult to say if any effect; the right eye may possibly be slightly contracted.
3.40. An observer ignorant of which eye had been treated was unable to distinguish any difference between the two pupils.
4.0. Pupils appear equal, and react to light with equal readiness. No appearance of irritation of conjunctiva.

EXP. 165.

P.M.
3.14. Two drops of a 0·5-per-cent. solution of coriamyrtin introduced into the left eye of a cat.
3.16. No change in size of pupil observed.
3.22. No change.
3.30. Pupils equal, and react to light with equal readiness.
4.0. Pupils appear to be equal.
4.30. No change.

EXP. 166.

Rabbit. Weight, 777 grams.

Jan. 24. At 4.50 gave 13·2 minims of a 0·1-per-cent. solution tutin (1 mlgm. per kilo), hypodermically.
„ 25. No obvious effect.
„ 27. Gave 13·2 minims of a 0·1-per-cent. solution, per os.
„ 28. Normal, so gave 13·2 minims of a 0·1-per-cent. solution, per os.
„ 30. Repeated dose of 13·2 minims of a 0·1-per-cent. solution, given per os.
Feb. 4. Weight, 848 grams. Gave 21·6 minims of a 0·1-per-cent. solution (1·5 mlgm. per kilo), per os.
„ 8. Normal. Gave 4 minims of a 0·5-per-cent. solution tutin (1·5 mlgm. per kilo), per os.
„ 11. Weight, 879 grams. Gave 2 mlgm. per kilo, per os.
„ 12. No symptoms; normal.
„ 14. Weight, 862 grams. Gave 7·3 minims of a 0·5-per-cent. solution tutin (2·5 mlgm. per kilo), per os.
„ 17. Weight, 922 grams. Normal, so gave 7·8 minims of a 0·5-per-cent. solution tutin (2·5 mlgm. per kilo), per os.
„ 20. Normal.
„ 24. Weight, 958 grams. Normal, so gave 9·7 minims of a 0·5-per-cent. solution (3 mlgm. per kilo), per os
„ 27. Weight, 983 grams. Gave 11·6 minims of a 0·5-per-cent. solution (3 mlgm. per kilo), per os.
Mar. 3. Weight, 991 grams. Gave 13·4 minims of a 0·5-per-cent. solution (4 mlgm. per kilo), per os.
„ 7. Normal. Gave 5 mlgm. per kilo, per os.
„ 9. Normal.
„ 12. Weight, 1,154 grams. At 2.40 p.m. gave 23·5 minims of a 0·5-per-cent. solution tutin (6 mlgm. per kilo), per os. At 4 p.m. shows symptoms; extends fore and hind limbs, and lies on belly; ears and head tremulous.
„ 16. Weight, 1,181 grams. Gave 7 mlgm. per kilo. Not continuously observed. Recovered.
„ 19. Weight, 1,176 grams. Gave 8 mlgm. per kilo. In 3½ hours showed symptoms (twitching of ears, chewing-movements, &c.). Recovered.
„ 24. Gave 11·6 mlgm. per kilo, per os. Result, death in two hours.

EXP. 167.

Jan 24. Guinea-pig. Weight, 627 grams.
P.M.
5.0. Gave 10·2 minims of a 0·1-per-cent. solution of tutin (1 mlgm. per kilo), hypodermically, with antiseptic precautions.
6.30. Convulsive movements of jaw; animal standing in unnatural attitude.
Jan. 25. Apparently normal.
„ 27. Gave 10·2 minims of a 0·1-per-cent. solution tutin (1 mlgm. per kilo), per os.
„ 28. Showed no symptoms; normal to-day, so repeated dose, 10·2 minims per os.
„ 30. No symptoms; repeated dose, 10·2 minims, per os.
Feb. 4. Weight, 644 grams. At 5.36 p.m. intended to give 17 minims of a 0·1-per-cent. solution tutin (1·5 mlgm. per kilo), per os, but syringe not set before giving, and so probably less than 17 minims given.
Feb. 8.
P.M.
5.50 Intended to give 17 minims of a 0·1-per-cent. solution tutin, per os, but 17 minims of a 0·5-per-cent. solution was given by mistake. Mistake discovered, and 0·5-per-cent. gram chloral-hydrate given, per rectum, at 6.5 p.m. Immediately on withdrawing nozzle of syringe a few pellets of fæces were discharged, but very little fluid returned.

P.M.
6.20. Is under the influence of chloral, but showing twitches of fore limbs.
7.5. Apparently still under chloral ; is quite limp.
9.0. Awake, and easily startled ; ears cold, and whole body shivering ; was wrapped in towel.
9.20. Will not remain covered up. Shivering not so marked.
10.0. Same.

Feb. 9.
A.M.
9.0. Apparently normal, quite warm, breathing is regular.
P.M.
2.0. Does not seem to have eaten ; seems dazed.
11.0. Did not try to escape when went to lift it, but resents being handled ; otherwise appears normal.

Feb. 10.
A.M.
9.0. Seems stiff in the hind quarters ; moans when touched ; has not eaten. Noticed moist condition of uroanal opening.
P.M.
2.30. Completely paralysed, and cold in hinder half of body ; breathing thoracic ; eyes kept wide open ; moans when handled, and showed some convulsive movements of fore limbs and head.
3.0. Found dead.

P.M.—Stomach distended with gas ; intestines contain mixed gas and fluid contents ; peritoneum much injected ; appearance suggestive of general peritonitis.

Exp. 168.

Feb. 27. Cat. Weight, 2·686 kilograms.
P.M.
5.12. Gave 13 minims of a 0·13-per-cent. solution of picrotoxin (0·375 mlgm. per kilo), hypodermically.
5.22. Quite normal ; cleaning itself.
5.30.
5.35.
5.40. Same. No departure from the normal.
6.30.

Feb. 28. Quite normal.

Exp. 169.

Mar. 3. Same cat. Weight, 2·699 grams. Fresh solution of picrotoxin.
P.M.
4.0. Gave 6·8 minims of a 0·25-per-cent. solution picrotoxin, freshly prepared (0·375 mlgm. per kilo), hypodermically.
4.16. No symptoms.
4.20. Has defæcated, and swallows occasionally, but seems so well that these may be normal appearances.
5.15. No apparent abnormality.
5.40. Same.

Mar. 4. Has displayed no symptoms, and seems perfectly well.

Exp. 170.

Cat. Weight, 2·699 kilograms.

This cat previously received 1 mlgm. tutin, and recovered ; will now receive an equimolecular solution of picrotoxin, $\frac{557}{336} \times 1$ mlgm. picrotoxin = 2·66 mlgm. picrotoxin = 18 minims of a 0·25-per-cent. solution picrotoxin.

P.M.
5.20. Gave 18 minims of a 0·25-per-cent. solution of picrotoxin.
6.0. No symptoms as yet, beyond occasional swallowing.
6.7. Salivating ; mouth open, panting, vomited ; vomiting repeated several times ; breathing slower after vomiting ; defæcated.
6.10. Retching ; this a more marked symptom than with tutin. Animal looks much less disturbed than with tutin at this stage.
6.15. Every now and then spasmodic contraction of diaphragm, suggesting hiccough ; looks sleepy.
6.20. Twitching affecting fore paws only ; no face or ear twitching.
6.25. Twitching again, more marked, causing a little spring with fore part of body ; is very easily startled.

P.M.
6.27. Another more marked twitch; sudden spring, with fore arms bowed, giving appearance of trying to cling to the ground; cat more alarmed and astonished at the twitching than in the case of tutin; cerebrum seems less affected; twitches at the slightest noise—*e.g.*, tap of foot on floor, or turning page of note-book.
6.32. Much more marked twitching; cat stands in unnatural attitude, afraid to move; every movement causes a sharp spasmodic contraction of muscles; breathing very rapid.
6.35. General clonic convulsion, lasting a minute and a half; no tonic stage noticed; rose immediately seizure had passed; stands in unnatural attitude, afraid to move; twitching of eyelids noticed for first time; seems quite clear mentally.
6.40. Very cautiously assumed a sitting-position, on haunches; continuous twitching; looks up at once if spoken to; twitching has not been so general since the convulsion, nor is it so easily excited by stamping the foot; not so much salivation as with tutin; watching with interest movements of a rabbit in a cage opposite.
6.50. Twitching only very occasional and slight; sitting with eyes closed, as if dozing; breathing normal.
6.55. Twitching more marked again, and is again easily induced by a sudden noise.
7.12. Sitting on haunches, in normal attitude; gives occasional uneasy starts; head drawn back quickly, or to one or other side.
7.22. Still twitching a little; eyes half-closed most of the time; no sign of pain.
7.33. Came to front of cage, and rubbed itself against wires; then sat down as before; is still disturbed by twitchings of fore limbs and head, but it is slighter than it was.
7.43. Drowsy, but wakes up with a start.
8.0. Starts are much less frequent, and very slight.
8.22. Apparently asleep, sitting on haunches; no further twitching noticed.
8.30. Same.
9.0. Apparently normal.
9.35. Same.
Next day. Quite recovered.

EXP. 171.

Cat. Weight, 3 kilograms.

P.M.
4.38. Received 10 minims of an emulsion of coriamyrtin (3 mlgm. or 1 mlgm. per kilo).
4.48. Twitching first noticed; saliva dripping from mouth; mouth open.
4.50. Vomited; breathing greatly exaggerated.
4.51. Defæcated
4.54. Breathing still rapid; twitching increases.
4.56. General convulsion, mostly clonic, lasted 30 seconds; pupils dilate with each twitching.
5.0. Panting hard and twitching constantly.
5.1. General tonic and clonic convulsion, emprosthotonos, almost standing on head; breathing suddenly became normal after convulsion; then lay with face pressed on floor, breathing heavily; minor twitching continues.
5.7. Clonic convulsions, chin bent down on chest, limbs spread-eagle on either side; stands in an elongated crouching attitude, pressing forehead against floor; respirations, 160 per minute.
5.8. Clonic convulsions, emprosthotonos, pupils return to normal size in intervals.
5.10. Another convulsion; pupils dilated, as usual.
5.11.
5.12.
5.14. } General convulsions; intervals very short.
5.16.
5.20. During a fit, tail rigidly arched over back; died in this convulsion. Heart inaudible to stethoscope immediately after.

P.M.—Three hours afterwards. Membranes of cord and brain markedly congested; intestines pale; heart, right side enlarged, left side contracted; hæmorrhagic patches in lung; urinary bladder empty; gall-bladder moderately full; uterus contained three fœtuses; pieces of cord and brain fixed in 8 per cent. formal sections, made by paraffin method.

EXP. 173.

Feb. 11.

Rabbit. Weight, 1·264 kilograms.

P.M.
4.47. Gave 0·6 grams of a 1-in-1 solution chloral-hydrate, per rectum. Slight loss of the fluid.
4.57. Is anæsthetised: gave 17·1 minims of a 0·5-per-cent. solution of tutin (4 mlgm. per kilo), hypodermically.

P.M.
6.25. Recovered consciousness; marked twitching of head and ears; sitting up.
7.15. Sitting erect on fore paws; salivating freely; convulsive movements of jaws.
7.25 to 7.45. Seizures almost continuous; placed on a table: it raises itself by straightening its fore paws, and pushes its body further and further back, then sinks forward apparently exhausted, so that the fore limbs are spread out at right angles to the trunk; meanwhile jaws are grinding together, and saliva seems to be swallowed; pupils moderately dilated, but as daylight nearly gone this may be natural.
7.57. As condition continues, gave another rectal dose of 0·6 gram chloral. After getting this it showed the symptoms described by Marshall, of pushing itself back till it actually fell backwards over its tail. The pupil was dilated, and would not contract when a match was held close to it.
8.7. No cessation of symptoms; fell over tail again; interval between seizures varies, about one minute; no general convulsion, as is the case when chloral is not given.
8.15. Has been quieter the last few minutes, as if dozing as it sits.
8.30. Lying on side, apparently under chloral; breathing very shallow; no twitching.
8.40. Respirations extremely feeble.
8.45. Spontaneous movements; tried to rise; raised head, and fell over on the other side.
9.0. No further tutin symptoms; moves occasionally, especially if touched.
9.30. Still the same; has passed urine; is sitting with nose in a corner of cage, as if dozing; eyes half-shut; does not mind being touched or handled; ears cool.
10.0. Same, but has changed its position several times.
10.40. Moving about more freely; seems to suffer from irritation of the anus; is more like normal than it has been since 7 p.m.
10.50. Same; has passed some pellets of fæces and some thin fæcal matter; behaves normally when approached, and seems wide awake; can use all its limbs.
Feb. 12. At 5 p.m. seems normal, except that it is suffering from diarrhœa.
„ 13. Found dead in the morning.

EXP. 174.

Rabbit. Weight, 1·455 kilograms.

P.M.
5.45. Gave, per rectum, 0·6 gram chloral-hydrate.
5.55. Gave 13·8 minims of a 0·5-per-cent. solution tutin (3 mlgm. per kilo), hypodermically.
6.10. Animal apparently fully anæsthetised; wrapped in a soft towel to maintain temperature.
6.25. Same.
7.5. Dazed and sleepy looking; no movements other than respiratory; eyes open.
7.35. Made starting-movements with head, and moved hind limbs: is still wrapped in towel; removed towel.
8.0. Has had frequent startings, but is very quiet most of the time.
8.25. Sitting up, apparently dozing; has been somewhat restless, but no sign of convulsion; covered it up with towel, and noticed that it has passed urine.
8.55. Sitting in a corner of cage, quite awake, but does not seem at ease; still frequent startings; breathing slow and deliberate.
9.7. Seems to feel some irritation at anus, possibly from the rectal injection; put its head down, as if to lick anus.
9.20. Apparently normal.
10.0. Has been continuously observed, but no sign of convulsions.
11.0. Apparently quite normal; resists having its ears pulled; has passed some fæces.
11.30. No further change; sitting with eyes wide open; easily startled.
Next day. Apparently normal.

EXP. 175.

Rabbit. Weight, 1·534 kilograms.

P.M.
3.15. Gave 1 c.c. (1 gram) of a solution of chloral-hydrate, per rectum, and 20·8 minims of a 0·5-per-cent. solution tutin, hypodermically (4 mlgm. per kilo).
3.25. Lying on side, under chloral anæsthesia; respiration, 42 per minute.
3.45. Still sleepy under chloral; breathing the same; no tutin symptoms.
3.49. Turned over on to the other side; respirations, 40 per minute; blinks eyes once or twice in succession occasionally.
5.0. Twitching and convulsive movements.
5.15. Same convulsive movements.
6.30. Same, but more feeble.
9.20. Died.

Exps. 176, 177, 178, 179.

Four frogs. Weights: A, 27 grams (Exp. 176); B, 37·5 grams (Exp. 177); C, 28 grams (Exp. 178); D, 34·5 grams (Exp. 179).

P.M.
6.0. To each frog was given 0·012 gram chloral-hydrate, hypodermically. It was intended to give 0·008 gram chloral-hydrate to frogs C and D, but by mistake they received the same dose (0·012 gram) as A and B.
6.5. B received 15·3 minims of a 0·05-per-cent. solution tutin (12 mlgm. per kilo), hypodermically; C received 10·4 minims of a 0·05-per-cent. solution tutin (11 mlgm. per kilo), hypodermically; D received 14 minims of a 0·05-per-cent. solution tutin (12 mlgm. per kilo), hypodermically.
Next day. A is normal, B is dying, C is dead, D is dying.

Exp. 180.

Rabbit. Weight, 1·4 kilograms.

P.M.
5.55. Gave 1·5 grams urethane, by stomach-tube.
6.20. Apparently under, very sleepy and limp. Gave 4 mlgm. tutin per kilo, hypodermically.
7.30. Symptoms first observed; they were not present at 7.15 p.m.
8.0. Twitching of ears and head, and starts of fore part of body; no salivation; was handled a little roughly in trying to see if salivation present, and went into a typical fit; it lay on one side, and fit succeeded fit in rapid succession; movements chiefly clonic; no tonic phase could be detected.
8.30. As fits still continue, and animal seemed doomed, tried about 1 c.c. of a 10-per-cent. sodium-carbonate, per rectum. While giving injection noticed involuntary urination.
8.45. Sodium-carbonate had produced no obvious effect, so tried chloroform; administered it as carefully as possible, with a Skinner's mask; breathing was shallow and rapid; under influence of chloroform animal became quiet, movements of limbs ceased, head moved slowly backwards, and breathing ceased suddenly without the least warning; the heart could not be felt beating, and artificial respiration had no effect.

Exp. 181.

Feb. 4. Rabbit was chloroformed, stomach-tube passed; 0·85 c.c. paraldehyde (1·2 c.c.
P.M. per kilo), dissolved in 10 c.c. water, given.
5.0. Noticed that reflexes had returned.
6.15. Asleep.
Feb. 5. Recovered.

Exp. 182.

Rabbit. Weight, 1·551 kilograms.

P.M.
4.48. Gave $\frac{1}{200}$ grain hypodermic tabloid of hyoscine hydrobrom, hypodermically.
5.15. Apparently no effect, so gave a second dose of $\frac{1}{200}$ grain, per os.
6.5. No effect.
Next day. Normal.

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ART. XXXIV.—*Notes on a New Zealand Actinian,* Bunodes aureoradiata.

By F. G. A. STUCKEY, M.A.

[*Read before the Wellington Philosophical Society, 3rd June, 1908.*]

THE family *Bunodidæ* was established by Gosse for the reception of forms "the surface of whose column is studded with persistent tubercles, and which is not provided with marginal spherules or with perforations of the integument." Among other genera it included *Tealia* and *Bunodes.* The latter genus included one species, *B. coronata,* which was provided with acontia,* structures which are now recognised as denoting sagartiad affinities. Among the "Challenger" material Hertwig found a *Bunodes* (*B. minuta*) "whose structure approaches that of *Sagartia* more closely than that of *Tealia.*" Considering, therefore, that *Bunodes* and *Tealia* should be widely separated systematically, he placed the genus *Bunodes* among the sagartiads,† and established the family *Tealidæ,* taking *T. crassicornis* as its type. He made the presence of a strong endodermal sphincter muscle the leading characteristic of the family, also regarding of importance the presence of a large number of perfect mesenteries, and including forms with both smooth and warty columns. Later‡ he changed the name of the family, restoring the older name *Bunodidæ.*

Referring to Gosse's description of various species of *Bunodes,* we find the hexamerous condition to be constant, the tentacular formulæ being $6 + 6 + 12 + 24 = 48$, $6 + 6 + 12 + 24 + 24 = 72$, or $6 + 6 + 12 + 24 + 48 = 96$. Again, in Delage and Herouard the number of mesenteries in *Bunodes* is stated to be 24 pairs, 12 of them being perfect. Gosse's description of *T. crassicornis* states the tentacular formula as $5 + 5 + 10 + 20 + 40 = 80$. Again, Bourne§ gives the mesenterial arrangement of *T. crassicornis* as follows: 10 pairs complete and apparently primary, 10 pairs secondary, 20 pairs tertiary. There appears to be reasonable ground for thinking that the hexamerous and pentamerous forms should not be associated in the same family. Bourne separates them, and, "provisionally accepting" an ingenious suggestion made by Boveri in his "Development and Phylogeny of Zooantharia," makes *Tealiidæ* one of his families in which the hexamerous arrangement is obscured by precocious development of the secondary and succeeding cycles of mesenteries.

In a paper (1901) which I have not seen, but which is referred to by Torrey,‖ McMurrich unites in a new family, *Cribrinidæ,* Ehrenberg's genus *Cribrina,* which he thinks synonymous with *Bunodes* (Gosse), *Bunodactis* (Verrill), and *Evactis* (Verrill). As I do not know his reasons for this change, I propose for the present to retain the older name of the family—namely, *Bunodidæ.*

Fam. BUNODIDÆ.

Tentacles digitate; pedal-disc present, acontia absent; sphincter strong, circumscribed, endodermal; numerous perfect mesenteries; column generally covered with warts.

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* "Actinologia Britannica," p. 204.
† "Challenger" Report, Zoology, vol. vi.
‡ Supplement to "Challenger" Report.
§ "Treatise on Zoology," ed. Ray Lankester.
‖ Proc. Wash. Ac. Sc., vol. iv, p. 390.

Genus Bunodes.

Bunodidæ with tubercles arranged in vertical series. Only the series corresponding to the mesenteries of the 1st cycle run the full length of the column. Marginal spherules on edge of disc. 24 pairs of mesenteries, 12 of them perfect, and all fertile except the directives.

Bunodes aureoradiata, n. sp.

Specific Character.—Yellow radii in 6 groups of 3.

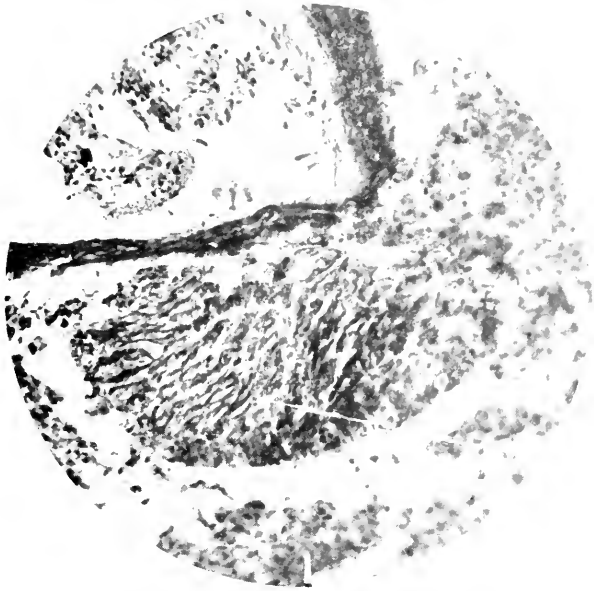
Pedal-disc.—Adherent; slightly wider than the column; the edge undulate to correspond with the vertical rows of tubercles. On each undulation are 2 or sometimes 3 perforations, through which, when irritated, the animal projects nematocysts torpedo-fashion, and in such a manner as at first sight to suggest feeble acontia.

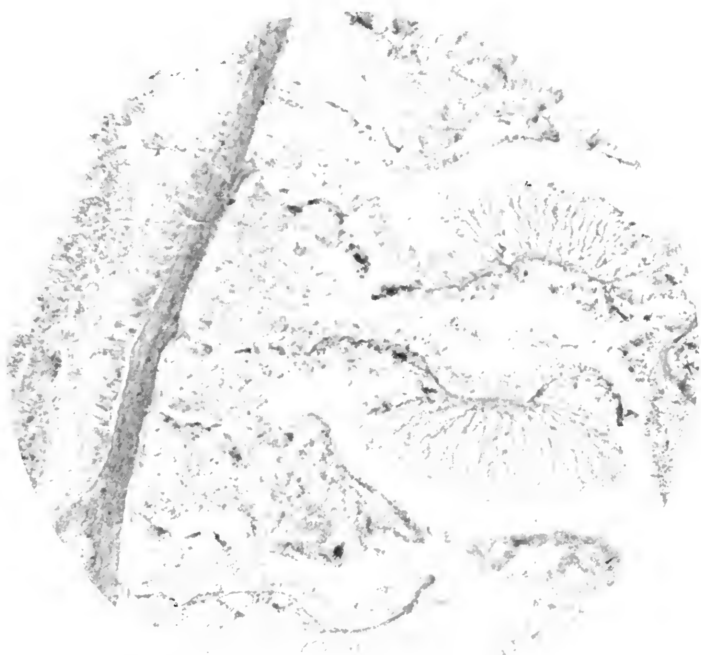
Column.—Cylindrical. In full expansion it is higher than the breadth. The lower half is light or yellowish-brown, upper half greenish-brown. There are 24 vertical rows of tubercles or verrucæ: near the bottom of the column these become mere markings; they increase in size as they ascend the column, culminating in a row of 24 white beads at the bases of the outer cycle of tentacles. The rows of tubercles correspond to the endocœles of he mesenteries; they consist of evaginations of the body-wall, and contain ctoderm, mesoglœa, and endoderm; they are perforated, and probably are able to act as suckers. The ectoderm of the column contains numerous nuclei, fairly regularly arranged. Cell outlines are indistinguishable in my preparations, but the nuclei are so arranged as to suggest that they belong to long narrow cells. The mesoglœa consists of fibres imbedded in a structureless vacuolated matrix, in which are also a few other immigrant cells from the ectoderm and the endoderm. There are no nematocysts. The endoderm here, as in all parts of the body, contains symbiotic zooxanthellæ, which are present in very large numbers. The circular muscle of the wall does not appear to be regularly developed through the whole length of the wall.

Tentacles.—Conical and gently tapering. Pore at tip. Colour bronze-green, like that of the oral disc. The tentacles are very sensitive, and completely and quickly retractile: they number 48, and are arranged in 4 cycles, the formula being $6 + 6 + 12 + 24 = 48$. The ectoderm of the tentacles is thinner than that of the column. The epithelial layer contains numerous nuclei, but no cell-walls are distinguishable. There are numerous nematocysts. The nervous layer of the ectoderm appears as a fibrous network, with here and there what are apparently nerve-cells. The longitudinal muscles of the tentacles appear as pleatings of the mesoglœa. The mesoglœa is not so distinctly fibrous as that of the column; it is thin and vacuolated. The structure of the endoderm is almost completely obliterated by the great numbers of zooxanthellæ that are present. A few folds on the endodermal side of the mesoglœa indicate the circular muscles of the tentacles.

Sphincter Muscle.—In transverse sections of the upper part of the column the sphincter appears as a ring lying in the angle formed by the wall of the oral disc. In cross-section it is seen to be well developed, endodermal, and of the circumscribed type, not unlike the sphincter of *Cradactis digitata* figured by McMurrich.*

* "Scientific Results of Explorations by the United States Fish Commission Steamer 'Albatross'" (Proc. U.S. Nat. Mus., vol. xvi, pl. xxxiii).





2

A NEW ZEALAND ACTINIAN. Stuckey.

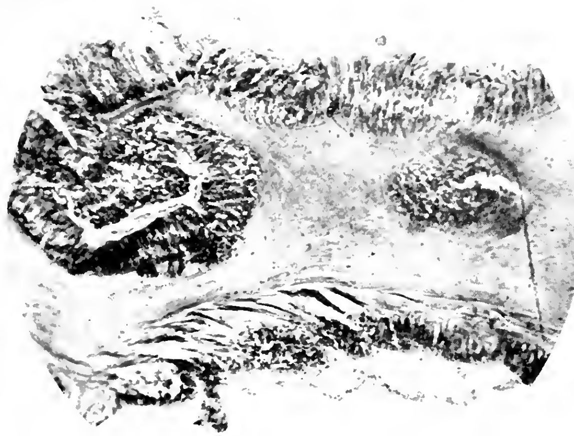
Face p. 568.

1

2

ANEMONES.—Stuckey.

1



3 2

ANEMONES.—Stuckey.

1

2

3

ANEMONES.—Stuckey.

Oral Disc.—The ectoderm resembles that of the tentacles. The nuclei are large, and there are fewer nematocysts. The radial or ectodermal muscles are strong, and are carried on deep pleatings of the mesoglœa. The mesoglœa is similar to that of other parts. The endodermal or circular muscles are weaker than the ectodermal. The "mouth" is borne on a prominent peristome surrounded by a broken circle of yellow, from which extend 6 groups, each consisting of 3 radiating yellow lines with a shorter yellow line between each 2 groups. These yellow radii correspond to the first 3 cycles of tentacles, the tentacles of the 4th cycle being set opposite to the interspaces.

Æsophagus.—The colour is greyish-white. There are 2 siphonoglyphs, with inconspicuous tubercles. The insertions of the mesenteries are shown by white markings. Each side of the œsophagus is thrown into 2 large lobes. Outgrowths of the mesoglœa, with corresponding foldings of the ectodermal lining of the œsophagus, give a much folded appearance, which in cross-sections somewhat resembles an exaggerated starfish.

Mesenteries.—There are 24 pairs of mesenteries, of which 12 pairs are perfect, 2 pairs being directives; they are arranged quite regularly—a pair of imperfect mesenteries in each exocœle of the perfect pairs. Strong retractor muscles are borne on the faces of the mesenteries. On the imperfect mesenteries they extend from near the body-wall to the inner end of the mesentery. The cells of the endoderm are spindle-shaped.

Gonads.—None present in any of the specimens sectioned.

Dimensions.—Oral disc 12 mm. wide in a good specimen. Height in full expansion rather more than 12 mm. The longest tentacles are about 8 mm.

Locality and Habits.—The only specimens I have seen were procured at Oriental Bay by Professor Kirk. The animal lives between tide-marks, almost completely buried in sand and mud. The presence of the zooxanthellæ probably enables it to adopt this habit. It lives well in captivity.

EXPLANATION OF PLATE XVII.

Fig. 1. Directive mesenteries (cross-section); × 64.
Fig. 2. Sphincter muscle (cross-section); × 270.

Art. XXXV.—*On Two Anemones found in the Neighbourhood of Wellington*—Leiotealia thompsoni *and* Sagartia albocincta.

By F. G. A. Stuckey, M.A.

[*Read before the Wellington Philosophical Society, 2nd September, 1908.*]

Leiotealia thompsoni.

This anemone was first described by Professor Coughtrey* under the name *Actinia thompsoni*. Professor Hutton† threw doubts on the correctness of the classification, and Mr. H. Farquhar‡ suggested that it would form the type of a new family of the *Artheadæ*. The strong endodermal character of the sphincter muscle, however, taken with the smooth body-wall and numerous perfect mesenteries, determine its place in the genus *Leiotealia*. This genus, which belongs to the family *Bunodidæ*, was erected by Richard Hertwig, 1882, for the reception of what were practically smooth-walled *Tealidæ*. This is referred to more fully in my account of *Bunodes aureoradiata*. McMurrich's family *Cribrinidæ*, there mentioned, would contain the genus *Leiotealia*. Torrey§ considers that *Leiotealia* is equivalent to *Epiactis* (Verrill), and gives the older name priority. I have, however, retained Hertwig's name. With the definition of *Bunodidæ* given in the note referred to above I define *Leiotealia* as follows: "*Bunodidæ* without verrucæ or acrorhagi, usually with the mesoglœal folds of the sphincter arranged pinnately, and often with longitudinal furrows in the outer surface of the wall."

L. thompsoni is one of the finest anemones found near Wellington, its stout tentacles and bright colours making it a very beautiful object when fully expanded.

Pedal-disc.—Adhesive to rocks and boulders. I have found one specimen adhering to an ascidian which was itself fixed to a piece of seaweed. When the animal is detached, the pedal-disc is often dilated to a great extent. Its substance is thin, plainly showing the insertions of the mesenteries. It is rather wider than the column. It presents all the general characteristics of the body-wall, processes of the mesoglœa running outward in the manner to be presently described.

Column.—Cylindrical in shape. Its height can be varied in a rather marked manner in proportion to the diameter of the oral disc. The colour is white and red in alternate longitudinal lines, which, however, are not generally entire, as stated in Professor Coughtrey's description. The colours are deposited in patches, the red in small irregular spots, the white marks being more or less elliptical. This gives the surface of the column a somewhat chequered appearance under a lens of low power. The white markings appear to correspond to the endocœles, the red to the exocœles of the mesenteries. There is a distinct ridge or collar round the top of the column. The colour of preserved specimens completely disappears, when the wall is

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* Trans. N.Z. Inst., vol. vii, 1874.
† Trans. N.Z. Inst., vol. xi, 1878.
‡ Lon. Soc. Journ. Zool., vol. xxvi, p. 528.
§ Proc. Wash. Ac. Soc., vol. iv, 1902, pp. 391–92.

seen to be thrown into parallel ridges which lie close together, running round the body of the animal like hoops round a cask. Each of these folds is wrinkled or pleated, the pleats being so close together and so nearly in line as to almost present the appearance of longitudinal ridges. The result is that both in cross-section and in longitudinal section the wall presents the appearance of being covered with numerous papillæ, into which the mesoglœa runs, often branching or folding in them (Plate XIX, fig. 1). Occasionally the folds grow together and fuse, so that here and there we have in the mesoglœa pits lined with ectoderm (Plate XIX, fig. 2). In cross-sections these appear as more or less circular spaces. The ectoderm peels off in the manner described by McMurrich in his account of *Leiotealia badia*. It presents the usual histological features. Nuclei are numerous, and crowded towards the outer part, while below this the outlines of the cells form a network. The fibrils of the nervous layer form a more or less continuous line. Nematocysts are present in great quantities, and there is great development of large gland-cells, some of which are lenticular, others pyramidal in shape. The mesoglœa presents a wavy appearance, and has a few large scattered cells. Fine processes of the mesoglœa project inwards, carrying the circular muscle of the wall. This muscle is not continuous all round the body, but is in bands, which overlap each other. The actual endoderm of the body-wall is thin, and does not present any unusual features.

Tentacles.—These are arranged in three cycles—10 in the first or inner, 20 in the second, 30 in the third. This arrangement gives the appearance of their being placed in groups of six, thus ⁝:· Each tentacle is conical in shape, and very stout. All the tentacles are equal in size. In colour they are of a dull white, with a mauve tip. In a few specimens, which, it is worth noting, were all obtained from Island Bay, the mauve tip was wanting, and in these cases the longitudinal markings of the body-wall appear to be entire. One specimen had light-brown tentacles. There is a pore at the tip of each tentacle. The tentacles of the first two cycles communicate with the endocœles, those of the third cycle with the exocœles of the mesenteries. There is a strong longitudinal muscle borne on numerous fine branching processes of the mesoglœa (Plate XIX, fig. 3). Outside this is the nervous layer in the form of a distinct reticulum. The endodermal or circular muscle of the tentacle is not particularly strong.

Sphincter Muscle (Plate XVIII, fig. 2).—This is very strong, and endodermal in character. It projects into the cœlenterm, and forms a rounded cord, easily seen by the naked eye in a dissection. With a good light behind an expanded specimen the sphincter can be seen through the body-wall. A transverse section of the sphincter presents the same pinnate appearance as that described by McMurrich in the sphincter of *L. badia*. The endoderm surrounding it is thin. The muscular fibrillæ are seen in cross-section as small swellings on the sides of the branching mesoglœal processes. In a longitudinal section of the sphincter we see the fibres of the mesoglœa running in wavy parallel lines, while beside them are the muscular fibres with their nuclei cut at various angles.

Oral Disc.—The colour is reddish-brown, marked in radiating lines by the insertions of the mesenteries. The mouth is set on a darker-coloured prominent peristome, round which is a depression. There are two siphonoglyphs marked by pink tubercles. The structure of the disc recalls that of the tentacles, except that the nervous and muscular layers are not so well developed.

Œsophagus.—The colour is a dull white, with brighter lines at the insertions of the mesenteries. Bourne* states that the sulcar and sulcular siphonoglyphs do not differ in size and structure, but in my preparations one siphonoglyph appears much deeper than the other. This is a feature that frequently appears in sectioned anemones, and may be the result of treatment. On the other hand, it may mark the position of the sulcular directives, which, being the first pair of directives, and having less to pull against than the second pair, may draw the stomodæum unduly towards them. In my sections of *L. thompsoni* the deeper siphonoglyph is curiously folded, being bent on itself some six times almost at right angles. The cilia of this siphonoglyph are strong, and stained distinctly with hæmatoxylin.

Mesenteries.—There are 30 to 32 pairs, all perfect. Two pairs are directives (Plate XVIII, fig. 1). On all the mesenteries both retractor and parietal muscles are very strong; indeed, the whole animal is remarkable for its great muscular development. The central fold of the mesenterial trefoil stands well out beyond the lateral folds.

Gonads.—These appear in the usual place in the mesenteries. In one of the animals sectioned no ovaries appeared, but the body-cavity contained developing ova and embryos from the 2-chambered to the 12-rayed stage. It is interesting to note that one such embryo had 5 chambers. The young develop between the mesenteries until, at any rate, the 12-rayed stage is reached. They then appear to be ready for an independent existence, as I have found none beyond that stage in the body of the parent.

Dimensions.—A good specimen would be as much as 6–7 cm. in height and 4–5 cm. in breadth; tentacles, 2·5 cm.

Locality and Habits.—The species is apparently littoral, being found just above and below low-water mark, attached to the rocks and to loose stones. It is apparently fairly well distributed on the coast of New Zealand, but is not very numerous in any locality. It is more plentiful at Plimmerton than at any other place so far as I know. It has been found at most places along the coast between Plimmerton and Wellington. Professor Coughtrey's specimens were found in Otago Harbour.

Sagartia albocincta.

This anemone was first described by Professor Hutton† as *Gregoria albocincta*. *Gregoria* was one of Gosse's genera of the family *Sagartidæ*. As it was erected for a single specimen, which Gosse himself thought might have been immature, and as no specimen has since been found, recent workers have agreed in dropping the genus. In reclassifying this animal I have adopted McMurrich's definition of *Sagartia*‡: "*Sagartinæ* with smooth column destitute of verrucæ, and with no special arrangement of the cinclides; margin tentaculate; tentacles concealed in contraction, the sphincter being fairly strong."

Pedal-disc.—This only slightly exceeds the breadth of the column, and is about equal to the height. It is strongly adherent, and the animal can hardly be removed without damage. The usual histological structures are present. The three layers are all very thin, the mesoglœa especially so.

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* "Treatise on Zoology," ed. Ray Lankester, pt. ii, Anthozoa, p. 38.
† Trans. N.Z. Inst., vol. ii, 1878.
‡ Proc. U.S. Nat. Mus., vol. xvi, p. 176.

Column.—The shape is cylindrical. The colour is deposited in alternating vertical stripes, pink and white, pellucid brown and white, brown and yellow, or green and yellow. The upper part often assumes an orange, the lower a greenish tinge. In full expansion the body-wall is semi-transparent. The wall is pierced by a number of irregularly arranged cinclides, which are easily made out in a fresh specimen. They have thickened margins. The wall is traversed by longitudinal ridges, which appear in cross-sections as papillæ-like projections. Neither ectoderm nor endoderm present any departure from the ordinary structure. In sections, especially in longitudinal sections, the mesoglœa presents numerous spaces, each containing a deeply staining particle. There is a feebly developed circular muscle in the wall.

Tentacles.—These are all opaque, white, and rather fine. They are regularly arranged in four cycles, 12 + 12 + 24 + 48. They can be wholly retracted, though the favourite position of the animal when not distended is one in which the tentacles are partially withdrawn, the tips forming a white central mass. In shape the tentacles are conical and pointed. They are subequal, the longest being $\frac{1}{2}$ to $\frac{3}{4}$ of the full diameter of the disc. The mesoglœa and endoderm of the tentacles are thin and the musculature weak. The nervous layer is well developed. Nematocysts are present.

Sphincter Muscle (Plate XX, fig. 3).—This is mesoglœal in character, and is represented by a clavate swelling of the mesoglœa. The thin end points downwards, and tapers off into the mesoglœa of the wall. In the thickened part run anastomosing strands of the supporting layer, forming irregular cavities, in which are seen the muscle-fibres, which here, consequently, are arranged in bundles.

Oral Disc.—The disc is bright orange in colour, with radial markings. The mouth is set on a peristome. On the inner side the mesoglœa bears short stout processes, giving it a notched appearance. The processes bear the endodermal or circular muscle of the disc. The ectodermal muscle is hardly perceptible.

Œsophagus.—The œsophagus is dull white, with brighter vertical lines. There are 2 siphonoglyphs, and sections show the œsophagus to be much folded. The mesoglœa is thick compared with that of other parts, and has a very striking reticular appearance, which recalls the structure of the sphincter.

Mesenteries (Plate XX, fig. 2).—These number 24 pairs, of which 2 pairs are directives. Of these 24 pairs, I take 6 pairs to belong to the first and 6 to the second cycle. These are all perfect, reaching the œsophagus, as also do some of the third cycle of 12 pairs. In addition, there are a few rudimentary mesenteries of a fourth cycle just showing. The retractor muscles on the perfect mesenteries are narrow, except on the directives, where they are strong, and placed close up to the œsophagus.

Acontia are emitted through the mouth and through the cinclides already mentioned. Some specimens emit the acontia much more reluctantly than others.

Gonads.—Only on one of the mesenteries did I see in my preparations any indication of a gonad—in this case an ovary.

Dimensions.—Height, 10–12 mm.; and diameter, 7–10 mm.

Habits and Locality.—This anemone is found on rocks, stones, and the roots of seaweed. It is very firmly attached, and can only be removed with difficulty. It opens freely in captivity. It is common in the neighbourhood of Wellington, and is also recorded from Lyttelton. Hutton's original specimens were found at Dunedin.

EXPLANATION OF PLATES XVIII–XX.

Plate XVIII.

Fig. 1. *Leiotealia thompsoni.* Directive mesenteries, parts of four other mesenteries, body-wall, and siphonoglyph.
Fig. 2. *Leiotealia thompsoni.* Cross-section of sphincter muscle.

Plate XIX.

Fig. 1. *Leiotealia thompsoni.* Body-wall, showing the ridges into which the outer surface is thrown (cross-section).
Fig. 2. *Leiotealia thompsoni.* Body-wall, showing the mesoglœa pits lined by ectoderm.
Fig. 3. ,, Part of tentacle (cross-section).

Plate XX.

Fig. 1. *Leiotealia thompsoni.* Showing embryos developing within the body of the parent; one embryo at the "2-chambered" stage, the first pair of mesenteries just developing; the other advanced to the 12-mesenteried stage.
Fig. 2. *Sagartia albocincta.* Directive mesenteries.
Fig. 3. ,, Cross-section of sphincter.

Art. XXXVI.—*A Review of the New Zealand Actiniaria known to Science, together with a Description of Twelve New Species.*

By F. G. A. Stuckey, M.A., Wellington.

[*Read before the Wellington Philosophical Society, 7th October, 1908.*]

Introduction.

This paper was written under the supervision of Professor H. B. Kirk, M.A., of Victoria College, Wellington, to whom I desire to express my deep sense of gratitude and obligation for instruction in biological method during a three-years course of study, and particularly for his advice and assistance in preparing the present paper. My thanks are also due to Mr. William C. Davis, for instruction in the art of micro-photography; and to Mr. H. Farquhar, who assisted me in the identification of species known to him, and also supplied me with a list of works on the subject.

Historical.

Considering the richness of the actinian fauna of New Zealand and the attractiveness of the work, it is strange that so few workers have studied this subject. Up to the present date, only three New Zealand workers have published accounts of Actiniaria: 1874—Coughtrey; one species. 1878—Hutton; nine species (five new; one previously described in the account of the Dana Exploration Expedition; two described by Quoy and Gaimard, voy. "Astrolabe"; and one previously described by Coughtrey). 1898—Farquhar; seven new species. The first two writers gave only external characters, but Farquhar described the internal anatomy of one of his species.

With the exception of *Mingas viridula*, all the species so far described are littoral. It is a remarkable fact that there were none of our New Zealand species in the "Challenger" material. So far as I can ascertain from a careful scrutiny of Hertwig's lists, the expedition took no actinians in

New Zealand waters, a circumstance which seems to point to the conclusion that there are in this region no abyssal or pelagic forms.

Methods.

Killing.—Several methods were used.

(1.) Electrocution with a strong current (14 amperes) was tried, but the results were fair only. I am of opinion that this method is not good for histological purposes, on account of the destruction of tissue brought about by electrolysis.

(2.) In another method the animals, after being expanded in a minimum of sea-water in small glass vessels, were dropped (vessels and all) into a boiling saturated solution of perchloride of mercury.

(3.) The animals were stupefied with magnesium-sulphate in sea-water (Tullberg's method), and then either chloroformed or dropped into boiling perchloride of mercury.

The last two methods yielded the best results.

Fixing, Imbedding, and Cutting.—All specimens were fixed by immersion for a longer or shorter period, according to size, in perchloride of mercury. The larger specimens were filled with the fixing fluid through the mouth by means of a glass syringe immediately after death. The mercury having been removed with iodine, the specimens were dehydrated in the ordinary way, and finally imbedded in paraffin. Sections were cut with a Cambridge rocking microtome, and, in the case of some of the large species, with a sliding microtome.

Staining.—Mass staining with borax-carmine yielded results which were satisfactory, but not so good as those obtained by staining on the cover-slip. Saffranin and methylin blue yielded good results, the nuclei staining well. Fuchsin was found a fine stain for nuclei and nematocysts. Kleinenberg's hæmatoxylin gave good definition of mesoglœa. The best results were got with Erlich's hæmatoxylin. This was used full strength (Squire's formula), or diluted with water in various proportions. All yielded excellent results. After staining on the cover-slip the sections were washed in "tap" water, in some cases being immersed in the water for several days. I am convinced that the best results with this stain are obtained by using it full strength, and then washing out for four or five days in water.

List of Species described.

Grade I. PARAMERA.

Order EDWARDSIIDEA.

Genus Edwardsia (Quatrefages).

1. *Edwardsia tricolor* (Farquhar), nom. nov.
2. *Edwardsia ignota*, sp. nov.

Grade II. CRYPTOPARAMERA.

Order ACTINIIDEA.

Suborder MALACACTINIÆ.

Group HEXACTINIÆ.

Fam. Antheadæ.

Genus Actinia (Browne).

3. *Actinia tenebrosa* (Farquhar).

Genus Anemonia (Risso).

4. *Anemonia olivacea* (nom. nov.), Hutton.

Fam. Sagartidæ.

Genus Sagartia (Gosse).

5. *Sagartia albocincta* (nom. nov.), Hutton.
6. ,, *nutrix* (sp. nov.).
7. ,, *vagrans* (sp. nov.).

Genus Thoe (Wright).

8. *Thoe albens* (sp. nov.).

Genus Halcampactis (Farquhar).

9. *Halcampactis dubia* (sp. nov.).

Fam. Paractidæ.

Genus Paractis (Andres).

10. *Paractis ferax* (sp. nov.).

Genus Tealidium (Hertwig).

11. *Tealidium cinctum* (sp. nov.).

Fam. Corallimorphidæ.

Genus Corynactis (Allman).

12. *Corynactis haddoni* (Farquhar).
13. ,, *gracilis* (Farquhar).
14. ,, *mollis* (Farquhar).
15. ,, *albida* (sp. nov.).

Fam. Phyllactidæ.

Genus Cradactis (McMurrich).

16. *Cradactis plicatus* (Hutton), nom. nov.
17. ,, *magna* (sp. nov.).

Fam. Bunodidæ.

Genus Bunodes (Gosse).

18. *Bunodes aureoradiata* (sp. nov.).
19. *Bunodes inconspicua* (nom. nov.), Hutton.

Genus Leiotealia (Hertwig).

20. *Leiotealia thompsoni* (nom. nov.), Coughtrey.

Fam. Alichidæ.

Genus Phlyctenactis (gen. nov.).

21. *Phlyctenactis retifera* (sp. nov.).
22. ,, *morrisonii* (sp. nov.).

Genus (?).

23. Species (?).

To this list I append, for the benefit of other workers, the following list of other New Zealand species which are at present known, but more or less inadequately described. I have not seen any of these species :—

24. *Edwardsia neozealanica* (Farquhar).
25. *Halcampactis mirabilis* (Farquhar).
26. *Paractis monilifera* (Drayton, Milne-Edwards, Hutton).
27. *Actinia striata* (Quoy and Gaimard, Hutton).
28. *Phymactis polydactyla* (Hutton).
29. *Minyas viridula* (Quoy and Gaimard, Milne-Edwards, Hutton).
30. *Sagartia crocata* (Hutton).
31. *Peachia carnea* (Hutton).

GENERAL RESULTS.

One new genus has been erected and one abandoned genus re-established. Twelve new species have been described, four species have been placed in other genera than those in which they were placed by their original describers, and one species has received a new specific name. For all these changes reasons are given in the text.

In general, the anatomy of all species is normal. *Actinia tenebrosa* shows great variation in the number and arrangement of its mesenteries.

The histology of the Actiniaria has been so fully worked out by the Hertwigs that little remains to be said on the subject. The structure of ectoderm and endoderm showed no departure from the normal type, with the exception of the ectodermal pits found in *Leiotealia thompsoni*. The mesoglœa, however, showed some considerable variation. In the majority of cases it presented the usual features—namely, " a homogeneous matrix in which fibres are imbedded." In other cases lacunæ were found to a greater or less extent, especially in the tentacles of *Phlyctenactis retifera*, where the mesoglœa was found to be highly reticular. There are fine sphincter muscles in *Leiotealia thompsoni* and *Cradactis plicatus*, more especially in the former.

A peculiar arrangement of the "trefoil" of the mesenterial filament was noted in *Actinia tenebrosa* and *Corynactis haddoni*.

With regard to gonads, it is a common occurrence for observers to fail to find them in their specimens, either because the animals are immature, or because the reproductive cells are found at certain seasons only. In the papers enumerated hereunder, describing British anemones and those collected in various expeditions, out of 163 species described gonads were found in sixty-nine only. Of the twenty-three examined by me, and described in this paper, gonads were located in nine. In two cases the animals were found to be viviparous : one had ova in brood-pouches ; another was observed to divide in a manner for which I suggest the name " lateral fission."

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Description of Species.

Genus Edwardsia (Quatrefages).

1. **Edwardsia tricolor** (nom. nov.), Farquhar, 1898.

This species (fig. 1) was described by Farquhar under the name *Edwardsia elegans*. I have changed the specific name to *tricolor*, the name *elegans* having been in use for another species since 1849. Mr. Farquhar has fully described the external appearance of this species, so I shall only briefly state my own observations. The body is brown, wrinkled, and covered with a rough cuticle, which is thin at the upper end. It is marked longitudinally by 8 double brown lines. There is a strong constriction between body and capitulum. The lower part of the capitulum is bulbous, and is divided into 8 segments by double white lines, continuous with the brown lines of the scapus (fig. 2). In colour each segment is brown, with a large white spot. Above this is a narrower white portion. The tentacles

Fig. 1.

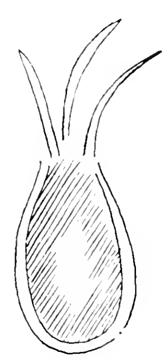

Fig. 2.

are in two cycles, 8 in each, those of the outer cycle corresponding to the white lines, those of the inner cycle to the interspaces. The tentacles are transparent, yellowish-brown in colour. Cross-sections show that there are 8

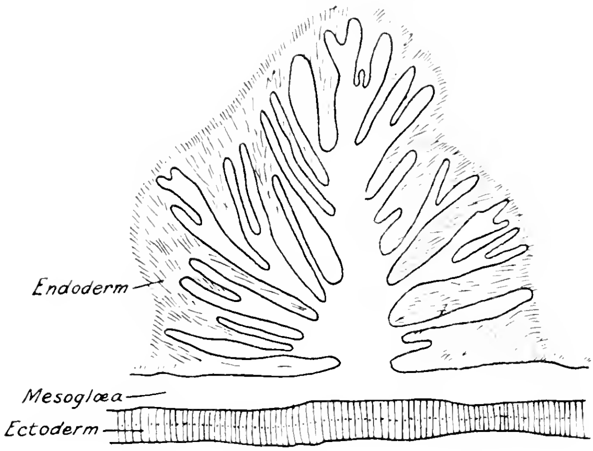

FIG. 3.

mesenteries which reach the stomodæum above, and are short and dendriform below, as shown in the sketch (fig. 3). There is nothing unusual in the histological structure of the body-wall. The ectoderm is thick, the mesoglœa thin and homogeneous. The endoderm is thicker than the mesoglœa, but not so thick as the ectoderm. In cross-sections of the tentacles the most noteworthy feature is the nervous layer, which is well developed, and reticular in form, with long processes running to the muscular layer, apparently one process passing between each of the mesoglœal folds carrying the muscle (fig. 4). It was not possible to locate the position of the reproductive organs in my specimens, but in all that were sectioned there were masses of ova in almost all parts of the body, including the stomodæum (Plate XXII, figs. 1 and 2).

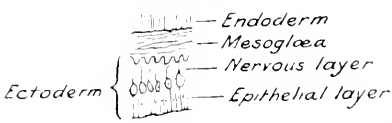

FIG. 4.

Distribution.—Of the genus—almost cosmopolitan. Of the species—Island Bay, Ohiro Bay.

2. Edwardsia ignota (sp. nov.).

The body is of the usual Edwardsian type, the physa, however, being rather reduced. The colour is a dirty white or light grey. The capitulum bears 8 light-brown lines. The tentacles are 8 in number, short and blunt. The disc is flattened and the mouth prominent. The scapus is naked, and the physa thin and rounded at the extremity. The animal collapsed when taken out of the water, but the capitulum was not introverted. Only one specimen was found, and on coming to section it I discovered that the body was full of sand, so that it was impossible to obtain any sections.

Distribution of the Species.—Island Bay.

Fam. ANTHEADÆ.

Hexactiniæ with long marginal tentacles. Sphincter muscle slightly developed or entirely absent. Numerous perfect mesenteries, and all (?) furnished with reproductive organs.

In the above I modify Hertwig's definition with respect to the sphincter muscle, which I found to be absent in *Actinia tenebrosa*, and the non-ability to cover the disc, which the same animal does completely and readily. There still appears to be doubt as to whether all the mesenteries bear gonads. McMurrich ("Albatross" Report) in describing *Actinia infecunda* says, "The ova appeared to occur on a few of the larger perfect mesenteries." In *A. tenebrosa* I found ova on what were apparently some of the mesenteries of the second or third cycles.

Genus Actinia (Browne).

"*Antheadæ* with acrorhagi."

3. **Actinia tenebrosa** (Farquhar).

Pedal-disc.—Adherent. Rather wider than the column. The ectoderm is thick, and secretes a thin cuticle. The nervous layer is fairly well developed. The mesoglœa is thick, and in cross-section appears very fibrous. The whole mesoglœa of this animal is remarkable for the large number of cells it contains, and is certainly the most highly developed mesoglœa that I found in the species I examined. The endoderm is thinner than the mesoglœa, and contains many gland-cells.

Column.—The column is smooth. Its colour is brown, in shades varying from reddish-brown to brownish-black. Mr. Farquhar records that he found a specimen which was "yellowish-white, with a slightly greenish tinge." He ascribes this colour to the absence of light. I have found these yellowish-green specimens in such large numbers as to make me think that they may possibly constitute a distinct variety of the species.

The column forms a fairly well-developed collar under the bases of the outer tentacles. On this are placed the marginal spherules, which are of a whitish colour, with a blue or lavender tinge.

The ectoderm of the column is similar to that of the pedal-disc. The nerve-layer is more noticeable, and there are large nerve-cells. The mesoglœa is noticeably fibrous in appearance.

Tentacles.—These are conical, and about half the diameter of the oral disc in length. Their colour is dull red. They are placed in three cycles, very crowded and numerous (200 or more). Their ectodermal muscles are very strong, the processes of the mesoglœa on which they are borne being long and straight, lying side by side, parallel and not branching at all, or only very slightly. There is a very thick nerve-layer between these and the epithelial cells. The outer part is crowded with nematocysts, and there is a thin cuticle. The mesoglœa is about one-third as thick as the ectoderm, while the endoderm is very thick, almost filling the cavity. The endodermal musculature is only very slightly developed.

Oral Disc.—The colour is the same as that of the tentacles. The mouth is set on a prominent peristome. In structure the disc closely resembles the tentacles, except that the mesoglœal processes which carry the ectodermal muscles anastomose rather freely. The disc and tentacles can be completely covered in contraction.

Stomodæum.—The stomodæum is not commonly everted. Cross-sections show it somewhat strongly folded, and with 2 siphonoglyphs.

Sphincter Muscle.—This is wanting in the present species, but there is at one place on the column (about one-third of the way down) a rather stronger development of the endodermal muscles. This probably fulfils the function of a sphincter.

Mesenteries.—There are 2 pairs of directives. The normal number of mesenteries appears to be 48 pairs, arranged in three cycles (12 + 12 + 24), but the number is very variable. In one section I counted 56 pairs. In this section, instead of 12 pairs of perfect mesenteries, there are 15 pairs that reach the stomodæum, and there is a superfluous development of the mesenteries of the third cycle. Not only so, but the members of the same pair are sometimes unequal. Both these features appear in the micrograph (Plate XXIII, fig. 1). The musculature is very weak on all the mesenteries. The mesenterial filaments show the usual structure. In the middle lobe of the "trefoil" the mesoglœa expands into a cup-shaped mass (Plate XXIII, fig. 2). A very curious feature is noticed in this species. Before reaching the "trefoil" portion the mesentery divides into three, each division ending in a trefoil. In many cases in my sections it happened that only one of the three trefoils was cut truly transversely, the others being cut at various angles, so that the mesentery showed a pair of curious comblike structures and a median trefoil. It will be easily seen that such a comblike appearance could be produced by cutting the free edge of a filament more or less longitudinally. All doubt, however, was removed by the discovery of several cases where the mesentery bore three unmistakable trefoils (fig. 5).

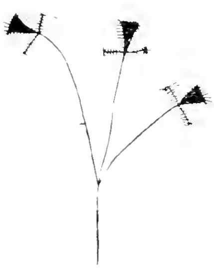

FIG. 5.

Distribution.—Of the genus—English Channel, Atlantic, Mediterranean, Torres Strait, Abrohlos Islands (Delage and Herouard); also New Zealand. Of the species—Cook Strait, Queen Charlotte Sound (Mr. Grant), Robin Hood Bay (Mr. Skelley), Stewart Island (Miss E. Morrison).

Genus ANEMONIA (Risso).

"*Anthea* without acrorhagi."

4. Anemonia olivacea (Hutton).

This species was described by Hutton as *Anthea olivacea.* It is referred to as *Anemonia olivacea* by Farquhar, who is probably right in so naming it, the older generic name having precedence.

Pedal-disc.—Ectoderm and endoderm are thin. The mesoglœa is thick and fibrous, the fibres being arranged in wavy branching lines. Numerous nuclei appear in the mesoglœa.

Column.—Smooth. Colour, olive-green. There are light longitudinal lines near the base. The ectoderm and endoderm present the usual characters, and the mesoglœa resembles that of the pedal-disc. It varies in thickness, thick and thin places alternating in my sections.

Tentacles.—About 50 in number, arranged in four cycles. In colour they are pellucid-green, of the same shade as the body. There is a slight constriction near the end, and the tip is darker in colour. They are conical and slender, and their length is equal to the diameter of the oral disc. They are not completely retractile. The ectoderm and endoderm are thick and the mesoglœa thin. The musculature is very weak.

Oral Disc.—The colour is brownish-green. The mouth is set on a slight elevation, from which radiate yellowish lines. The structure of the disc closely resembles that of the tentacles.

Stomodæum.—This is pinkish-white in colour, and there are 2 siphonoglyphs. In cross-section the stomodæum is seen to be strongly folded.

Sphincter.—Weak, endodermal. Its shape in cross-section is semi-ovate, the flattened side closely applied to the body-wall.

Mesenteries.—There are 24 pairs, every second pair being perfect. Two pairs are directives. The musculature is strong, especially on the perfect mesenteries. The muscle-banners extend almost from wall to stomodæum.

Gonads.—None seen in my specimens.

Size.—Diameter, about 20 mm.; height, rather less.

Habits.—This species is found in rock-pools, often inhabiting quite small "pot-holes" on the upper part of the rocks. Its colour is strongly protective.

Distribution.—Of the genus—English Channel, Atlantic Mediterranean, Patagonia, Torres Strait, Pichelingue Bay (Delage and Herouard); also New Zealand. Of the species—Dunedin (Hutton), Cook Strait.

Fam. SAGARTIDÆ.

"*Hexactiniæ* furnished with acontia."

In thus defining the *Sagartidæ* I have followed what seems to be the general tendency of recent authors. Hadden has somewhat fully discussed the classification of sagartians, though he arrived at no very definite conclusion. In using the term "sagartians" he says, "By the latter term I include all those *Actiniæ* which possess acontiæ." McMurrich ("Albatross" Report, 1893) says, "It seems at present convenient to associate all *Actinia* with acontia in a single family." Most authors, however, in defining the family still include the provision "sphincter muscle mesoglœal." I should like to point out, on the authority of G. C. Bourne, that *Actinoloba*, a sagartian genus, has an endodermal sphincter.

Subfam. SAGARTINÆ.

"*Sagartidæ* with naked ectoderm. Cinclides usually present."

Genus SAGARTIA (Gosse).

"*Sagartidæ* with smooth column; no verrucæ; no special arrangement of cinclides; margin tentaculate; tentacles concealed in contraction, the sphincter being fairly strong" (McMurrich).

5. **Sagartia albocincta** (nom. nov.), Hutton.

A description of this species is published at p. 372 of this volume.

Distribution.—Of the genus—Arctic Ocean, North Sea, English Channel, Atlantic, Mediterranean, Cape Horn, Pacific coast of South America, East Indies, Australia (Delage and Herouard); also New Zealand. Of the species—Dunedin (Hutton), Plimmerton (H. B. Kirk), Cook Strait.

6. **Sagartia nutrix** (sp. nov.).

This is the brown sagartian mentioned by Farquhar as probably forming the food of the butter-fish. It is found only on *Lessonia*, where it establishes itself in colonies.

Pedal-disc.—The ectoderm is thin and folded, with straight mesoglœal processes. It is covered by a thin cuticle, which is also found on the column, but becomes less distinct as it ascends. The mesoglœa is thin, and contains lacunæ. The most prominent feature is the endoderm, which is thick and regular, the cells being straight and fine.

Column.—The colour is, in general, deep brown, but there is some variation. I have collected some specimens that were greenish, some blue, and some yellow. The whole animal is iridescent. Preserved specimens become light brown. The ectoderm resembles that of the pedal-disc, though slightly thicker, and without the mesoglœal processes. Exceedingly slight ectodermal elevations or papillæ appear in cross-sections. No cinclides are present. The mesoglœa is fibrous.

Tentacles.—These are short and fine, and placed at the edge of the disc in three or four crowded cycles. The mesoglœa is distinctive. Though thin, it contains numerous spaces, each with a darkly staining particle. The processes that bear the ectodermal muscles branch and slightly anastomose. The muscle-fibres themselves show very distinctly on these processes. There is a very noticeable fibrous layer below the epithelial layer, which is itself covered with a cuticle like that of the pedal-disc and column.

Oral Disc.—The colour is generally iridescent green, but it is very variable. The mouth is pink or magenta, and there are radial markings. The structure of the disc resembles that of the tentacles, but the musculature is weaker.

Sphincter Muscle.—This is mesoglœal in character. There is a club-shaped swelling of the mesoglœa in the upper part of the wall, tapering gradually at the lower end, and coming almost to a point suddenly at the upper end (Plate XXI, fig. 2).

Mesenteries.—There are 24 pairs, every second pair being perfect. Two pairs are directives.

Gonads.—I saw no reproductive organs in my cross-sections, but ova appeared on a mesentery in a longitudinal section. They were close up to the sphincter. I was unable to determine to what cycle the mesentery belonged. Presumably the young of this species are retained in the body till fully formed, for I found one specimen which had twelve young ones attached to the outside of the body-wall in a regular transverse circle about one-third of the height of the wall from the foot. This is shown in fig. 6 of the text, and in Plate XXI, fig. 1. If the young are not retained till they are considerably advanced, it is difficult to see how they can become attached in this manner unless there are external brood-pouches. I have seen no evidence in support of the latter view.

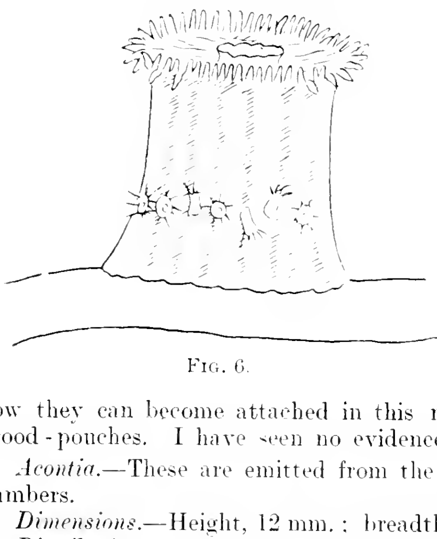

FIG. 6.

Acontia.—These are emitted from the mouth readily, but not in great numbers.

Dimensions.—Height, 12 mm.; breadth, about the same.

Distribution of the Species.—Island Bay, Ohiro Bay.

7. Sagartia vagrans (sp. nov.).

Pedal-disc.—The ectoderm is thick, and presents no unusual feature. The mesoglœa is much "vacuolated," and the endoderm is thin.

Column.—The colour is dirty-white and olive-brown in alternate longitudinal lines, or the whole may be dirty-white, or grey, or even pink. There is a circular muscle in the wall throughout its entire length carried on regular folds of the mesoglœa.

Tentacles.—These are very fine and threadlike. Their colour is salmon-pink, though in some specimens they are white. They are of different lengths in the different cycles. There are several cycles, but the tentacles are so numerous and crowded that it is impossible to make out how many cycles there are. Judging from cross-sections I should say there are four cycles. In structure the tentacles resemble those of the last species (*S. nutrix*), but there is a specially well-developed nervous layer.

Oral Disc.—Colour olive-brown generally, but there is considerable variation. The structure is identical with that of the tentacles, and closely resembling the same part of *S. nutrix*.

Stomodæum.—The colour is a rich pink, with darker-coloured red longitudinal lines. The inner edge of the mouth is also red. The stomodæum is freely everted, when the red lines, together with the edge of the mouth, form a rosette-like design on the disc. There are 2 siphonoglyphs.

Sphincter Muscle.—This is mesoglœal in character. There is only a slight thickening of the mesoglœa under the bases of the tentacles, but the whole body-wall has the character (more or less) of a diffuse mesoglœal sphincter. In contraction the tentacles and oral disc are much infolded, the wall completely overarching them.

Mesenteries.—There are 48 pairs, 12 pairs being perfect, the arrangement of the cycles being 6 + 6 + 12 + 24 = 48. Two pairs are directives. (Plate XXVII, fig. 2.)

Gonads.—None were present in my specimens.

Acontia.—These are extruded through lens-shaped cinclides, which are invisible except at the time of discharge. These cinclides appear to be on the white lines only, and to be limited to a zone encircling the middle third of the body.

Locality.—Professor H. B. Kirk has brought me specimens from Plimmerton. I myself have found the species in large numbers on the breastwork of the Thorndon Esplanade, Wellington Harbour, and on the piles of the baths. This anemone adheres so strongly that it is impossible to remove it without damage. It is attached also to shells of mussels, and this makes it possible to obtain good specimens.

Habits, &c.—This animal lives well in captivity. Some that I kept in an aquarium wandered about at will.

Size.—My largest specimens were 40 mm. high and 20 mm. in diameter, but I am told there are larger ones on the piles of the Queen's Wharf, Wellington.

Affinities.—Probably closely allied to *S. albocincta*.

Distribution.—Of the genus—As above. Of the species—Plimmerton (H. B. Kirk), Wellington Harbour.

Genus Thoe (Wright).

On page 122 of the "Actinologia Britannica," Gosse, after referring to the genus *Sagartia*, says, "A group less typical I consider to be formed

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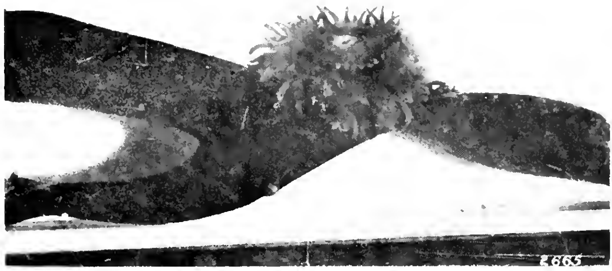

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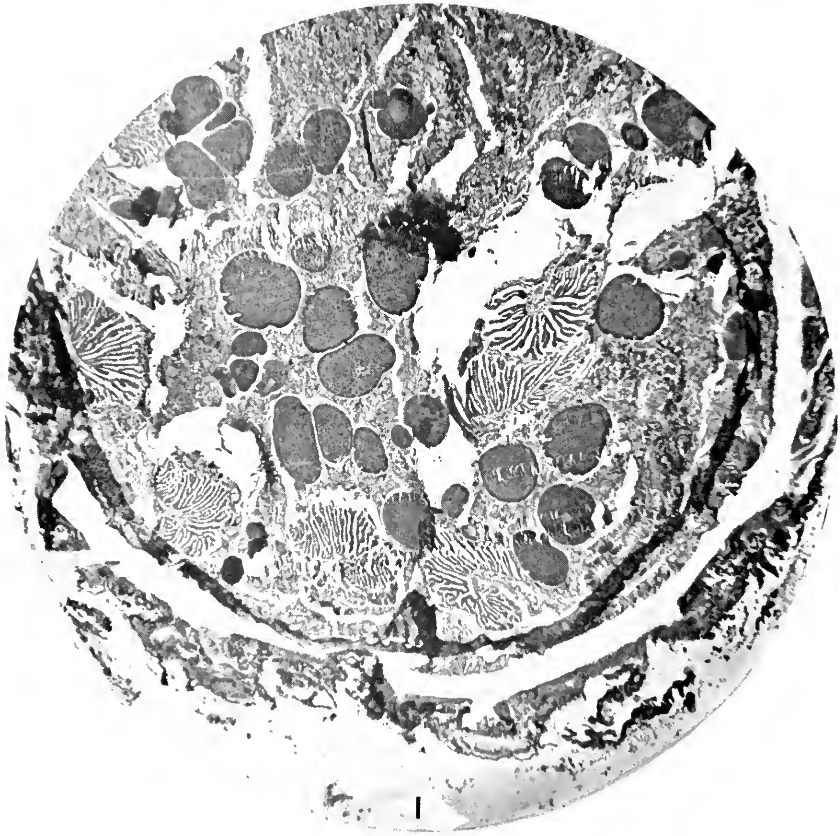
REVIEW OF NEW ZEALAND ACTINIARIA.—Stuckey.

Face p. 381.



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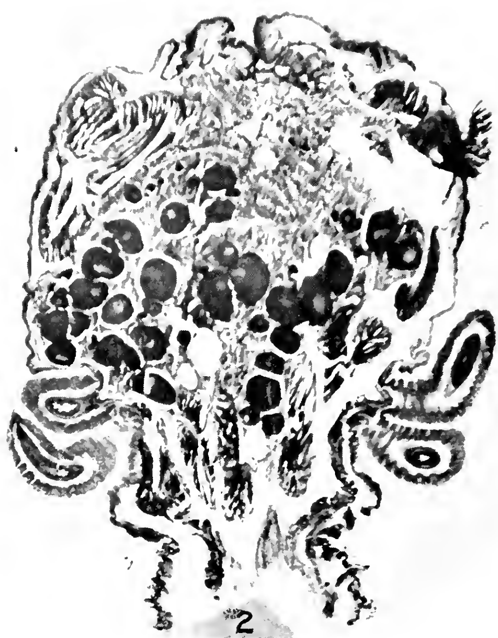

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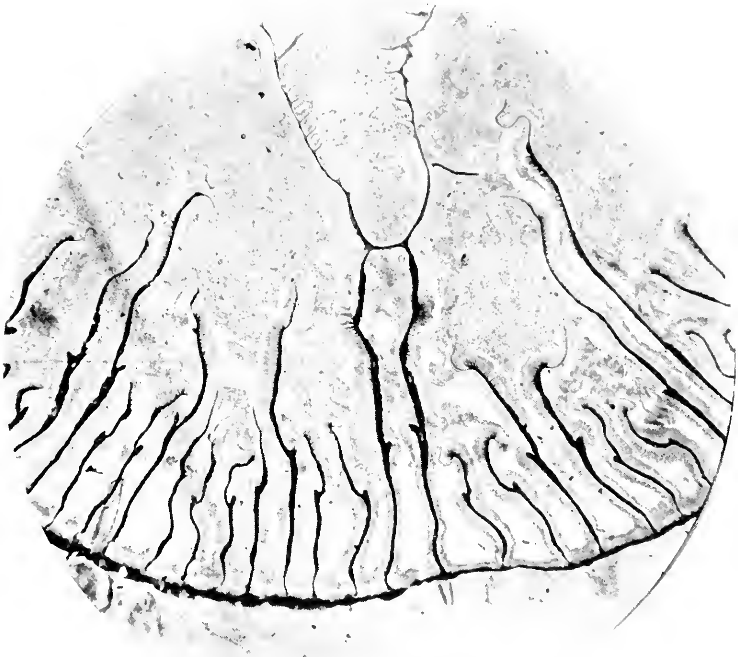

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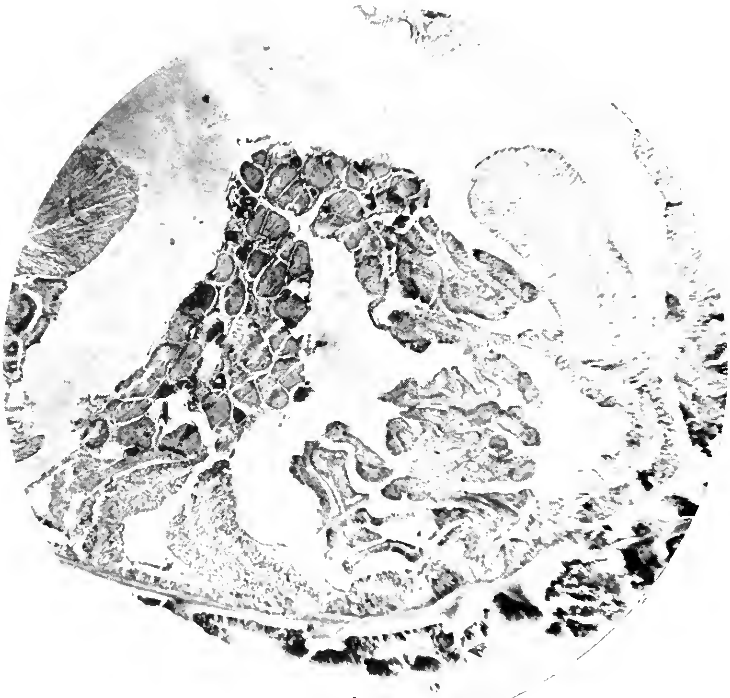

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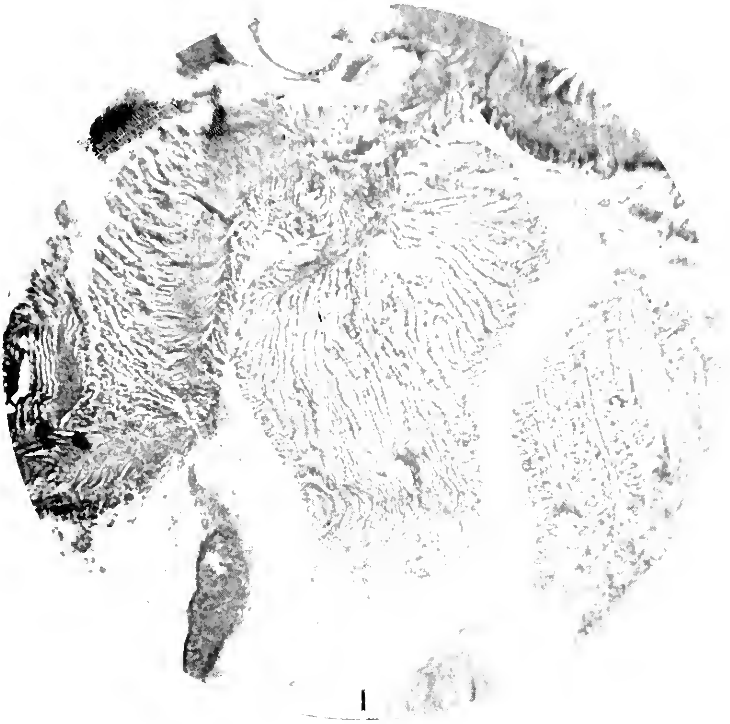

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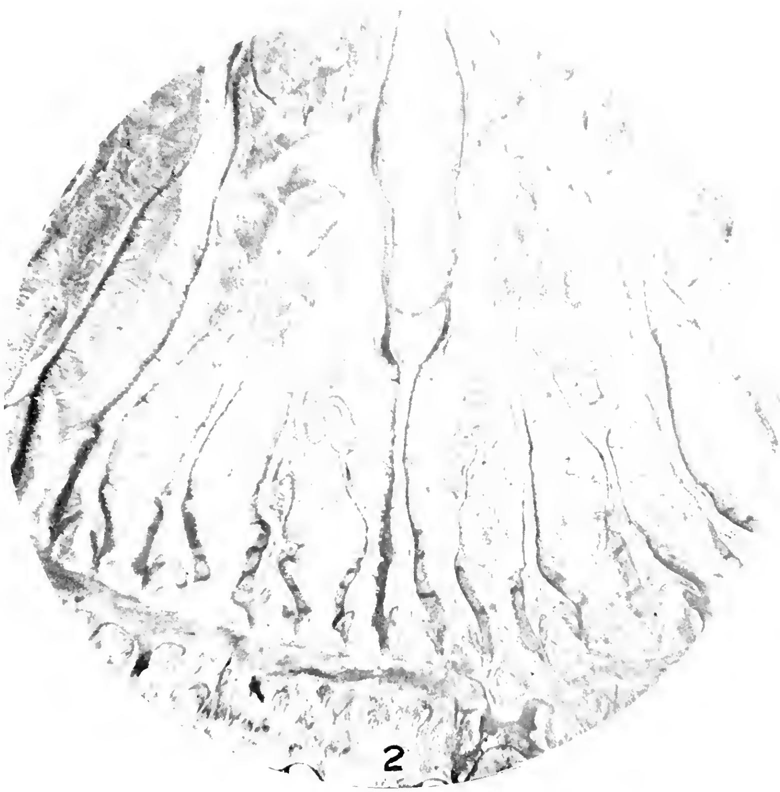

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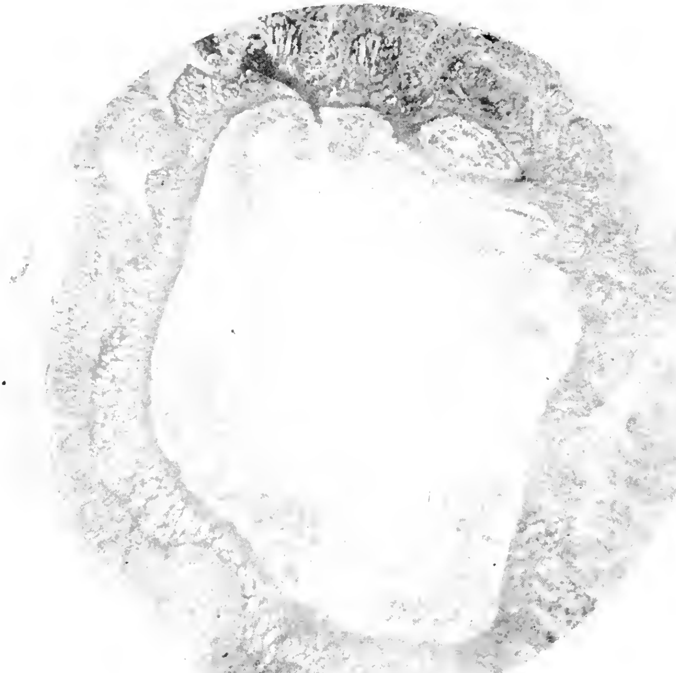

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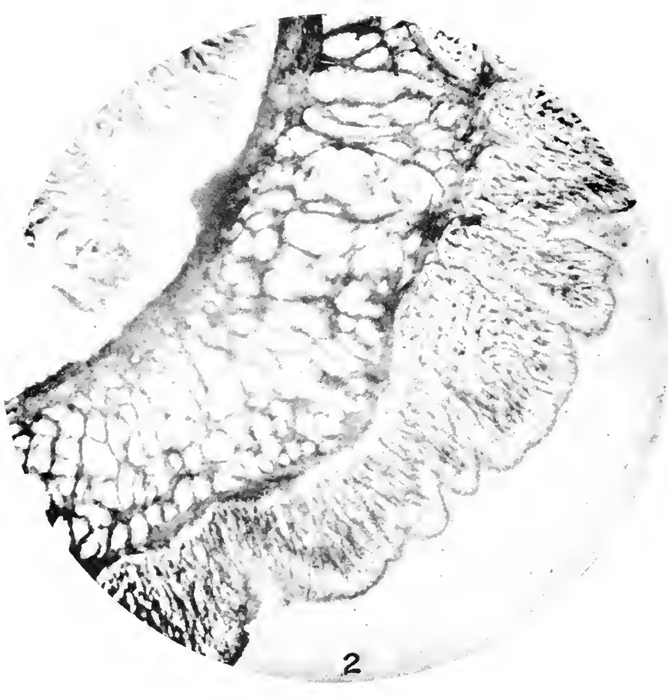

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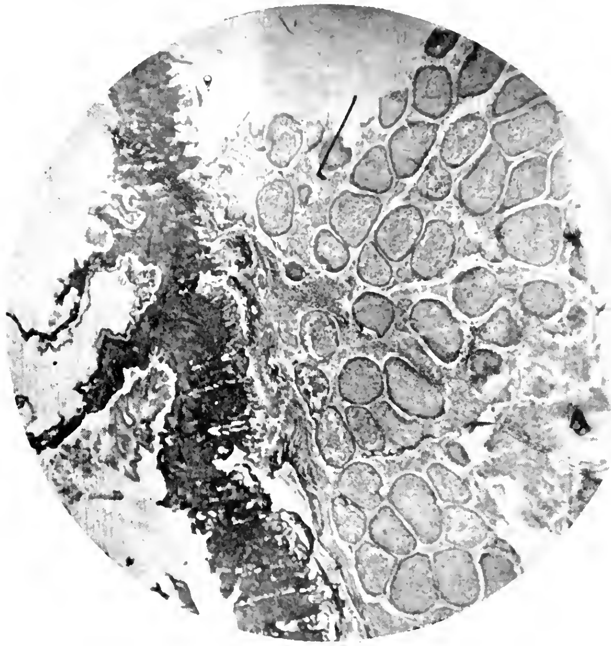

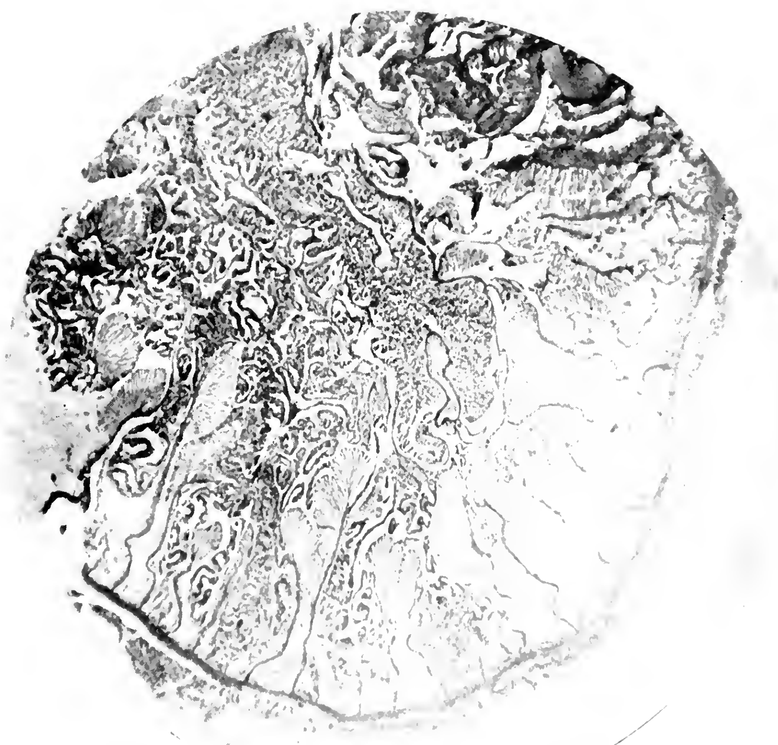

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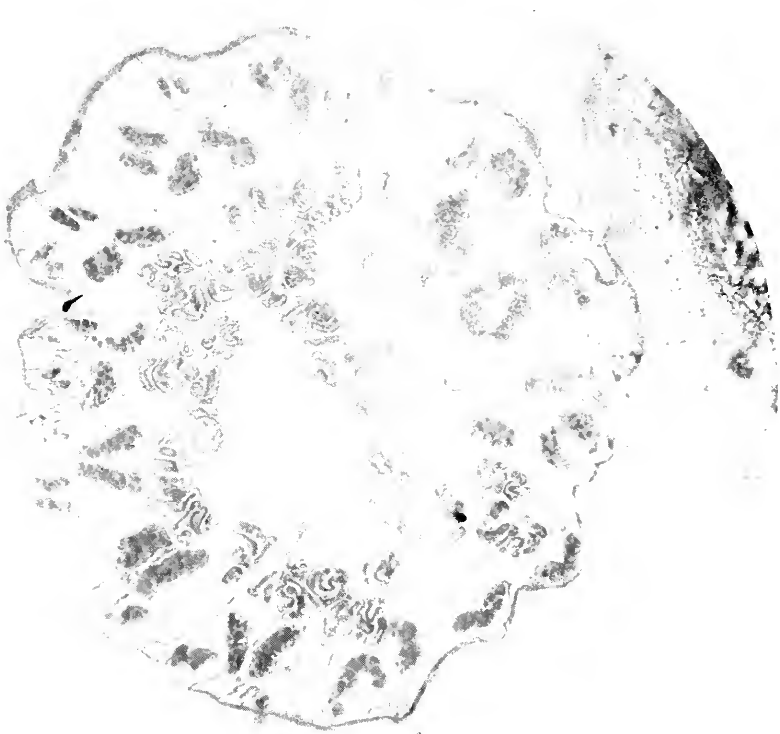


REVIEW OF NEW ZEALAND ACTINIARIA.—Stuckey.

by the following species: *sphyrodeta, pallida, pura*—to which will be added most of the species which I defer to the appendix. These have no conspicuous suckers, discharge acontia less and less abundantly, are in general destitute of positive colour, and have a tendency to a colourless transparency. . . . Should a generic name ever be required for this group I propose for it that of *Thoe*."

(I have above ascribed the name *Thoe* to Wright, and it would appear that this is correct, since he described the genus in 1858, while the date of the "Actinologia Britannica" is 1860. It should be noted, however, that that work was published in parts, the publication extending from March, 1858, to January, 1860.)

Sphyrodeta has a smooth column; substance pulpy—features which it possesses in common with *pallida* and *pura*. *Sphyrodeta* and *pallida* each have rings of colour round the bases of the tentacles; *pura* has the bases of the tentacles more opaquely white than the rest of the body.

On *Lessonia* at Island Bay occurs a small sagartiad anemone which strikingly exhibits features in common with the species above named. The discovery of this form has induced me to re-establish Wright's genus by accepting Gosse's suggestion.

The genus would contain the following species:—

Thoe sphyrodeta (*A. candida*, Gosse, 1853; *S. sphyrodeta*, Gosse, 1858; *A. candida*, Tagwell, 1856; *T. sphyrodeta*, Wright, 1858; *S. sphyrodeta*, Gosse, 1860).

Thoe pura (*A. pellucida*, Alder, 1857; *S. pellucida*, Gosse, 1858; *T. pura*, Wright, 1858; *S. pura*, Gosse, 1860).

Thoe pallida (*A. pallida*, Holdsworth, 1855, and Milne-Edwards, 1857; *S. pallida*, Gosse, 1858, 1860).

Thoe albens, sp. nov.

And also, with less certainty, the five species enumerated by Gosse (Act. Brit. p. 354): *alderi* (Cocks), *pellucida* (Cocks), *yarrellii* (Cocks), *bellii* (Cocks), and *hastata* (Wright).

The genus will be defined thus: "*Sagartinæ* without conspicuous suckers; cinclides absent, or visible only on the discharge of acontia; body-wall smooth or with inconspicuous suckers; acontia discharged reluctantly; generally without positive colour or with only local deposits of pigment; substance of body pulpy."

8. **Thoe albens** (sp. nov.).

This species in expansion is opaque-white, but is so pulpy that in contraction it looks like a small shapeless mass of transparent jelly. This makes it difficult to kill well, and extremely difficult to make good histological preparations of the animal.

Pedal-disc.—Adherent to *Lessonia*, below low-water mark. The ectoderm and endoderm are thicker than the mesoglœa. The latter shows the fibrous structure characteristic of most actinians. It also contains a number of lacunæ. The nerve-layer of the ectoderm is very well developed. The disc spreads out a little beyond the column, the outspread portion being marked with golden-yellow radial lines.

Column.—Similar in structure to the pedal-disc, but thinner. It has the appearance of having a mesoglœal circular muscle throughout its whole height. It is smooth, with no suckers or verrucæ. Neither are there any visible cinclides except when the acontia are ejected. The colour is white.

Sphincter Muscle.—There is a spindle-shaped thickening of the mesogloea in the upper part of the column, causing a slight bulging of the wall. In the sphincter the muscle spaces are very close together, but otherwise this muscle is of the usual sagartian type.

Tentacles.—There are 96, in four cycles, 12 + 12 + 24 + 48 = 96. In colour they are opaque-white, like the column; in shape, conical and tapering. The length is rather more than half the diameter of the disc. At the base of each tentacle is an incomplete ring of yellow pigment, the open part directed inwards and the outer circumferences of the rings close together, so as to make an almost continuous ring of yellow round the top of the column under the tentacles (fig. 7). Nematocysts are numerous in the tentacles. The ectoderm and endoderm are relatively thick, the mesogloea being reduced to a mere streak. The muscle-bearing processes on both sides are few in number. The nerve-layer is compact, and appears almost as a line in cross-sections. There are numerous large irregular spaces in the ectoderm.

Fig. 7.

Oral Disc.—Colour white, as in the tentacles and column. Mouth is set on a peristome. The stomodaeum is white, and there are 2 siphonoglyphs.

Mesenteries.—Owing to the difficulty of killing and fixing this species I was unable to determine accurately the number and arrangement of the mesenteries.

Acontia.—These are emitted reluctantly, some through the mouth, others from cinclides which are placed on the column just under the yellow line at the bases of the tentacles. The acontia are long, and contain very large numbers of nematocysts, together with many nerve-cells. The processes of the nerve-cells run between the closely packed nematocysts (fig. 8).

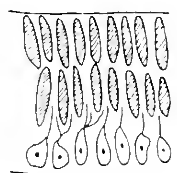


Fig. 8.

Habits.—This species lives in the chinks among the "roots" of *Lessonia*. It is impatient of light.

Dimensions.—In full expansion it is 12 mm. high and 10 mm. in diameter. The pedal-disc is rather wider than the column.

Distribution.—Of the genus—British Isles, New Zealand. Of the species—Island Bay.

Genus Halcampactis (Farquhar).

This genus, which I consider to be closely allied to *Chondractinia* or to *Paraphellia*, will probably become the type for a new subfamily of sagartiads. By its author it is ascribed to the family *Halcampidae*. At the same time he considers it as constituting a link between that family and the *Sagartidae*. I have not been able to find Farquhar's *Halcampactis mirabilis*, though I made one search in company with Mr. Farquhar, and have been out several times myself and with Professor Kirk, the original discoverer of the animal. I have, however, seen the original sections of *H. mirabilis*, but until I have been able to rediscover the species described by Farquhar I prefer to simply place the genus provisionally in the *Sagartidae*. While searching for *Halcampactis mirabilis* I found three specimens of the species to be now described, a species which probably belongs to the same genus.

9. **Halcampactis dubia** (sp. nov.).

The body is pink in colour and vermiform in shape. The epidermis is smooth, with very minute papillæ on the upper portion. The body is divisible into capitulum, scapus, and physa, the division between the last two being slight. A red line marks the division between scapus and capitulum. The capitulum, which is capable of being entirely invected, bears 24 pink tentacles, in two cycles. The scapus is marked by 6 double longitudinal white lines. The physa is adherent and flattened. It is thin, the filaments and acontia being plainly visible through it. The animal does not emit the acontia, but if a slit be made in the body they stream out readily. They are of the usual character, and the nematocysts are closely packed. I have not yet worked out the anatomy and histology of this species.

Dimensions.—The largest specimen was 25 mm. long and about 3 mm. in diameter.

Distribution.—Of the genus—The coast near Wellington. Of the species—Island Bay.

Fam. PARACTIDÆ.

I adopt Hertwig's definition as modified by McMurrich: "*Actiniæ* usually with numerous perfect mesenteries; circular muscle strong, imbedded in the mesoglœa; acontia wanting."

Genus Paractis (Andres).

"*Paractidæ* with smooth body-wall, without papillæ or marginal spherules; tentacles slender, and not exceptionally numerous; nearly equal in length and strength; margin not lobed; sphincter widening somewhat abruptly in its upper part, and occupying, near the margin, nearly the entire thickness of the mesoglœa."

10. **Paractis ferax** (sp. nov.).

Pedal-disc.—Adherent to the under-sides of stones, or to rocks, in dark places. The chief histological feature is the thick mesoglœa, which is indeed a noticeable feature of the whole animal. The fibres are wavy, and there are many lacunæ. The ectoderm is of the usual type, about half as thick as the mesoglœa. The endoderm is thin.

Column.—It is generally cylindrical in shape, but is occasionally constricted at various parts, giving the animal a vase-shaped contour. The column bears, especially in contraction, fine transverse wrinkles. Its height can be varied very considerably, but is generally equal to two or three times the diameter. The colour is milky white. In contraction the animal is drawn into a hard rounded ball of the size of a small marble. The ectoderm and endoderm are of the normal type. The mesoglœa is thick, about equal to the ectoderm, but at intervals it becomes thin, as shown in fig. 9. This feature seems to be characteristic. In other places, numerous enough for the structure to be considered characteristic, the mesoglœa forks, sending out a process which is lined on both sides by ectoderm, and which lies close to the body-wall (fig. 10).

Fig. 9.

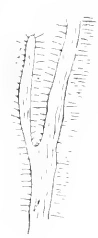


Fig. 10.

Tentacles.—These are conical in form, tapering to a fine point, and reducible to thin filaments. In colour they are white, with brown markings. Each has a brown tip. They are arranged very evenly in four cycles, the inner two nearly equal. Each of these two contains 6 tentacles; the third contains 12 slightly shorter; the fourth contains 24, shorter still. The ectodermal muscles are strong, and are borne on long processes of the mesoglœa. The mesoglœa is very fibrous, and contains a large number of nuclei. There are numerous nematocysts.

Oral Disc.—The disc is white, with a slight brownish tinge. Some specimens have radiating brownish lines. There is a pair of opaque-white lines radiating from the siphonoglyphs to the edge of the disc. The mouth is somewhat depressed, and the siphonoglyphs are not prominent. The stomodæum is not readily everted. The histological characters of the disc closely resemble those of the tentacles.

Sphincter Muscle.—This is mesoglœal in character, consisting of a thickening of the mesoglœa in the upper part of the column, the thickened portion containing numerous muscle-spaces. The whole mesoglœa of the wall is muscular, producing, no doubt, the strong contraction which is so characteristic of the animal.

Mesenteries.—There are 32 to 36 pairs, 2 pairs being directives. The musculature is very strong, the muscle-banners appearing as great rounded masses, but slightly attached to the mesentery (fig. 11).

Gonads.—The mesenteries are all fertile, except the directives. All the animals sectioned happened to be females, and all showed remarkable fertility. Ova appeared at nearly all stages. At first they occupy a position imbedded in the mesoglœa (fig. 11), but as they advance in maturity they form great masses, almost filling the intermesenterial spaces (Plate XXIV, fig. 4). Finally they may become detached from the mesenteries and form globular masses, showing in cross-sections as rounded discs or rings (Plate XXVII). No embryos were seen.

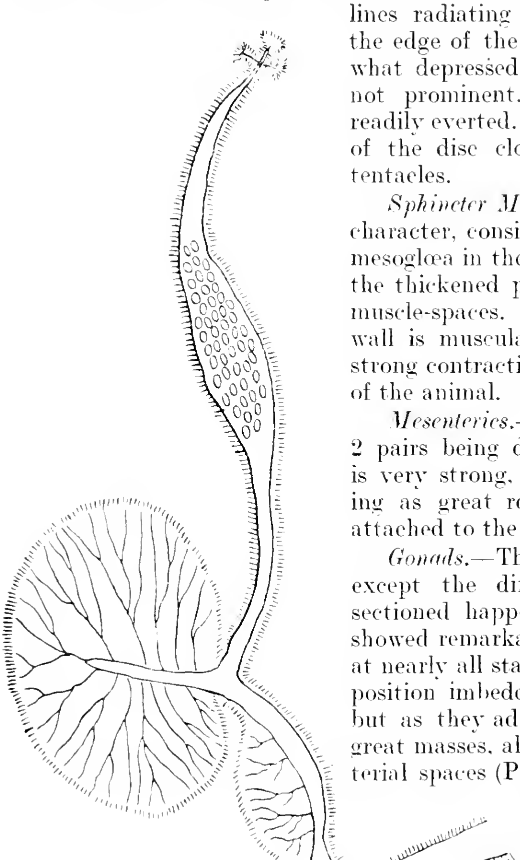


Fig. 11.

Habits.—All my specimens were found in dark places, never more than four in one place, usually single specimens. The species seems rather uncommon.

Dimensions.—.2–18 mm. in diameter, 25–45 mm. in height.

Distribution.—Of the genus—Mediterranean, Red Sea, Indian Ocean, Atlantic, Tierra del Fuego, New Zealand, Pacific, China Sea. Of the species —Island Bay, Ohiro Bay.

Genus TEALIDIUM (Hertwig).

Paractidæ having the tentacles placed in several rows of uniform size in the same row, and having the body-wall covered with fine papillæ. All mesenteries perfect and gonophoric except the directives. (Hertwig's definition modified.)

This genus was erected by Hertwig for the reception of a form found in the "Challenger" material, a form which agreed with *Paractis* except in the warty character of the body-wall. In Hertwig's species (*Tealidium cingulatum*) the wall bulges outwards, forming a girdle below the tentacles. This he attributes to the great development of the sphincter. In the species described below the same thing is seen, though I have no direct evidence that it arises from the cause ascribed by Hertwig. Probably this feature may come to be regarded as of generic value.

11. **Tealidium cinctum** (sp. nov.).

Pedal-disc.—Adherent in cleft of rock, making the animal difficult to remove. The mesoglœa is fibrous, and contains numerous lacunæ.

Column.—The upper part is brownish in colour, the lower part dirty-white. The upper part is covered with verrucæ in vertical rows; small shells, &c., are attached to these verrucæ. The lower part, which is imbedded in a cleft of the rock, is without the verrucæ, and is channelled by fine furrows. The verrucæ act as suckers, by which the animal covers itself with bits of shell and other *débris*. In full expansion the column bulges outwards, forming a circular swelling just under the bases of the tentacles. The ectoderm is somewhat irregular, and there appear here and there spaces between the cells. The nerve-layer is feebly developed. The mesoglœa is well developed, and contains small lacunæ. It runs into the ectoderm in the form of conical papillæ.

Tentacles.—These are 48 in number, apparently in four cycles. Length, about 16 mm. They are pellucid, with a mauve-pink shade. There are white transverse markings on the inner sides. The ectoderm is of the same irregular character as that of the column, but the intercellular spaces are smaller. The nervous layer is well developed, being several cells deep. There is a fair development of the ectodermal muscles, but the endodermal musculature is weak. The lumen of each tentacle is filled with what appears to be hypertrophied endoderm.

Oral Disc.—The colour is pale brown, with a ring of green round the mouth, and a broken ring of yellow round the green. The histological features resemble those of the tentacles.

Sphincter Muscle.—This is mesoglœal and diffuse, extending through the whole wall of the column. There is, however, a decided thickening under the edge of the disc, and this probably constitutes the true sphincter. Hertwig describes a similar sphincter in *Antholoba reticulata*.

Mesenteries.—There are 24 pairs, 2 pairs being directives. All reach the stomodæum, and are about equal in development. All are gonophoric except the directives. I have made this a generic feature, since *Tealidium cingulatum* (Hertwig), the only other known species, has all its mesenteries perfect and gonophoric (? directives). The musculature is well developed. (Plate XXIV, fig. 2.)

Gonads.—Placed much as in *Paractis ferax*, and form large masses between the mesenteries.

Dimensions.—Height, 40 mm.: diameter, 30 mm.

Distribution.—Of the genus—Antarctic Ocean (Delage and Herouard): also New Zealand. Of the species—Island Bay.

Fam. CORALLIMORPHIDÆ.

"Hexamerous *Actiniæ* with a double corona of tentacles, a corona of marginal principal tentacles, and a corona of intermediate accessory tentacles. Mesenteries slightly differentiated and all gonophoric. Muscular system weak in all parts of the body. No sphincter."

Genus CORYNACTIS (Allman).

The tentacles are all knobbed. They are arranged in radial series, so that more than one communicate with each inter- or intra-mesenterial space.

Farquhar described three species of *Corynactis* from the neighbourhood of Wellington. These are *C. haddoni* (with seven varieties), *C. mollis*, and *C. gracilis*.

In external form these species are all very similar, their chief apparent difference being in the matter of colour. I think it not unlikely that the species and varieties enumerated by Farquhar may prove on investigation to belong to only one species. I have not yet, however, been able to collect specimens of all the species of *C. haddoni*, and have therefore to defer the investigation. To the species mentioned above I add a fourth, *C. albida*. In external appearance this corresponds closely to *C. haddoni*, except in colour, which is pure white, without any deposit of pigment. The principal tentacles are very long and slender, inclining slightly outwards in expansion. The accessory tentacles stand upright.

Farquhar has so carefully described the external appearance of his species that there is no need for repetition here. I have not yet fully worked out their anatomy and histology, but have made the following notes:—

12. **Corynactis haddoni** (Farquhar).
13. ,, **gracilis** (Farquhar).
14. ,, **mollis** (Farquhar).
15. ,, **albida** (sp. nov.).

Mesenteries.—In all four species there are 24 pairs, of which 12 pairs appear, typically, to be perfect. There is scarcely any indication of retractor muscles in any species, but the parietal muscles are generally fairly well developed. On the filaments in some sections I noticed the same appearance of three trefoils as I have described in *Actinia tenebrosa*.

Sphincter Muscle.—On account of the complete infolding of the tentacles Farquhar supposes the sphincter to be well developed, and in this belief he is supported by Delage and Herouard. A large number of longitudinal sections of the four species under survey failed, however, to show the slightest indication of a sphincter.

C. haddoni: Though there is no sphincter, there is a fairly distinct circular muscle in the wall. This consists of a few fibres running on the endodermal side of the mesoglœa. The mesoglœa is homogeneous. The ectoderm is the thickest of the three layers, the other two each being about half its thickness.

C. gracilis: The mesoglœa of the column contains a single row of spaces, more or less round. This feature, however, may prove to be the result of treatment.

C. mollis: The mesoglœa is very slightly fibrous. The stomodæum is much folded, and into it run processes of the mesoglœa. The musculature of the mesenteries is stronger than that of the other species.

C. albida: As in *C. mollis*, the stomodæum is much folded, and has mesoglœal processes projecting into its ectoderm. Each of these processes is opposite to the attachment of a pair of mesenteries. The outer parts of the mesenterial spaces are filled with hypertrophied endoderm.

Reproduction.—No gonads appeared in any of my sections, but masses of ova and young animals appeared in the bowl with the animal that divided in the manner to be described below. This was a specimen of *C. haddoni* taken on the 31st August, 1908. It was on a small stone, and attracted attention on account of the fact that it had spread itself out in the form of a flattened elliptical disc, the length of which was four or five times the diameter of an ordinary specimen, while the breadth was half the length. It was so flattened that the oral and pedal discs were almost in contact. The mouth gaped wide, having been stretched in the same way as the body.

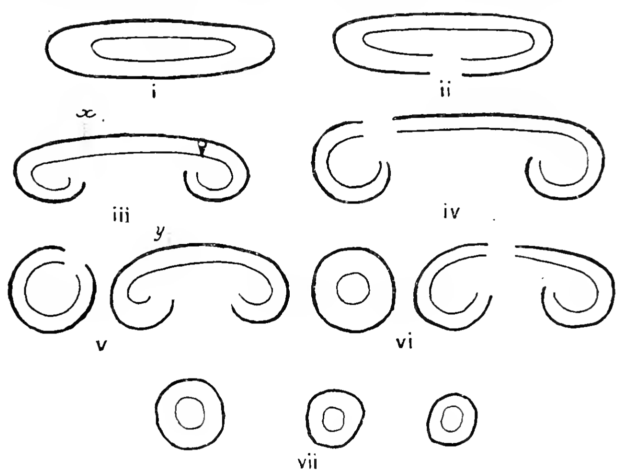


FIG. 12.

The mesenterial filaments were plainly visible. The tentacles were almost completely retracted, only the knobs showing. The animal, on its stone, was placed in an aquarium, and closely watched. In two or three days the wall became thin at one extremity of the minor axis of the ellipse, finally splitting at that point. The free ends began to retreat, as it were, in a direction parallel to the major axis. As they approached the vertices of the ellipse they began to curl inwards. A second split occurred about the place marked *x* in the diagram, and the first daughter organism became free. The two ends gradually curled round, and finally coalesced. In the meantime the last-freed ends began to curl inwards, and another split began to form at the place marked *y*. The second and third daughter organisms closed up as the first had done. Thus three organisms were formed by a process of fission, which I have called "lateral fission." The whole process, to the complete formation of the last daughter organism, occupied about seven weeks. In addition to this, a bud appeared, at an early stage, on the foot of what became the last-formed organism. This bud increased in size, and a constriction began to be formed, cutting it off from the parent. This illustrates the process of pedal gemmation mentioned by Farquhar. The method of asexual reproduction which I have called "lateral fission" appears to be different from any of those described in the "Cambridge Natural History," and it also appears to differ from the method called by Delage and Herouard (p. 476) "scissiparite longitudinale." It is an interesting fact that during the process of fission ova were released and developed into embryos about $\frac{1}{3}$ mm. in height. This nascent colony would doubtless have yielded interesting results, but it was unfortunately destroyed through the neglect of a laboratory attendant, who allowed the water to be polluted by dead molluscs. The drawings illustrating the process described above are only diagrammatic "ground-plans," as it were. (Fig. 12.)

Fam. PHYLLACTIDÆ.

"*Hexactiniæ* with simple conical tentacles at some distance from the apparent margin; between them and the margin are low tentacular or foliose structures (fronds). Sphincter endodermal, more or less circumscribed, lying in the interval between the tentacles and the frondose or tentacular structures. From two to several cycles of mesenteries perfect."

Genus Cradactis (McMurrich).

"*Phyllactidæ* with the fronds represented by bunches of simple or slightly branched, short, tentacle-like structures. Sphincter aggregated or circumscribed. Column with verrucæ."

16. Cradactis plicatus (nom. nov.), Hutton.

This anemone was first described by Hutton as *Oulactis plicatus*. He described the margin of the disc, when expanded, as "thrown into five deep folds." Though I have observed many specimens, both in their natural home and in an aquarium, I have been unable to observe this feature. At the same time, I have no doubt as to the identity of the species. Hutton placed this anemone in the genus *Oulactis*, but I have been led by the character of its fronds to place it in McMurrich's genus *Cradactis*.

Pedal-disc.—Adherent and somewhat thin, the insertions of the mesenteries being plainly visible through its substance. When removed from the rocks the "flange" round the base becomes very noticeable. The ectoderm is comparatively thick, and is curiously strengthened by strands of mesoglœa which in places appear to have lost their connection with the main part of the mesoglœa. These strands are not fibrous like the rest of the mesoglœa, in which the fibrous structure is particularly noticeable.

Column.—This is cylindrical, generally wider than high, and with only a slightly expanded lower portion. Verrucæ are present, arranged in vertical rows. They are absent on the lower part of the column. The upper verrucæ act as suckers, by means of which the animal covers itself with stones and shells, so that, when retracted, it resembles a small pile of stones. The colour of the column is yellowish-brown, passing into dirty white below. The mesoglœa is prolonged into the ectoderm in pinnate processes. These are arranged in regular vertical rows corresponding to the verrucæ.

Tentacles and Fronds.—The simple tentacles are conical, and are more than the radius of the disc in length when the whole animal is fully expanded.

Their colour is pellucid pale brown, like the colour of thin shavings of horn. They are barred with white on the oral aspect. At the bases of the tentacles, and sending points between them, is a zigzag circle of yellow, with a suggestion of pink. The ectodermal and endodermal muscles are both well developed, more especially the former. The nervous layer and the epithelial layer are both thick. Outside the simple tentacles, and just on the edge of the disc, is a single row of "compound" tentacles or "fronds," 48 in number, structures which McMurrich regards as differentiated acrorhagi. These are white in colour and multilobed, each often having as many as twenty lobes. They form a wide frill round the animal, giving it a fine appearance when fully expanded. One of the lobes of each frond is constantly pigmented with a pink spot or knob. The lobes of the fronds are able to act as suckers. They are not sensitive to tactile stimuli. All the elements of the body-wall enter into the composition of the fronds, except the nervous layer of the ectoderm.

Oral Disc.—The margin is raised, as is also the peristome, giving the disc a concave form. The colour varies, yellow, crimson, and deep velvety brown being the chief varieties. The edge of the mouth is generally lighter in colour than the rest of the disc, and is ringed by a deposit of pigment. There are also radiating lines of an orange colour, and there is a broken circle of yellow round the bases of the tentacles, as already mentioned. There are well-developed ectodermal muscles, but the endodermal muscles are weak. On the under-side of the disc—that is, the roof of the cœlenteron—are spaces each of which encloses a developing ovum. These spaces are apparently brood-pouches.

Sphincter Muscle.—This is endodermal and circumscribed. In cross-section it is heart-shaped. It is placed under the fronds. (Plate XXV, fig. 1.)

Stomodæum.—There are 2 prominent siphonoglyphs, each marked externally by a yellow tubercle with a pink top. The stomodæum is grey in colour, and shows the edges of the mesenteries. Cross-sections of the animal show the siphonoglyphs to be deep and narrow. In addition, the stomodæum is folded into 10 other grooves. The ectoderm is provided with a large number of gland-cells.

Mesenteries.—There are 48 pairs, two of them directives; twelve pairs reach the stomodæum. The muscles are strong, the "banners" occupying the larger part of the mesentery. There is strong development of parietal muscles. (Plate XXV, fig. 2.)

Gonads.—In one specimen testes were seen on the imperfect mesenteries. In another, ova were found, as described, in brood-pouches. These were the only cases in which I saw sex-cells.

Habits, &c.—The animal adheres strongly, the lower part of the column often being placed in a chink of the rock. Its colour is protective, and, in addition, its habit of covering itself with bits of stone and shell helps to conceal it. The concave disc, also, is often covered with sand, so that nothing shows but the mouth and tentacles.

Dimensions.—Variable. The largest specimens are 6 cm. in diameter and rather less in height.

Distribution.—Of the genus—Delage and Herouard give "Cape Horn," but this does not agree with McMurrich, who locates his species in the Bermudas and "Station 2766, lat. 36° 47′ S., long. 56° 23′ W.," that is just south of the Rio de la Plata. Of the species—Dunedin, Cook Strait.

17. **Cradactis magna** (sp. nov.).

I have not seen this species alive. I give the following notes of the gross dissection of a preserved specimen: The base is adherent. The column has about 100 rows of verrucæ. The ectoderm is thick, and peels off readily. Not only does the animal attach pieces of shell to itself, but these even become imbedded in the ectoderm. At the oral end of the column is a ring of foliose structures. The tentacles and disc are strongly infolded, suggesting the presence of a powerful sphincter. The mesoglœa throughout the animal is thick and strong. The tentacles are very numerous, and apparently in four rows; each has a pore at the tip. There are 96 pairs of mesenteries, the first and second cycles being perfect, and each apparently consisting of 12 pairs; 2 pairs are directives; all appear normally to be fertile. In contraction the animal is 7 cm. high and 5 cm. broad. Its size when expanded could not be less than 10 cm. in height, and not much less in diameter. This species is found at Plimmerton.

Since the above notes were prepared I have seen four specimens alive. The column varies in colour, being respectively brownish-yellow, pinkish-yellow, yellowish-green, and pale green in the four individuals respectively. The disc is radially marked with brown streaks, with regular white patches between. The tentacles are short, and arranged in four cycles. They are bicoloured, being in three of the specimens deep purple at the proximal end, bright claret at the distal end. In the fourth the colours were orange and yellow. The number of lobes in the fronds is great; they are dull grey in colour, not so prominent as the same structures in *C. plicatus*. The pink spot of *C. plicatus* seems to be represented here by a white one. The verrucæ are somewhat cylindrical. The stomodæum is white. There are 2 siphonoglyphs.

Fam. BUNODIDÆ.

Genus Bunodes (Gosse).

18. **Bunodes aureoradiata** (sp. nov.).

This is fully described in this volume at p. 368.

Distribution.—Of the genus—Norway, English Channel, Atlantic, Mediterranean, Bahamas, Indian Ocean (Delage and Herouard); also New Zealand. Of the species—Wellington Harbour.

19. **Bunodes inconspicua** (nom. nov.), Hutton.

This species was named, by Hutton, *Phymactis inconspicua.* The vertical arrangement of its verrucæ, however, gives it a place in the genus *Bunodes.*

Basal Disc.—Adherent, rather wider than the column. The ectoderm is twice as thick as the mesoglœa. The latter contains lacunæ.

Column.—Cylindrical, slightly widening towards the base. Verrucæ in vertical rows, long and short rows alternating. Towards the lower end of the column they become less numerous and smaller, at last becoming mere marks. The colour of the column is whitish below, olive-brown above. The column closely resembles that of *Bunodes aureoradiata.* The ectoderm and endoderm are normal, the latter containing zooxanthellæ. The mesoglœa runs out into the ectoderm, taking part in the constitution of the verrucæ. Under the tentacles is a ring of white tubercles or "marginal beads," each one being placed at the top of a vertical row of warts.

Tentacles.—These are placed in four cycles, and are about 120 in number. The largest is equal in length to the diameter of the disc. They are conical.

and taper to a fine point. In colour they are olive-brown, with from 2 to 6 white spots on the inner side. They are completely retractile, and very sensitive. The nerve-layer is distinct, and the ectodermal muscles are strong. The endomermal muscles are weak. The lumen is filled with zooxanthellæ.

Oral Disc.—Flat; peristome raised. Colour olive-brown. Stomodæum white, often everted. The histological features resemble those of the tentacles.

Sphincter Muscle.—Endodermal. Closely resembles that of *B. aureoradiata.*

Mesenteries.—Closely resemble those of *B. aureoradiata.*

Gonads.—I saw none in my preparations.

Dimensions.—My largest specimens were 15 mm. high, and about the same in diameter, but I am told they grow much larger.

Distribution.—Of the genus—As above. Of the species—Dunedin. Wellington.

Genus LEIOTEALIA (Hertwig).

20. **Leiotealia thompsoni** (nom. nov.), Coughtrey.

This species is described in this volume in a separate paper.

Distribution.—Of the genus—Magellan Strait, Chili, Kerguelen Island, Arctic Ocean (Delage and Herouard); also New Zealand. Of the species—Dunedin (Coughtrey); Cook Strait, from Plimmerton to Seatoun.

Fam. ALICIIDÆ.

"*Hexactiniæ* with large, flat, contractile base. Tentacles simple, subulate, entacmæous. Column with simple or compound hollow outgrowths or vesicles over more or less of its surface, arranged mostly in vertical rows. No cinclides. Sphincter muscle endodermal and diffuse, variable in amount of development. Perfect mesenteries few or numerous. No acontia." (Duerden.)

Up to the present time this family contains four genera — *Alicia, Cystiactis, Bunodeopsis,* and *Thaumactis.* I have several specimens of a form taken at Island Bay and one specimen taken at Stewart Island. Both these forms certainly belong to the *Aliciidæ,* but do not seem to be referable to any one of the hitherto recognised genera. They differ from *Alicia* in their larger number of perfect mesenteries; from *Cystiactis* in the large number of short tentacles; from *Bunodeopsis* in the disposal of the phlyctenia over the whole of the column; from *Thaumactis* in the lenticular form, and absence of a pedal-disc in the latter genus. For these reasons I propose for these two species a new genus, *Phlyctenactis.* The differences between this genus and the other four are shown by the following table:—

TABLE OF THE GENERA OF THE FAMILY ALICIIDÆ.

Genus.	Tentacles.	Perfect Mesent.	Vesicles.	Column.	Pedal-disc.
Alicia	..	6 pairs	..	..	..
Cystiactis	Few; long	..	..	..	..
Bunodeopsis	..	..	On proximal part	..	..
Thaumactis	..	..	..	Lenticular	Absent
Phlyctenactis (gen. nov.)	Many; short	12 pairs	All over column	Cylindical	Present

Genus Phlyctenactis (gen. nov.).

Aliciidæ of large size, with numerous short tentacles arranged in several cycles. Column entirely covered with simple vesicles, sessile or on short pedicles, arranged more or less in vertical rows, and communicating with the intermesenterial spaces. More than six pairs of perfect mesenteries.

21. Phlyctenactis retifera (sp. nov.).

Pedal-disc.—Lobed, wider than the column. Only slightly adherent, the animal being able to "crawl" about on it, and to become free and float away at will. The colour of the pedal-disc is yellowish-orange.

Column.—Cylindrical in form, and covered with large blisterlike vesicles, which in the contracted state of the animal lie in contact, but in expansion are separate. Their longitudinal arrangement is not evident, except when the animal is expanded. They open by small openings into the cœlenteron. They appear to assist in the flotation of the animal. The colour of the column is dark velvety brown. The mesoglœa of the wall is very thick, appearing as a homogeneous mass, bordered on each side by parallel fibres, and crossed by oblique transverse fibres. I have seen no definite sphincter, but the circular endodermal muscle of the wall is developed through its whole length. The ectoderm and endoderm of the wall are not so well developed as the mesoglœa. The vesicles contain all the elements of the wall.

Tentacles.—Very numerous and crowded, in about six cycles. They are simple, and conical in shape. Their colour is pale yellow. Their histology is interesting. Next to the ectoderm comes a thin layer of homogeneous mesoglœa, followed by a thick layer of highly reticular mesoglœa, then a thin homogeneous layer, under which is the endoderm. (Plate XXVI, figs. 1, 2.)

Oral Disc.—The disc is flat, with the mouth on a large mound-shaped peristome. The colour of the disc is light yellow, that of the peristome very dark brown or black. The mouth bears two bright-yellow tubercles.

Stomodæum.—This is white in colour, and has a very thick layer of ectoderm. There are 2 siphonoglyphs.

Mesenteries.—There are 12 pairs of complete mesenteries, which are all sterile, and 36 pairs of incomplete ones, which bear gonads. Two pairs of mesenteries are directives. The musculature is very weak on the complete mesenteries, stronger on the incomplete.

Gonads.—Only ova were seen. These are borne in the usual way, on the imperfect mesenteries.

Habits.—This anemone frequents quiet pools among the rocks, but is sometimes seen floating at the surface, oral disc downwards. Rather uncommon.

Dimensions.—Fully expanded the animal is 18 cm. in height and 10 cm. in diameter.

Distribution.—Of the genus—New Zealand. Of the species—Cook Strait.

22. Phlyctenactis morrisonii (sp. nov.).

This species was sent me (one specimen) from Stewart Island by Miss E. Morrison, M.A. It had been some time in spirit, and was not well preserved. It agreed in most respects with spirit specimens of the last species, and I have no doubt that the two belong to the same genus. It differs from the last in one important respect. The ova (which were very numerous in the specimen) are borne on much-reduced mesenteries, and appear, indeed, to spring direct from the body-wall. They are arranged in plates or lamellæ, each plate consisting of a large number of strings of ova lying side by side (Plate XXVII fig.1). In some of the tentacles I found small stones of the size of a pea. These probably came there by accident. On the other hand, they may serve a hydrostatic purpose. The colour of the specimen was purplish-blue.

Distribution.—Of the genus—As above. Of the species—Stewart Island.

Genus (?).

23. (?) species.

This anemone, which I have been unable to classify, was found alive in the radial canal of a large acraspedote medusa at Plimmerton. It was very badly preserved when handed to me, having lain for some days in sea-water before being placed in spirit. It was good for neither dissection nor histology. The length is about 25 mm., shape cylindrical, colour white. It is not quite as thick as a lead-pencil. It was impossible to ascertain anything about the tentacles or disc. There is no indication of division into capitulum, scapus, and physa. The aboral end, however, was rounded. The column is divided by 12 longitudinal furrows.

SPECIES NOT SEEN BY ME.

24. **Edwardsia neozealanica** (Farquhar).

25. **Halcampactis mirabilis** (Farquhar).

These species are known to exist in the neighbourhood of Wellington, but I was unable to find them, though both Mr. Farquhar and Professor Kirk (their original discoverers) accompanied me in my searches.

26. **Paractis monilifera** (Drayton, Milne-Edwards, Hutton).

Andres regards this species as not belonging to *Paractis*, but to some other (unnamed) genus.

27. **Actinia striata** (Quoy and Gaimard, Hutton).

The description of this species as given by Andres does not mention the presence of acrorhagi. He says, "Il Milne-Edwards la menziona con dubbio." It probably belongs to some genus other than *Actinia*.

28. **Phymactis polydactyla** (Hutton).

The disposal of the verrucæ, as given by Hutton, is different from that generally given in the diagnosis of *Phymactis*.

29. **Minyas viridula** (Quoy and Gaimard, Milne-Edwards, Hutton).

Andres places this species in the genus *Accrominyas*, which he describes as an uncertain genus. The absence of tentacles is curious, and he suggests that they may have been torn off. Apparently only one specimen has been found.

30. **Sagartia crocata** (Hutton).

31. **Peachia carnea** (Hutton).

These are given in the "Index Faunæ," but the references are incorrect, and so far I have been unable to find Hutton's descriptions.

EXPLANATION OF TEXT-BLOCKS.

Fig. 1. *Edwardsia tricolor.*
Fig. 2. „ One segment of the capitulum.
Fig. 3. „ Musculature of a mesentery.
Fig. 4. „ Diagrammatic representation of portion of cross-section of a tentacle.
Fig. 5. *Actinia tenebrosa.* Diagram showing manner of division of mesenteric filament into three branches.
Fig. 6. *Sagartia nutrix.* Young attached to body-wall. Animal expanded.
Fig. 7. *Thoe albida.* Diagram to show manner of deposit of pigment round bases of tentacles.
Fig. 8. *Thoe albida.* Portion of an acontium. (From a rough slide—diagrammatic.) The nerve-cells appear to be on one side, the nematocysts on the other.
Fig. 9. *Paractis ferax.* Part of a cross-section of body-wall to show the characteristic thinning of the mesoglœa at intervals.
Fig. 10. *Paractis ferax.* Showing forking of the mesoglœa in the body-wall.
Fig. 11. „ A mesentery in cross-section, showing parietal muscle, retractor muscle, ova, and mesenterial filament.
Fig. 12. *Corynactis haddoni.* Diagrams to illustrate the steps in lateral fission.

EXPLANATION OF PLATES XXI–XXVIII.

Plate XXI.

Fig. 1. *Sagartia nutrix* photograph on a piece of seaweed. Animal partly contracted.
Fig. 2. „ Cross-section of sphincter.

Plate XXII.

Fig. 1. *Edwardsia tricolor.* Part of a cross-section, showing some of the mesenteries and ova in the body-cavity; × 50.
Fig. 2. *Edwardsia tricolor.* Longitudinal section of capitulum, showing ova in stomodæum.

Plate XXIII.

Fig. 1. *Actinia tenebrosa.* Part of a cross-section, showing one pair of directives and one siphonoglyph; also, unequal development of mesenteries. On the right—Dirs. III, II, III, I; on the left—Dirs. III, II, III, II, III, I.
Note.—The junctions of the two pairs of primaries with the stomodæum do not show clearly in the micrograph, though they were clear enough in the preparation.
Fig. 2. *Actinia tenebrosa.* "Trefoil" of mesenteric filament.

Plate XXIV.

Fig. 1. *Paractis ferax.* Part of a cross-section, showing a mesentery with ova in an advanced stage.
Fig. 2. *Tealidium cinctum.* Part of a cross-section, showing directives and other mesenteries, and part of siphonoglyph.

Plate XXV.

Fig. 1. *Cradactis plicatus.* Cross-section of sphincter.
Fig. 2. „ Part of a cross-section, showing directives and other mesenteries, and one siphonoglyph.

Plate XXVI.

Fig. 1. *Phlyctenactis retifera.* Cross-section of tentacle, showing reticular structure of the mesoglœa. Greatly magnified.
Fig. 2. Portion of the same, more highly magnified.

Plate XXVII.

Fig. 1. *Phlyctenactis morrisonii.* Portion of a longitudinal section, showing body-wall, ova, and one vesicle.
Fig. 2. *Sagartia vagrans.* Part of a cross-section, showing directives and other mesenteries, and part of stomodæum.

Plate XXVIII.

Paractis ferax. Section below the stomodæum, showing mesenteries, with ova and mesenterial filaments; also masses of ova between the mesenteries.

ART. XXXVII.—*Some Hitherto-unrecorded Plant-habitats* (IV).

By L. COCKAYNE, Ph.D.

[*Read before the Philosophical Institute of Canterbury, 4th November,* 1908.]

FILICES.

Trichomanes reniforme, Forst. f.

This is an extremely rare fern in Stewart Island. Kirk (Trans. N.Z. Inst., vol. xvii, p. 230) gives Paterson Inlet and Half-moon Bay as its habitats, writing, "Restricted to a few square yards above high-water mark in each locality." Mr. J. W. Murdoch informs me it occurs at Kaipipi Bay, Paterson Inlet.

Trichomanes strictum, Menzies.

Recorded by Kirk for Stewart Island only on Ulva. I have also noted it in a moist gully in the forest west of Half-moon Bay.

Dryopteris Thelypteris (L.), A. Gray, var. **squamulosum** (Hook. f.), Schlecht.

In swamp of dunes near Waikanae, Wellington. L. C. !

Blechnum Patersoni (R. Br.), Mett., var. **elongatum** (Mett).

Forest, Kaituna Valley, Banks Peninsula. L. C. !

POTAMOGETONACEÆ.

Potamogeton ochreatus, Raoul.

Natural pond near the River Turakina, not far from its mouth. L. C. !

Potamogeton pectinatus, L.

Sluggish stream near mouth of River Rangitikei. L. C. !

CYPERACEÆ.

Eleocharis neo-zelandica, C. B. Clarke.

In hollows of dunes between Manawatu and Rangitikei Rivers. L. C. !

Carex dissita, Sol., var. **monticola**, Kük.

Subalpine meadow, Mount Anglem, Stewart Island. L. C. !

LILIACEÆ.

Phormium Cookianum, Le Jolis.

(1.) Hollow in dune near mouth of River Turakina, Wellington, in company with *P. tenax*; L. C. ! (2.) On cliff-faces, River Waitotara; L. C. !

IRIDACEÆ.

Libertia ixioides, Spreng.

Very common in all the swampy ground amongst the dunes of the west coast of Wellington. L. C. !

ORCHIDACEÆ.

Thelymitra uniflora, Hook. f.

Mount Grey, Canterbury. T. Keir !

URTICACEÆ.

Urtica ferox, Forst. f.

Outskirts of forest, Taumarunui. L. C. !

Elatostemma rugosum, A. Cunn.

(1.) Waipoua Forest (accidentally omitted from list of species in "Report of Botanical Survey of Waipoua Kauri Forest"). (2.) Gullies in forest near Waitotara; L. C. ! (3.) Reserve on bank of River Manawatu, Palmerston North; L. C. !

LORANTHACEÆ.

Korthalsella salicornioides (A. Cunn.), Van Tiegh.

Parasitic on *Leptospermum scoparium*, old dunes, Waikanae. L. C. !

POLYGONACEÆ.

Rumex neglectus, T. Kirk.

Gravelly shore, Ruapuke Island. L. C. !

CARYOPHYLLACEÆ.

Stellaria Roughii, Hook. f.

Takitimu Mountains, Southland. J. Crosby-Smith ! Mount Torlesse is the southern limit in Cheeseman's Manual.

Colobanthus Muelleri, T. Kirk.

Centre Island and Dog Island, Foveaux Strait. L. C. !

Scleranthus biflorus (Forst.), Hook. f.

Dog Island. L. C. !

RANUNCULACEÆ.

Ranunculus Monroi, Hook. f., var. **dentatus**, T. Kirk.

(1.) Mount Somers; R. M. Laing ! (2.) Puketeraki Mountains, Canterbury; L. C. !

Ranunculus aquatilis, L. (Introduced.)

Very plentiful in lake near mouth of River Rangitikei. L. C. !

CRUCIFERÆ.

Cakile maritima, Scop. (Introduced.)

Dunes, New Brighton, Canterbury. L. C. ! Not previously recorded for New Zealand.

CUNONIACEÆ.

Weinmannia racemosa, L. f.

Forest, Mount Grey, Canterbury. T. Keir !

ROSACEÆ.

Geum parviflorum, Sm.

Takitimu Mountains, Otago. J. Crosby-Smith !

Geum uniflorum, Buch.

Takitimu Mountains, Otago. J. Crosby-Smith!

OXALIDACEÆ.

Oxalis magellanica, Forst.

Mount Matthews, Rimutaka Range. H. H. Travers!

RHAMNACEÆ.

Discaria toumatou, Raoul.

Dunes, west coast of Wellington. L. C.!

MALVACEÆ.

Hoheria sexstylosa, Col.

Forest near Greymouth. H. H. Travers!

VIOLACEÆ.

Viola Cunninghamii, Hook. f.

Swampy ground of dunes near mouth of River Turakina. L. C.!

Hymenanthera dentata, R. Br., var. **angustifolia**, Benth.

Bank of river, Otautau, Southland. L. C.!

Hymenanthera dentata, R. Br., var. **alpina**, T. Kirk.

Through an oversight, I stated (Trans. N.Z. Inst., vol. xl, p. 310) that *Hymenanthera* was not recorded for Stewart Island in Cheeseman's Manual. This is incorrect; but the Stewart Island plant is there referred, on the authority of Kirk, to *H. crassifolia*, Hook. f. The plant under consideration occurs on Mount Anglem, but is much more abundant on the flattish ground near the stream flowing into Crooked Reach, Port Pegasus.

MYRTACEÆ.

Metrosideros Colensoi, Hook. f.

Forest near Waitotara. L. C.!

ONAGRACEÆ.

Fuchsia excorticata, L. f.

Accidentally omitted from "List of Species of Waipoua Kauri Forest."

HALORRHAGIDACEÆ.

Halorrhagis uniflora, T. Kirk.

Dog Island, Foveaux Strait. L. C.!

Gunnera arenaria, Cheesem.

Very plentiful in sandy hollows of dunes from Waikanae to Patea. L. C.!

ARALIACEÆ.

Nothopanax simplex (Forst. f.), Seem., var. **parvum**, T. Kirk.

Waimarino Forest, near Ohakune. E. Philipps Turner!

CORNACEÆ.

Corokia Cotoneaster, Raoul.

(1.) Forest, Taihape; E. Philipps Turner! (2.) On old weathered rock amongst dunes near shore, a few miles south of Wanganui; L. C.!

MYRSINACEÆ.

Suttonia nummularia, Hook. f.

Almost at sea-level, near Port Pegasus, Stewart Island. L. C.!

CONVOLVULACEÆ.

Calystegia Soldanella, R. Br.

Ruapuke Island. L. C.!

BORAGINACEÆ.

Myosotis Goyeni, Petrie.

By a slip of the pen I wrote *Myosotis Cheesemannii* for the above in Trans. N.Z. Inst., vol. xl, p. 313. The habitat is cliffs, Broken River, Canterbury.

SCROPHULARINACEÆ.

Mazus pumilio, R. Br.

Abundant in damp ground near the coast from Waikanae to the Waitotara River. L. C.!

Veronica Petriei (Buch.), T. Kirk.

Takitimu Mountains, Southland. J. Crosby-Smith!

CAMPANULACEÆ.

Pratia perpusilla, Hook. f.

On damp sandy ground amongst old dunes between Rangitikei and Turakina Rivers: not common. L. C.!

Isotoma fluviatilis (R. Br.), F. von Muell.

Margin of Lake Letitia, and other places on wet ground in neighbourhood of Mount White, Waimakariri district, Canterbury. L. C.!

COMPOSITÆ.

Lagenophora pinnatifida, Hook. f.

(1.) Beech forest, Paradise, Otago Lake district; L. C.! (2.) Beech forest (*Nothofagus cliffortioides*), Kowai Bush, Canterbury; L. C.!

Olearia Colensoi, Hook. f.

Near summit of Mount Matthews, Rimutaka Range. H. H. Travers!

Olearia nitida, Hook. f., var. **capillaris** (Buch.), T. Kirk.

Waimarino Forest, near Ohakune. E. Philipps Turner!

Olearia fragrantissima, Petrie.

(1.) Port Hills, Canterbury; L. C.! (2.) Bank of creek, Otautau, Southland; L. C.!

Olearia Hectori, Hook. f.

Bank of creek, Otautau, Southland. L. C. !

Olearia virgata, Hook. f.

Common in many swamps amongst dunes between the Manawatu and Turakina Rivers. L. C. !

Celmisia Lindsayi, Hook. f. (?)

If I am mistaken in my identification, the plant is very close to the above. Mount Franklin, Southland. J. Crosby-Smith !

Celmisia Lyalli, Hook. f.

Takitimu Mountains, Southland. J. Crosby-Smith !

Celmisia viscosa, Hook. f.

Takitimu Mountains, Southland. J. Crosby-Smith !

Gnaphalium trinerve, Forst. f. (?)

(This may be a form of *G. keriense*, A. Cunn., but it seems to me best placed as above.) On low cliff, mouth of Ototoka Stream, Oheku, near Wanganui. L. C. !

Gnaphalium Lyallii, Hook. f.

Abundant in large sheets on face of cliffs near mouth of Waiongoro River, Taranaki. L. C. !

Raoulia australis, Hook. f.

On rock, and also on sandy ground covered with stones near shore, south of mouth of River Waitotara. L. C. !

Senecio bellidioides, Hook. f.

Canterbury Plain, at from 70 m. above sea-level, near Waimakariri River. L. C. !

Senecio latifolius, Banks and Sol.

Margin of Waimarino Forest, Waimarino Plain. L. C. !

Senecio elæagnifolius, Hook. f.

Mount Matthews, near summit. H. H. Travers !

Senecio cassinioides, Hook. f.

Mount Franklin, Southland. J. Crosby-Smith !

Art. XXXVIII.—*On a Collection of Plants from the Solanders.*

By L. Cockayne, Ph.D.

[*Read before the Philosophical Institute of Canterbury, 4th November,* 1908.]

The Solanders are two small islands lying in the Tasman Sea, twenty-two miles south of the southward coast of the South Island, and W. ½ S. thirty-five miles from the north-west end of Stewart Island. The largest island, Solander Island, is nearly a mile in length, and rises abruptly from the sea to a height of 1,100 ft. The other island, much smaller, lies a mile to the westward.

On the 22nd October, Captain J. Bollons, of the G.s.s. "Hinemoa," while searching for a missing vessel, landed on the main island, and, eager as he always is to advance our knowledge of New Zealand natural history, made, together with Mrs. Bollons, a collection of the plants. This he was so kind as to hand over to me, and I hasten to bring before your notice this first collection of plants made on this isolated island.

As seen from the appended list, nineteen species were collected, of which four are ferns. The vegetation is evidently closely allied to that of the outlying islands of the Stewart Island group, on the one hand, and, more distantly, to the coastal scrub of the West Coast Sounds, on the other. *Poa foliosa* and *Senecio Stewartiæ* also connect it with the Snares. Neither of these two plants has been found on the South Island, nor has the *Senecio* been recorded from Stewart Island itself, though it is fairly common, I understand, on the small outlying islands. The *Stilbocarpa* differs from that of Stewart Island, being much more hairy, of a rather dull green, and the small veins on the back of the leaf are much raised, making it almost lacunose. It increases by means of runners, as does the Stewart Island plant, and consequently differs altogether from the Snares plant, with its massive rhizome and no runners.

A more searching examination than Captain Bollons was able to give will probably show that other plants are present. One would certainly expect *Olearia angustifolia, Scirpus aucklandicus, S. cernuus, Gentiana saxosa,* one or two species of *Hydrocotyle,* and probably certain common coastal plants; also, the higher parts of the island not visited should have species not found at a low level.

List of Plants.

Pteridophyta.

Asplenium obtusatum, *Forst. f.*
,, lucidum, *Forst. f.*
Blechnum durum (*Moore*), *C. Chr.*
Histiopteris incisa (*Thbg.*), *J. Sm.*

Spermophyta.

Gramineæ.

Poa foliosa, *Hook. f.*
,, Astoni, *Petrie.*

Cyperaceæ.

Carex trifida, *Cav.*

Juncaceæ.

Luzula campestris, *D. C.*, *var.* australasica, *Buchen.* (?)

Orchidaceæ.

Thelymitra uniflora, *Hook. f.*

Aizoaceæ.

Mesembrianthemum australe, *Sol.*

Crassulaceæ.

Crassula moschata, *Forst. f.*

Araliaceæ.

Stilbocarpa Lyallii, *J. B. Armstg.*

Umbelliferæ.

Apium prostratum, *Lab.*
Aciphylla intermedia (*Hook. f.*).

Boraginaceæ.

Myosotis capitata, *Hook. f.*, *var.* albiflora, *J. B. Armstg.*

Scrophularinaceæ.

Veronica elliptica, *Forst. f.*

Compositæ.

Olearia Colensoi, *Hook. f.*
Senecio Stewartiæ, *J. B. Armstg.*
,, rotundifolius (*Forst. f.*), *Hook. f.*

ART. XXXIX.—*Note on Aerial Rhizomes in* Cordyline australis.

By L. COCKAYNE, Ph.D.

[*Read before the Philosophical Institute of Canterbury, 4th November*, 1908.]

As is well known, the common New Zealand cabbage-tree (*Cordyline australis*) sends deep down into the ground a continuation of its ordinary upright-growing trunk, from which it differs in its positive geotropism, possession of roots, and rudimentary scale-like leaves. This rhizome functions not merely as an anchor for the plant, which is kept in place by the spreading horizontal or semi-horizontal roots; but it serves as a storage-organ for food, on the relative amount of which depends, doubtless, the blooming of the tree. If the trunk be cut off below the level of the ground, new aerial negatively geotropic shoots will be produced, and, *vice versa*, if the cut-off aerial portion can be induced to grow, a new positively geotropic shoot (rhizome) will be produced at its base. Frequently the trunk will put forth from any part ordinary leafy shoots, and occasionally near its base small positively geotropic rhizomes will be developed.

Some years ago the Hon. E. C. J. Stevens, M.L.C., called my attention to a fine specimen of *Cordyline australis* growing in the grounds of the Christchurch Club, which had a profusion of aerial rhizomes issuing from its trunk, not from near the base, but at a considerable distance from the ground.

The trunk of this tree is at the present time about 34 cm. in diameter, the actual base being swollen and wider. At 1·8 m. from the ground it gives off four erect branches, and it is at this point that the bunches of rhizomes are situated, though not merely at the forking, but to within 1·25 m. from the base of the tree. Plate XXIX gives a far better idea of the appearance, &c., than any detailed description. The largest bunch of rhizomes is 38 cm. long and 18 cm. deep. These bunches arise from lateral branches being freely produced, and which, through their positive geotropism, are brought close together. A rather large branch measures 18 cm. in length and 17 mm. in diameter. Short rudimentary lateral roots pass off horizontally from their sides.

Regarding the cause of this abundant growth of aerial rhizomes I can say nothing. The tree is at present rapidly dying, and the growth may be in the first instance pathological. It is not altogether dependent on the branching of the tree, since some of the rhizomes are given off far below the forking; others, again, where there is no branching, on one of the primary branches. It is evident, however, that under certain conditions—at present unknown—*Cordyline australis* can put forth from presumably the same tissue either an ordinary leafy ascending shoot or a rhizomatous descending one.

EXPLANATION OF PLATE XXIX

Aerial rhizomes growing high up on trunk of *Cordyline australis*.

Art. XL.—*The Wellington Tide-gauge.*

By C. E. Adams, M.Sc., A.I.A. (Lond.), F.R.A.S.

[*Read before the Wellington Philosophical Society, 1st July, 1908.*]

The Wellington tide-gauge differs materially from all other tide-gauges, and, as its design avoids most of the sources of error in the usual patterns, an account of its great advantages is now submitted; but in order to appreciate these advantages it will be necessary to refer briefly to the essential features of the usual forms.

In vol. xvi* of the G.T. Survey of India it is stated that "the object aimed at in any complete system of tidal observations is to obtain the height of the tide above some fixed mark or datum for every instant of time during a more or less extended period. . . . This object is attained graphically by causing the rise and fall of the water to communicate its motion by mechanical means, to a pencil which traces a line on paper wound round a drum turned by clockwork once in twenty-four hours. . . . An instrument such as above briefly described is called a self-registering tide-gauge, and of these various forms have from time to time been constructed. The best form is, according to the opinion of Sir William Thomson, one in which the drum is inclined to the vertical, as this enables the friction between the pencil and the paper to be nicely regulated. The pattern almost ex-

* "Details of Tidal Observations," p. 9.

Face p. 106.

AERIAL RHIZOMES ON CORDYLINE AUSTRALIS. Cockayne.

clusively used in India is that known as Newman's pattern, in which the drum is horizontal, the only exception being a small gauge at Prince's Dock, Bombay, where the drum is vertical."

Full details of the Indian gauges are given in vol. xvi, while a description of the Newman gauge is also given in Baird's Manual.* The horizontal drum of the Newman gauge is 5 ft. 3 in. long, and exactly 24 in. in circumference. The drum revolves by clockwork once a day, and has attached to it the record-paper. A pencil moves in a slide along the top of the drum, and to the pencil-carriage a wire is attached which is actuated by the float through cog-wheels. In this arrangement there are many defects: "First, the drum for the diagrams was not quite circular in section, the ellipticity in some cases being very marked. Secondly, the drum was not stable in every position of its revolution—*i.e.*, when disconnected from the clock and turned by hand it assumed a certain position of its own accord."

To overcome the first defect it was necessary to make the clerk in charge mark the exact position of the pencil on the diagram at four different times of the day, then to redivide the diagram from these marks. Thus the whole advantage of a ruled diagram was lost, as also many of the advantages of a self-registering gauge, as constant attention of the clerk in charge is required. The second defect was ingeniously overcome by a special back-lash weight. There were many other defects, particularly in the adjustment of the drum in relation to the clock, and to overcome all these defects so many additions were necessary as to render the gauge a complicated piece of mechanism requiring skilled attention.

In the Indian gauges constant attention is required to prevent the error of the clock becoming serious. The duties of the clerk in charge of an Indian tidal observatory involve constant attendance at 7 and 10 a.m. and 4 and 6 p.m. daily, and where labour is cheap (£2 to £2 10s. per mensem) this attention can be easily arranged for; but in other parts of the world gauges requiring less attention are necessary.

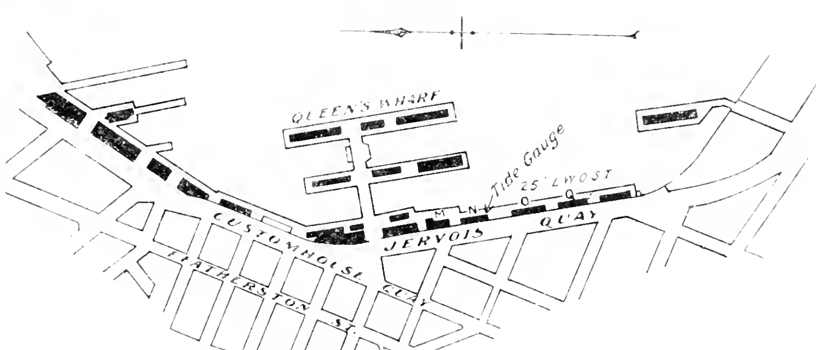


FIG. 1.
(Scale, 1,000 ft. to an inch.)

The Wellington tide-gauge was designed by Mr. William Ferguson, M.A., M.Inst.C.E., formerly Engineer and Secretary to the Wellington Harbour

* "A Manual for Tidal Observations," by Major A. W. Baird. London: Taylor and Francis, 1886.

Board. It was erected in 1887, and is at present situated in N shed, on Jervois Quay, Wellington, as shown in fig. 1.

The general design of the gauge is shown in fig. 2. The cylinder or drum is 4 ft. long and 0·4 ft. in diameter.* It is horizontal, and carries a wheel 2·4 ft. in diameter on the end of its axle. The float is attached by a band to the circumference of the wheel. A smaller wheel carries a counterweight to keep the float-band always taut. The pencil-carriage moves horizontally at a uniform rate, and is in train with the driving-chain of the eight-day lever clock. Its motion is approximately 6 in. a day, so that one week's record is obtained on the drum.

It will be seen that the design of this gauge avoids all the defects of the Newman and other forms of gauge. Thus, owing to the smaller diameter of the drum, it can be readily turned truly circular, and, as it is the amount of motion under the pencil that has to be measured, small ellipticity of

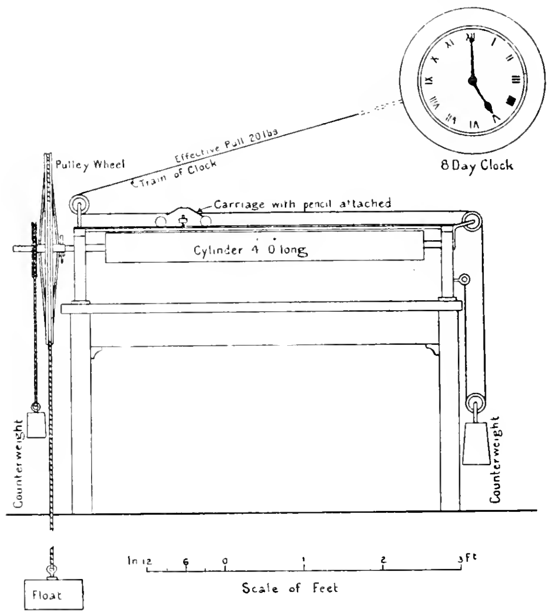


FIG. 2.—THE WELLINGTON SELF-REGISTERING TIDE-GAUGE.

section does not vitiate the record, and, although the drum is naturally turned as evenly as possible, any defect in balancing is immaterial, as the counterweight can be adjusted to overcome it. It is, however, in the adjustment of the time that the greatest improvement becomes apparent. The clock is wound up once a week, and when wound up the pencil-carriage is drawn to the left end of the drum. A new record-paper is attached to the drum, which is then revolved underneath the pencil, and on the line so drawn the correct local mean time is written, independent of what time is shown on the clock. At the end of the week the drum is again turned round,

* The range in Wellington is about 4 ft. or 5 ft., so that when used elsewhere the ratio of the diameters of the drum and wheel must be altered to keep the record within practical limits.

so that the pencil draws a second line: the correct local mean time is written on this line, and again no record is made of the time shown on the clock. In fact, the sole purpose of the clock is to give uniform motion to the pencil, and so long as the clock's rate does not materially vary the record will be correct. And at any time during the week a check line can be similarly drawn, and the correct local mean time noted on it. A check on the rate of the clock is obtained by measuring the distance between the end lines on the record.

Fig. 3 shows a portion of the record of this gauge, beginning 1908, July 11. The first line was drawn at 9.55 a.m., and a check line is shown at 11.45 a.m. The last line (not shown) was drawn on July 18 at 9.20 a.m., while other check lines (not shown) were drawn on July 14 at 12.40 and 13.00. The lines showing midnight are drawn in by scale from the first and last lines on the diagram.

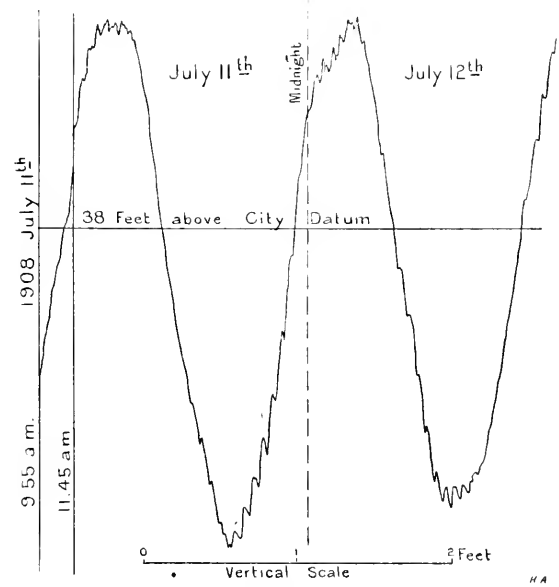


FIG. 3.

Particulars of the Wellington gauge were recently sent to Sir G. H. Darwin, who replied, "I never heard of a tide-gauge such as that you describe, but there seems no reason why it should not work very well."

HARMONIC TIDAL CONSTANTS.

Through the courtesy of Mr. Thomas Wright, of "Lyndhurst," Victoria Drive, Eastbourne, Sussex, the harmonic tidal constants for Wellington and Auckland are here recorded. Mr. Wright states, "They have been obtained by the aid of Government grants from the Royal Society, and were deduced by methods devised by Sir G. H. Darwin, and will be presented for publication in the Proceedings of that Society. The constants for Wellington were obtained from twelve months' observations, the epoch to which the figures refer being 1901, January, 1 d. 0 h. The constants for Auckland were obtained from observations covering a period of the same length, the epoch being 1900, May 1."

New Zealand Ports.—Harmonic Tidal Constants for Auckland and Wellington (deduced from High- and Low-water Observations).

	Auckland. Epoch 1900, May 1.		Wellington. Epoch 1901, January 1.		
Tide.	H. Feet.	κ. Degrees.	H. Feet.	κ. Degrees.	Tide.
S_2	0·633	266	0·11	308	S_2
M_2	3·826	205	1·70	123	M_2
O	Neglect.		0·13	194	O
K_1	0·265	169	0·18	275	K_1
K_2	0·172	266	0·03	308	K_2
P	0·088	169	0·06	275	P
L	0·164	196	Neglect.		L
N	0·778	175	0·45	83	N
S_a	0·354	139	0·07	295	S_a
S_{sa}	0·224	242	0·20	212	S_{sa}
	A_0 = 5·871 ft.		A_0 = 37·74 ft.		

Art. XLI.—*A Natural Classification of English Poetry.*

By Johannes C. Andersen.

[*Read before the Philosophical Institute of Canterbury, 5th August, 1908.*]

The discovery of the law guiding the formation of verse-lengths suggested in the paper on "Origins of English Metre," read last session, has made it possible to scheme out a natural classification of the whole of English poetry.

For purposes of classification it is necessary to fix on some characteristic common to all species—a characteristic which, whilst it varies, does so in a regular manner, so that, whilst the characteristic itself is not perfectly constant, each variation is constant in itself. In poetry the problem has been to detect such a characteristic in the midst of an apparent maze of variations. One classification attempted has been according to *quality*—that is, all lyrics, including songs, odes, sonnets, have been grouped together: didactic poems, narrative, epic, dramatic, and so on: but this is similar to classifying flowers by their hues and scents. Again, another classification has been according to the number of stresses in a line *as printed;* so that one class included one-stressed or two-syllabled lines, another three-stressed, another four-stressed, and so on: this, too, is artificial, though it is nearer the true classification: as in the system of Linnaeus, the true organs have been taken, but classification has been by their number instead of by their development.

Under the breath-law, the various poetic forms in use group themselves into certain evident classes. This law indicated the first great characteristic —the length of line; and this gives two distinct classes—lines of five stresses and lines of eight stresses, each of which two classes I have named after their predominant types, Heroic and Ballad respectively. Setting aside the internal syllabic variation of verse, the places of greatest variation are at the beginning and end of lines. Variation at the end being the more pronounced, this has been taken as the distinguishing feature of the various ballad forms into which the Ballad class has been divided, and the variation at the beginning as the feature of the subvariations of the different forms. Thus in Romance Metre, or Parent Ballad, the line-end may lose a stress-unit, or foot, and become Popular Ballad, of seven instead of eight stresses. In the Popular Ballad, again, there are two variations—in one the stressed syllable at the end of every half-line is dropped, in the other the whole unit at the end of every half-line. These two forms would have been kept as subvariations of the Popular Ballad were it not for the fact that the former constitutes the normal ballad-metre of Denmark and Germany—and from the epic of the Nibelungen Noth being written in it I have called it the Nibelungen Metre—and the latter constitutes the ballad-metre of France, and has already been called the Alexandrine, from its forming the metre of a French epic on the deeds of Alexander.

The stress-unit at the beginning of the line can be varied only in two ways. In its normal form it consists of two syllables, the first unstressed, the second stressed. The unstressed syllable may be dropped, or it may be preceded by an extra unstressed syllable: from these variations are produced the subvariations in each of the Ballad forms.

Minor variations are formed by adding or dropping syllables at the line-ends. Thus, in Romance Metre an unstressed syllable may be added, when what is called a feminine or weak ending is produced. If it drop a syllable, it produces feminine Popular Ballad; if it drop two syllables, it produces ordinary Popular Ballad. If Popular Ballad drop a syllable at the half-line end, it produces Nibelungen. If Nibelungen drop a syllable at the half-line end, it produces Alexandrine; if it add a syllable at the line-end, it produces either feminine Nibelungen or feminine Alexandrine.

Though these comprise the whole of the variations, except the internal syllabic variations which are rather to be considered as scent and colour, it will be seen that they include all regular formations outside lines of five stresses. These latter form the second great class, the Heroic. This does not show nearly the amount of variation of line-end shown by the former; its lines contain within themselves other and more subtle means of variation, such as pause, overflow, &c.—features practically denied to Ballad. Its subdivisions will be more readily seen. Firstly, the Common Heroic includes all poems in riming couplets, with a subvariation including riming stanzas, such as Spenserian, Sonnet, Rime Royal, &c. Secondly, Blank Verse includes two divisions—Epic, Narrative, and Didactic poems; and the Drama, rimed or unrimed. A third class, which I have called Irregular, includes the Ode, poems in which the length of line follows no one of the preceding classes exclusively, Metrical Tales, and Songs; a subdivision I have called Prose Lyrics, to include much of Walt Whitman's poetry; another division will contain those eccentricities, once popular, where poems are written in the shape of diamonds, crosses, pyramids, and so on. A subclass will contain Exotics, such as the Rondeau, Rondel, Ballade, Villanelle, &c.

The following table shows the classification in a concise manner, the name of a specimen poem being quoted with each by way of illustration :—

Class I.—Ballad.

A. Native.

1. Eight-stressed lines (16-syllabled) = Romance Metre (Parent Ballad)—
   (*a.*) Continuous. (Gower's "Confessio Amantis.")
   (*b.*) Stanzaic. (Burns's "Ye Banks and Braes.")
2. Seven-stressed lines (14-syllabled) = Popular English Ballad—
   (*a.*) Continuous. (All old ballads before printing.)
   (*b.*) Stanzaic. (Coleridge's "Ancient Mariner.")
3. Seven-stressed lines (13-syllabled) = German Ballad : Nibelungen—
   (*a.*) Continuous. (Ehlenschlæger's "Hrolf Krake.")
   (*b.*) Stanzaic. (Macaulay's "Horatius.")
4. Six-stressed lines (12-syllabled) = French Ballad : Alexandrine—
   (*a.*) Continuous. (Drayton's "Polyolbion.")
   (*b.*) Stanzaic. (Shelley's "Indian Serenade.")

B. Exotic.

1. Six-stressed lines (syllables indefinite) = Greek Ballad : Imitation of Hexameter. (Longfellow's "Evangeline.")

Class II.—Heroic. (All lines of five stresses.)

1. Heroic Couplet—
   (*a.*) Continuous. (Pope's "Essay on Man.")
   (*b.*) Stanzaic. (Rime Royal, Spenserian Stanza, Sonnet, Ottava Rima, &c.)
2. Blank Verse—
   (*a.*) Epic, Narrative. Didactic, Descriptive. (Milton's "Paradise Lost," Browning's "The Ring and the Book," Young's "Night Thoughts," Thomson's "Seasons.")
   (*b.*) Drama. (Shakespeare, Marlowe, &c.)

Class III.—Irregular.

A. Native.

1. The Ode—
   (*a.*) Ode, Song, Metrical Tale. (Dryden's "Alexander's Feast," C. Rossetti's "Echo," Southey's "Curse of Kehama.")
   (*b.*) Prose Lyrics. (Whitman's "President Lincoln's Burial Hymn.")
2. Artificials—
   Poems in shape of diamonds, crosses, &c. (Herrick's "Cross," Withers's "Diamonds.")

B. Exotic.

Rondeau, Rondel, Triolet, Ballade, Villanelle, Virelai, Pantoum, &c.

Lest these subdivisions appear at first sight very limited, the further subdivisions of Division 1 of the Ballad may be shown :—

DIVISION 1 OF CLASS I, BALLAD.

(*a.*) *Continuous.*

(1.) Long Verse. (Tennyson's "Locksley Hall.")

(2.) Split—

(*a.*) Ordinary (iambic). (Butler's "Hudibras.")

(*b.*) Abrupt (trochaic). (Shelley's "Lines written among the Euganean Hills.")

(3.) Trisyllabic. (Goldsmith's "The Retaliation.")

(*b.*) *Stanzaic.*

I. A. 1. (*a.*)	.. /	.. /	.. /	.. /	.. /	.. /	.. /	.. /		(1)
(*b.*)	.. /	... /	... /	... /	... /	... /	... /	... /		(2)
(*c.*)	.. /	.... /	.... /	.... /	.... /	.... /	.... /	.... /		(3)
(*d.*)	.. /	... /	... /	... /	... /	... /	... /	... /		(4)
(*e.*)	... /	.... /	.... /	.... /	.... /	.... /	.... /	.... /		(5)
2. (*a.*)	.. /	.. /	.. /	.. /	. /	.. /	.. /	.. /		(6)
(*b.*)	.. /	... /	... /	... /	. /	... /	... /	... /		(7)
(*c.*)	... /	... /	... /	... /	. /	... /	... /	... /		(8)
3. (*a.*)	.. /	.. /	.. /	.. /	... /	.. /	.. /	.. /		(9)
(*b.*)	.. /	... /	... /	... /	.... /	... /	... /	... /		(10)
(*c.*)	... /	... /	... /	... /	.... /	... /	... /	... /		(11)
B. 1. (*a.*)	.. /	.. /	.. /	.. /	.. /	.. /	.. /	.. /	.	(12)
(*b.*)	.. /	... /	... /	... /	... /	... /	... /	... /	.	(13)
(*c.*)	.. /	.... /	.... /	.... /	.... /	.... /	.... /	.... /	.	(14)
(*d.*)	... /	... /	... /	... /	... /	... /	... /	... /	.	(15)
(*e.*)	... /	.... /	.... /	.... /	.... /	.... /	.... /	.... /	.	(16)
2. (*a.*)	.. /	.. /	.. /	.. /	. /	.. /	.. /	.. /	.	(17)
(*b.*)	.. /	... /	... /	... /	. /	... /	... /	... /	.	(18)
(*c.*)	... /	... /	... /	... /	. /	... /	... /	... /	.	(19)
3. (*a.*)	.. /	.. /	.. /	.. /	... /	.. /	.. /	.. /	.	(20)
(*b.*)	.. /	... /	... /	... /	.... /	... /	... /	... /	.	(21)
(*c.*)	... /	... /	... /	... /	.... /	... /	... /	... /	.	(22)
C. 1. (*a.*)	.. /	.. /	.. /	.. /	.. /	.. /	.. /	.. /	..	(23)
II. A. 1. (*a.*)	. /	.. /	.. /	.. /	.. /	.. /	.. /	.. /		(24)
(*b.*)	. /	... /	... /	... /	... /	... /	... /	... /		(25)
(*c.*)	. /	.... /	.... /	.... /	.... /	.... /	.... /	.... /		(26)
2. (*a.*)	. /	.. /	.. /	.. /	. /	.. /	.. /	.. /		(27)
(*b.*)	. /	... /	... /	... /	. /	... /	... /	... /		(28)
3. (*a.*)	. /	.. /	.. /	.. /	... /	.. /	.. /	.. /		(29)
(*b.*)	. /	... /	... /	... /	.... /	... /	... /	... /		(30)
B. 1. (*a.*)	. /	.. /	.. /	.. /	.. /	.. /	.. /	.. /	.	(31)
(*b.*)	. /	... /	... /	... /	... /	... /	... /	... /	.	(32)
(*c.*)	. /	.... /	.... /	.... /	.... /	.... /	.... /	.... /	.	(33)
2. (*a.*)	. /	.. /	.. /	.. /	. /	.. /	.. /	.. /	.	(34)
(*b.*)	. /	... /	... /	... /	. /	... /	... /	... /	.	(35)
3. (*a.*)	. /	.. /	.. /	.. /	... /	.. /	.. /	.. /	.	(36)
(*b.*)	. /	... /	... /	... /	.... /	... /	... /	... /	.	(37)
C 1. (*a.*)	. /	.. /	.. /	.. /	.. /	.. /	.. /	.. /	..	(38)

In the above table the units, of which there are eight in the Romance Metre, are divided off by the /, the syllable preceding the bar bearing the stress in every case: each . represents a syllable.

Example (1) is then ordinary duple, or iambic metre; (2) is ordinary triple, or anapestic metre, with iambic opening; (3) is ordinary quadruple with iambic opening; (4) is pure triple; (5) is quadruple with triple opening; (6) is ordinary duple, the second half-line beginning abruptly, or with a stressed syllable; (9) is ordinary duple with a feminine first half-line, producing a triple unit in the middle of the verse.

Class B, (12) to (22), is exactly the same as Class A, (1) to (11), except that all the varieties in the former have feminine verse-ends.

Class C (23) may be extended in a similar way of Classes A and B; it differs from them in the verse ending with a double feminine, but this is of such rare occurrence that, unless specimens are actually found or made, it is unnecessary to cite the various varieties, all of which are, however, possible, and occur often enough in isolated couplets in eccentrics such as the "Ingoldsby Legends."

Group II, again, is similar to Group I, except that throughout the former the beginning of the verse is abrupt—that is, it begins with a stressed syllable: so that, whilst Group I contains the so-called iambic and anapestic metres, Group II contains the trochaic and dactylic.

Those above tabled are the main variations. There are intermediate forms: for example, between (1) and (2) the following form often occurs:—

../ .../ .../ .../ ../ .../ .../ .../

where both half-lines of the triple metre begin with a duple unit. The extremes of variation only are given in the table, intermediate forms readily falling into their places.

It must be noted, however, that it is as much the exception as the rule to find verses entirely in any one of the above varieties. They may change from one to another, or hover around several of the forms in each of the Divisions A, B, and C, but they can always be readily assigned their place in the scheme. For instance, Shelley's "Sensitive Plant" is a mixture of duple and triple metre:—

> A Sensitive Plant in a garden grew,
> And the young winds fed it with silver dew,
> And it opened its fan-like leaves to the light,
> And closed them beneath the kisses of night.

This, divided into units, reads,—

> A Sen/sitive Plant/ in a gar/den grew/, and the young/
> winds fed/ it with sil/ver dew/,
> And it o/pened its fan-/like leaves/ to the light/, and
> closed/ them beneath/ the kis/ses of night/

or

../ .../ .../ ../ .../ ../ .../ ../
.../ .../ ../ .../ ../ .../ ../ .../

It will be seen that it hovers between (*a*) and (*d*)—(1) and (4)—of Group I, Class A, Division 1.

The various divisions of the table have been made, as there is a vast number of poems that can be wholly placed in one or other of them. In the quotations following, the numbers correspond with the numbers of the variations in the table:—

> (1.) Ye banks/ and braes/ o' bon/nie Doon/, how can/ ye bloom/ sae fresh/ and fair?

(2.) Our bu/gles sang truce/ for the night-/cloud had lower'd/, and the sen/tinel stars/ set their watch/ in the sky/.

(3.) An' half/ our bullicks per/ished when the drought/ was on the land/, an' the burn/in' heat that daz/zles as it dan/ces on the sand/.

(4.) The Assy/rian came down/ like a wolf/on the fold/, and his co/-horts were gleam/ing in pur/ple and gold/.

(5.) And the bush/ hath friends to meet/him and their kind/ly voices greet/ him in the mur/mur of the breez/es and the riv/er on its bars/.

(6.) Since when/ all songs/ for jo/vial souls/ hav/ing no/thing, thought/divine/.

(7.) As gay/ as a lark/, and as blythe/ as a bee/, hand/some, gen/erous, spright/ly, and young/.

(8.) I have read/her roman/ces of dame/and knight/; she/was my prin/cess, my pride/, my pet/.

(9.) When love/ly wo/man stoops/ to fol/ly, and finds/ too late/ that men/ betray/.

(10.) Then up/ with the Ban/ner, let fo/rest winds fan/ her, she has blazed/ over Et/trick eight a/ges and more/.

(11.) Of the mail/ cover'd ba/rons, who proud/ly to bat/tle led their vas/sals from Eu/rope to Pal/estine's plain/.

(12.) And is/ she dead ?/ and did/ they dare/ obey/ my fren/zy's jea/-lous ra/ving ?

(13.) The pine/ boughs are sing/ing old songs/ with new glad/ness, the bil/lows and foun/tains fresh mu/sic are fling/ing.

(15.) At the dance/ in the vil/lage thy white/ foot was fleet/est ; thy voice/ 'mid the con/cert of maid/ens was sweet/est.

(16.) And the daugh/ters of the Var/dens—they are beau/tiful as Gra/ces—but the bal/cony's deser/ted, and they rare/ly show their fa/ces.

(17.) Awake !/ my love/, the sun's/ bright ray/, hill/ and val/ley's now/adorn/ing.

(20.) Her voice/ did qui/ver as/ we part/ed, yet knew/ I not/ that heart/was brok/en.

(21.) The soul/ speaking eyes/ are the lan/guage of bliss/es, and we'll talk/ with our eyes/ amidst si/lent kiss/es.

(22.) Though thy beau/ty must fade/, yet thy youth/ I'll remem/ber: that thy May/ was my own/ when thou show/est Decem/ber.

(23.) The coach/man then held/ the door fast/ in his hand/, to let/ me get out/ he was not/ at all will/ing, sirs.

Oh, I'm/ call'd the Ja/mus, the pride/ of gentil/ity, as jus/tice I act/, I'm sure/, with abil/ity.

As the wise/, brave, and good/, of thy frowns/ seldom shape/ any, witness brave/ Belisa/rius, who begged/ for a ha'-/penny.

(24.) Aske/ me why/ I send/ you here/ this sweet/ Infan/ta of/ the yeere ?/

(25.) Bird/ of the wil/derness, blith/some and cum/berless, light/ be thy ma/tin o'er wood/land and lea !/

(27.) Must/ thou go/ my glo/rious chief/, se/ver'd from/ thy faith/-ful few ?/

(28.) Hie/ upon Hie/ lands and low/ upon Tay/, bon/nie George Camp/bell rode out/ on a day/.

(29.) God/ be with/ thee, glad/some o/cean ! how glad/ly greet/ I thee/ once more !/

(31.) There's/ a wo/man like/ a dew-/drop, she's/ so pur/er than the pur/est.

(32.) Fair/ stood the wind/ for France, when/ we our sails/ advance, nor/ now to prove/ our chance long/er we tar/ry.

(34.) My/ dear Mis/tress has/ a heart/, soft/ as those/ kind looks/ she gave/ me.

(35.) Howl/ not, ye winds/, o'er the tomb/ of the brave/ ; roar/ not, ye waves/, at the foot/ of the moun/tain.

(36.) I/ will an/swer, These/ discov/er what faint/ing hopes/ are in/ a lov/er.

There are several intermediate forms, of which entire poems are composed, and it might be found advisable to make divisions for their insertion. For example, the following form the scheme of well-known poems :—

Between (1) and (2),—

O, young/ Lochinvar/ is come out/ of the West/ : through all/ the wide Bor/der his steed/ was the best/ ;

Between (12) and (13),—

Oh, say/ not, sweet Anne/, that the Fates/ have decreed/ the heart/ which adores/you should wish/ to dissev/er ;

Between (24) and (25),—

Bright/est and best/ of the sons/ of the morn/ing ! dawn/ on our dark/ness and lend/ us thine aid/ ;

Between (31) and (32),—

Where/ shall the lov/er rest, whom/ the fates sev/er from/ his true maid/en's breast/, parted for ev/er ?

There are further irregular variations, as when Romance Metre mixes with Ballad or Alexandrine, Ballad with Alexandrine or Nibelungen, &c. The table shows only regular forms ; the irregular, whilst they could be classified, are hardly of sufficient importance to warrant more than one general sub-division. Poems in regular structure vastly predominate, and it is, indeed, only because this is so that it has been found possible to compile the table.

Each of the other Ballad forms—Ordinary, Nibelungen, and Alexandrine —vary in the same way, though not to the same extent, as the Romance Metre.

The stanza form has not been taken as a standard of classification, as it varies in a manner altogether arbitrary : the line formations follow a definite law, and their variations from this law can readily be perceived. The stanza, on the other hand, appears to follow no fixed law, though it is a curious fact that the normal stanza of all the Ballad metres is composed of eight half-lines, and the parent Ballad line of eight stresses. The formation of the line is primarily rhythmical, then syntactical ; the formation of the stanza appears to be primarily syntactical.

A few normal stanzas are quoted, to show the variation of form that may take place within the same metrical scheme :—

Variation (1).

Ye banks and braes o' bonnie Doon,
  How can ye bloom sae fresh and fair ?
How can ye chant, ye little birds,
  An' I sae weary, fu' o' care ?
Thou'lt break my heart, thou warbling bird,
  That wantons thro' the flowering thorn :
Thou minds me o' departed joys,
  Departed,—never to return.

(Burns, "The Banks o' Doon.")

She's mounted on her milk-white steed,
  And she's ta'en Thomas up behind;
And aye, whene'er her bridle rang,
  The steed gaed swifter than the wind.

O they rade on, and farther on,
  The steed gaed swifter than the wind;
Until they reached a desert wide,
  And living land was left behind.
("Thomas the Rhymer.")

From Oberon, in fairye land,
  The king of ghosts and shadows there,
Mad Robin I, at his command,
  Am sent to viewe the night-sports here.
    What revel rout
    Is kept about,
  In every corner where I go,
    I will o'ersee,
    And merry bee,
  And make good sport, with ho, ho, ho!
("Robin Good-Fellow.")

With deep affection,
And recollection,
I often think of
  Those Shandon bells,
Whose sounds so wild would,
In the days of childhood,
Fling round my cradle
  Their magic spells.
On this I ponder
Whene'er I wander,
And thus grow fonder,
  Sweet Cork, of thee;
With thy bells of Shandon,
That sound so grand on
The pleasant waters
  Of the river Lee.
(F. Mahony, "The Shandon Bells.")

Variation (2).

Our bugles sang truce, for the night-cloud had lower'd,
  And the sentinel stars set their watch in the sky;
And thousands had sunk to the ground, overpower'd,
  The weary to sleep and the wounded to die.
When reposing that night on my pallet of straw,
  By the wolf-scaring fagot, that guarded the slain,
In the dead of the night a sweet vision I saw,
  And thrice ere the morning I dreamt it again.
(Campbell, "The Soldier's Dream.")

(Half-stanzas.)

The glad birds are singing,
The gay flowrets springing,
O'er meadow and mountain and down in the vale;
The green leaves are bursting;
My spirit is thirsting
To bask in the sunbeams, and breathe the fresh gale.
(Barton, "Spring.")

By love and by beauty,
By law and by duty,
I swear to be true to
  My Eppie Adair!

A' pleasure exile me,
Dishonour defile me,
If e'er I beguile thee,
  My Eppie Adair!

(Burns, "Eppie Adair.")

Variation (4).

(Half-stanzas.)

The Assyrian came down like a wolf on the fold,
And his cohorts were gleaming in purple and gold.
And the sheen of their spears was like stars on the sea,
When the blue wave rolls nightly on deep Galilee.

(Byron, "The Destruction of Sennacherib.")

'Tis the last rose of summer
  Left blooming alone;
All her lovely companions
  Are faded and gone;
No flower of her kindred
  No rosebud, is nigh,
To reflect back her blushes
  Or give sigh for sigh.

(Moore, "The Last Rose of Summer.")

It will be seen that the same rhythm runs through all these examples, the variations being external—as it were in the matter of scent and colour.

Besides showing poets and others what forms had been much or little used, a classification of English poetry on these lines might lead to the discovery of yet more laws guiding its growth.

Art. XLII.—*Development of Four-syllabled Metrical Unit in the Australian Modification of the English Ballad.*

By Johannes C. Andersen.

[*Read before the Philosophical Institute of Canterbury, 5th August*, 1908.]

Between every two beats or stresses which distinguish poetry from prose there are found a comparatively regular number of syllables; and each stress, with the syllables between it and the adjoining stress, either behind or before, constitutes the most elementary unit in verse, usually called a "foot." These feet, which will be hereafter called "stress-units," or "units," have been classified, according to the position of the stress, and according to whether they contain two or three syllables, as iamb, trochee, anapest, amphibrach, and dactyl. As pointed out in the paper of last session, these may be resolved to two fundamental units—the iamb, and its extension the anapest; and the stress is always on the last syllable of the unit, which I have therefore called "stress-unit" in preference to "foot." For the purposes of the present paper it is necessary only to state that so greatly do two- and three-syllabled, or dissyllabic and trisyllabic, units preponderate in English poetry that they are commonly held to be the only units, though the *existence* of a four-syllabled unit is admitted. As, however, when such units do occur in good verse it is almost always in isolation, they have been regarded as accidental rather than intentional. They may be found in the old ballads, in Shakespeare and in Milton; but they have such a "rapid" effect that except in very few cases they are displeasing.

Whilst there is no doubt that it has never been extensively employed as a basic unit in the poetry of Britain, the case is different as regards the poetry of Australia, where it has become the basis of the most popular of the colonial metres. The poetry most in favour in Australia is that which in spirit approaches the old English ballad, though it must be confessed it is the degenerate ballad that has exerted most influence—the "Robin Hood" type rather than the "Glasgerion," "Clerk Saunders," or "Wife of Usher's Well" type; but there is this to be said: that it is rather the *form* of the type than its *matter* that has exerted the influence.

Three-syllabled units constantly occur in even the best ballads, and, where artistically used, with most pleasing effect: they impart a "rapid" movement to the metre; and when the themes become more commonplace, more humorous, treating as they do of the lighter rather than the tragic side of life, this rapid movement becomes more and more marked, until many of the ballads are entirely trisyllabic. Though the four-syllabled unit is more rapid even than the three-syllabled, it did not evolve from the three-syllabled, and is more rarely found in that metre than in the two-syllabled.

The popular poetry of Australia is undoubtedly humorous, and it was to be expected that the humorous metre of England would exert its influence on the Australian poet, on account of its lively movement if for no other reason; and in Lindsay Gordon, who has been called the father of Australian poetry, out of his sixty-seven collected poems forty-five are three-syllabled, whilst only eighteen are two-syllabled. In four poems there can be traced the germ of what was to become a dominant metre: these four are "Unshriven," "Whisperings in Wattle Boughs," "A Hunting Song," and the well-known poem "The Sick Stockrider." The new metre is most likely to result from poems written in what are called trochaics, or two-syllabled feet stressed on the first syllable: in such cases the first and every alternate stress are dropped. In the poems of Kendall, the most truly poetic of the older Australians, there are twelve in these trochaics; but in no instance does the metre lapse into the metre under discussion, the four-syllabled.

It is different when we turn to later writers, well-known favourites such as Paterson and Lawson. Paterson's first book opens with and takes its name from a piece in this very measure, "The Man from Snowy River." Here the beat is much more distinct than in Gordon:—

> There was movement at the station, for the word had passed around
>   That the colt from old Regret had got away,
> And had joined the wild bush-horses—he was worth a thousand pound,
>   So all the cracks had gathered to the fray.
> All the tried and noted riders from the stations near and far
>   Had mustered at the homestead overnight,
> For the bushmen love hard riding where the wild bush-horses are,
>   And the stock-horse snuffs the battle with delight.

The usual reading of this stanza would require a stress on the first, third, and every odd syllable; but on an actual reading a very different result ensues. The first two lines are read—

> There was mòve/ment at the stà/tion, for the wòrd/ had passed aròund/
>   That the còlt/ from old Regrèt/ had got awày/.

There is a slight stress on "passed," "old" and "got," but otherwise the lines fall perfectly naturally into four-syllabled units, giving lines of alternately four and three stresses—nothing more than English ballad-metre: in fact the whole stanza is a perfect bal'ad stanza, but with four-syllabled units.

In Paterson's two volumes of poems, out of their eighty-one pieces there are twelve in the four-syllabled metre; in Lawson's two volumes, out of 111 pieces no less than twenty-eight bear the unmistakable stamp of this metre; Ogilvie has eleven out of a hundred; Boake four out of thirty-two; Brunton Stephens the high average of twelve out of fifty-seven.

Two pieces may be taken as contrast. In Kendall's imaginative poem "Hy-Brasil" occur the lines,—

> Thère indèed was sìnging Èden, whère the grèat gold rìver rùns
> Pàst the pòrch and gàtes of crỳstal, rìnged by stròng and shìning ònes!
> Thère indèed was Gòd's own gàrden, sàiling dòwn the sàpphire sèa—
> Làwny dèlls and slòpes of sùmmer, dàzzling strèam and ràdiant trèe!

Here it is impossible, except perhaps in two instances, to slur the stressed odd syllables; but read in the same way the following stanzas from Lawson's "Australian Bards and Bush Reviewers," and instead of humorous they are ridiculous:—

> If you sing of waving grasses where the plains are dry as bricks,
> And discover shining rivers where there's only mud and sticks;
> If you picture "mighty forests" where the mulga spoils the view—
> You're superior to Kendall, and ahead of Gordon too.

Two British poems containing suggestions of the metre are the Hon. Mrs. Norton's "Bingen on the Rhine," and S. Ferguson's Irish ballad "The Fairy Thorn." A stanza from each follows:—

> A soldier of the Legion lay dying in Algiers—
> There was lack of woman's nursing, there was dearth of woman's tears;
> But a comrade stood beside him while his life-blood ebb'd away,
> And bent, with pitying glances, to hear what he might say.
> The dying soldier falter'd, as he took that comrade's hand,
> And he said, "I never more shall see my own, my native land;
> Take a message and a token to some distant friends of mine,
> For I was born at Bingen—at Bingen on the Rhine."

> They're glancing through the glimmer of the quiet eve,
> Away in milky wavings of neck and ankle bare;
> The heavy-sliding stream in its sleepy song they leave,
> And the crags in the ghostly air.

Scott has a rare example of the metre appearing in three-syllabled surroundings:—

> He is gòne on the mòun*tain*,
> *He is lòst* to the fòr*est*.
> *Like a sùm*mer-dried fòun*tain*,
> *When our nèed* was the sòrest.
> The fòunt reappèar*ing*
> *From the ràin*-drops shall bòr*row*.
> *But to ùs* comes no chèering,
> To Duncan no mòrrow!

When found in three-syllabled metres its existence can be shown to be accidental rather than intentional. The poet has made feminine or weak rimes at the half-line or line-endings, as in the example given, and, an anapest following, a four-syllabled unit results. A line from the Irish ballad "Mary le More" shows this:—

> As I stràỳ'd o'er the còmmon on Còrk's rugged bòr*der*,
> *While the dèw*-drops of mòrn the sweet prìmrose arràỳ'd.

It is usually avoided by making the first unit of the line an iamb instead of an anapest, as in the last line in the example from Scott, and in most lines of the ballad "Mary le More."

Longfellow's "Belfry of Bruges" would receive strange handling from a four-syllabled Australian. Instead of—

> Ìn the màrket plàce of Brùges stànds the bèlfry òld and bròwn ;
> Thrice consùmed and thrìce rebuìlded, stìll it wàtches ò'er the tòwn.
> As the sùmmer mòrn was breàking, òn that lòfty tòwer I stòod,
> And the wòrld threw òff the dàrkness, lìke the wèeds of widowhòod.

it would be read—

> In the màr/ket place of Brù/ges stands the bèl/fry old and bròwn ;/
> Thrice consùmed/ and thrice rebuild/ed, still it wàtch/es o'er the tòwn
> As the sùm/mer morn was brèak/ing, on that lòf/ty tower I stòod./
> And the wòrld/ threw off the dàrk/ness, like the wèeds/ of widowhòod.

Now, it was at one time considered that the three-syllabled unit could never be made the basis for true poetic work. In the old ballads, in the romance metre of Gower, it gives a beautiful variation to the iambic, but it is only in the degenerate ballads that it predominates. Guest, one of the great writers on English metre, calls it the "tumbling metre," and speaks of it with contempt ; indeed, the three-syllabled unit was, after the date of ballads, avoided by poets generally until Cowper revived it, and in these later days Swinburne and other masters have shown what excellent harmonies it is capable of producing. So it is with the four-syllabled unit : at present, except in isolation, it is outside the pale of true poetry ; but there are indications that it may yet exert as great an influence as the three-syllabled, and produce as distinctive a music. Already it has been used in British poetry for its heightening effect, as the three-syllabled unit was first used, and there is no doubt that it also will produce a type of its own, crude at first, but gradually soaring into true music.

It was no doubt the rapidity of the motion produced by the four-syllabled unit that first attracted the Australian writers : poets accustomed to horse-riding, as the popular Australian poets all were and are, preferred a galloping metre ; and, finding one even faster than the three-syllabled, they instinctively adopted and developed it—still retaining the ballad *form* whilst they modified its internal structure. The following lines from Paterson's "Clancy of the Overflow" give a faint echo of no mean music :—

> And the bush hath friends to meet him, and their kindly voices greet him
> In the murmur of the breezes and the river on its bars,
> And he sees the vision splendid of the sunlit plains extended,
> And at night the wondrous glory of the everlasting stars.

One fact greatly in favour of the Australian ballad is its breezy joviality and good humour ; and what is now contemptuously looked on as mere unpoetic jingling will, I feel sure, prove to be the preliminary tuning-up of a new string to the lyre of Apollo.

Art. XLIII.—*New Zealand Bird-song.*

By Johannes C. Andersen.

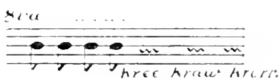
[*Read before the Philosophical Institute of Canterbury, 4th November, 1908.*]

I spent a week in December of last year in the neighbourhood of a clump of thirty or forty acres of native bush near Stony Bay, Little Akaroa; and as this was my first time of being for any length of time near the bush, I occupied myself in recording the notes of such birds as happened to be there.

The most elusive notes I found to be those of the bell-bird (korimako—*Anthornis melanura*). I could catch and fix individual notes, but it was some days before I could be sure of their sequence. The reason will be seen on referring to the records following:—

and so on. The pitch of the initial note of the phrases (1) and (2) varied from *d* to *c*, as shown in (3). The consequence was that on checking the notes taken one day with notes taken the next I found they differed, often to a wide degree. I was not able to discover if the variation in pitch was due to the song being sung by different birds, or if one bird was able to vary it as it pleased. The most usual phrase was (1): the notes follow one another very quickly, the two concluding the phrase being most distinctive and characteristic. A variation where these two notes are discarded is shown in (2). Here the whole phrase is lengthened, and two notes of different pitch introduced—the two last, which are sustained longer than those preceding. These concluding notes are very pleasing, the last especially being deep, full, and melodious. I only heard this variation as a continuation of (1), and then only when the two distinctive notes were discarded. The difference between the day-song and the even-song was very marked; in the latter the notes were sung more deliberately, and, whilst the general theme of the day-song was followed, the intervals were slightly different. The parallel of the more usual day-song was also the more usual even-song (4): it will be seen that a pause approximately twice the length of the note was made after each note, and the distinctive note uttered only once, the interval between the acciciatura and the main note being also less. The variation of the even-song (5) ended on the same note as the variation of the day-song. I more than once saw a bell-bird on the top of a dead tree at the edge of the bush repeating one or other of the phrases (4) and (5) in the evening, at intervals of perhaps half a minute, and for five or more minutes at a time. As twilight deepened a new theme was taken up: the tree-top sentinel disappeared, and from the dark bush came the quickly uttered notes shown in (5). These would be continued, with the slight variations shown occurring now and again, for two and three minutes without pause or cessation; and when they ceased no other note was heard, the next cry coming from the now stirring morepork: his cry consisted of two muffled but clear notes, the second a semitone lower than the first.

I heard more of the whirring flight of the tui (*Prosthemadera novæ-zealandiæ*) than of his song, the commonest call I heard during the week being a repetition of a single note, from four to eight times, the most frequent number being five, as shown in (1) following:

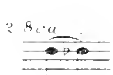
(1)


(2)


(3)


It was especially noticeable of the pitch of this note that it never varied: every time I tried it it was *b*. Fenwick, travelling in the southern part of this island, recorded the note as *f*, and said that it varied in different localities. The five notes were generally, though not always, followed by the three gutturals *kree, kraw, krurr*. These gutturals have no definitive pitch; each has its distinct vowel sound, however, and they can be imitated by breathing the words rather than articulating them; the *r* carries the German sound, produced by slight vibration of the uvula. The five notes are ventriloquous—that is, they appear to come from a distance away from the bird; and I, having been told the notes were those of a bell-bird, thought the tui I was watching answered them with the gutturals: I soon saw, however, that the same bird produced both. The notes have a clear, mellow tone, and when uttering them the bird sits motionless, with outstretched neck, in some high tree—usually, when I saw him, in a totara or black-pine. The last of the gutturals, *krurr*, was at times used as the initial for the slur shown in (2). This high slurred note was very sweet and plaintive—one of the sweetest of all I heard. I heard these calls of the tui much more often than his song. This song (3) is an instance of seeming imitation: the theme is the same as in the song of the bell-bird, the difference being in the intervals and the tempo. The initial note varied almost to the same degree as that of the bell-bird. The two distinctive final notes of the latter, however, I did not hear imitated. In the tui song the fourth and sixth notes, both *a*, were long-drawn and most melodious. I heard no other notes from the tui: I came too late in the season to hear him at his best.

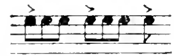
The black fantail (tiwakawaka—*Rhipidura fuliginosa*) had a slurred note that was similar to the slur of the tui, but was a sixth higher.



I heard the fuller song of this bird only once. It alit on the rough bark of a black-pine only a yard from me, and twittered a pleasant little song, of limited range, however, and little variation. I did not wish to interrupt it, as it was the first time of hearing it, so did not take the pitch; and, unfortunately, I did not hear the song a second time. It hovered about the opening-note, never more than a tone (more often a semitone) above or below, being, indeed, hardly more than a twitter.

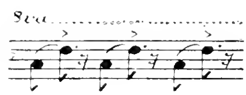
I saw only two parrakeets (kakariki—*Cyanoramphus novæ-zealandiæ*) during the week, and from them obtained (1) and (2) following:—

(1) 

(2) 

The first notes sounded very like the words "Take me back," and were repeated at fairly long intervals. The quality of the parrakeet's note differs considerably from any others that I heard: it could be imitated on an oboe or clarionet; the tui and bell-bird might be imitated on a mellow flute, though it would be difficult to render the high notes with sufficient softness.

The weka (*Ocydromus*) was fairly common, but I obtained only two calls, as follow:—

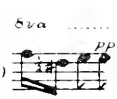
(1) 

(2) 

The first call was the usual one; I heard the second only once. These I take to be the call of the female weka; for, according to an old Maori war-tale, the cry of the female is *ko-ee, ko-ee, ko-ee*, whilst that of the male is *tee-waka, tee-waka.*

Of all the songs I heard, the most interesting to me was that of the grey-warbler (riroriro—*Pseudogerygone igata*). In the bush, it was the least developed of the songs that had got beyond a mere twitter, such as that of the fantail—that is, it has not yet acquired a definite succession of phrases, nor is the range of notes at all wide: but, whilst it is the least developed, it shows great possibilities for varied development. The warbler is one of the native birds commonly found around human habitations; it may constantly be heard, especially in the morning; and the peculiar thing is that away from the bush, possibly under the influence of introduced song-birds, the song of the warbler has acquired a certain definiteness. The melody that may be heard almost every morning in any part of Christchurch is shown in (1):—

(1) 

(2) 

The phrases always follow in this sequence when the full song is sung. It may break off at any part, or, if continued beyond the notes written, it is an exact repetition. There is, however, a variation that I have heard in the song of the town bird; the variation is in the four concluding notes, as shown in (2). Here an enharmonic note is introduced, adding still more to the plaintiveness of the melody. The last note is invariably much lighter than those preceding, and there is a distinct accent on the first note of every phrase of five. Last year, when the variation was introduced, I did not once hear the song continued beyond it: this year I have heard one bird continue it, repeating the variation. The song is very sweet, though so highly pitched. On hearing the variation, one is impressed by the idea that it is a late development, as there is a hesitation in the uttering of the enharmonic note: the interval introduced, too, is wider than usual. Knowing this song, it was with surprise that I heard the very different song of the bush-warbler. The phrase of five notes, the last a semitone below the first four, evidently the basic phrase, was constant, but the combination of the variously pitched phrases followed no sequence that I could discover. It meandered on in the way shown below :—

There was nothing regular nor determinate : the phrases did not always fall in three sequences, a higher interval following as frequently as a lower : the song, too, was prolonged indefinitely, as if the bird itself had no idea of rounding it off. In the bush I only once had the good fortune to actually see a warbler singing. It was perched on the topmost branchlet of a ribbon-wood at the edge of the bush, which lay below it in a deep valley, and it sat turned towards the trees below, facing, with outstretched neck, now this way, now that, singing like a *prima donna* to a rapt audience. I have often seen the dilating and throbbing throat of a singing-bird, but in this warbler not only the throat but the skin completely round the neck seemed puffed out with ruffled feathers, and throbbed as the bird sang its long, irregular, indeterminate, minor melody. This was the most tantalizing of the songs : I constantly heard it, faintly as if far away in the bush, and it repeatedly distracted me into endeavouring to catch a sequence in its measures whilst I was taking the pitch of other notes. I was unsuccessful, however, in obtaining any definite sequence beyond the five notes of the basic phrase. The pitch is very high, and I do not know of any instrument by which it could be imitated.

Another very highly pitched note was that of what I assume to be a young bush-wren or rifleman (titipounamu—*Acanthidositta chloris*). It was the only bird of the kind I saw, and it sat on a vine a couple of yards away, uttering the very faint, cheeping notes :—

It was hardly louder than the chirp of a cricket, and though so high in pitch was remarkably sweet and plaintive.

There was one bird which I was unable to identify, either on the spot or subsequently, though now I think it may be a hedge-sparrow (*Accentor modularis*). It was a little larger than a sparrow, dark grey, with darker colouring along the upper parts, and tail long and narrow. I saw it singing several times : it clung to a vine, moved its head a little from side to side as it sang, its tail quivering as the note with the tremolo, as shown in the melody below (1), was uttered :—

As will be seen, the melody, which is very regular and distinct, is much longer than that of any other of the bush birds ; and this led me to conjecture that it was not a New-Zealander. The melody was not always sung fully through; more often it was broken after the first or second tremolo, or after the theme ending on *g* flat. Sometimes the two phrases enclosed between single bars would be replaced by the phrase enclosed between double bars; but I repeatedly heard the full melody as above. On certain days this bird was very plentiful; and one day, there being but little bird-song, I was trying Schubert's "Fisher-maiden" on my whistle, when no less than four of them perched close beside me piping away most energetically, and the louder I whistled the louder and faster they piped, as if they thought it their duty to pipe me down. The pitch varied considerably, but, as I doubted the bird's being a native, I was content to take down the melody. A call which the bird sometimes uttered, with no melody preceding or following, is shown in (2). Should this prove to be the song of the *Accentor*, it would be interesting to know how it compares with the song of the Home bird.

Observations will have to be much more extended before any comparisons can be made or remarks offered on the different songs; and I have offered these incomplete notes in the hope that others who are in the bush may be induced to record notes in various parts of the Islands, so that complete records may be had of the songs of all our birds, *in all the months of the year*, as well as in all localities.

Additional Records taken in December, 1908, from Birds in the same Bush.

Bell-bird: The notes were similar to those taken last year.

Tui: The following additional notes were obtained:—

When uttering the notes *a* opening (4) the neck was stretched out, with the bill half-open. The sounds represented by *tiu tiu aurr* were repeated very quickly: the *tiu* was like the striking together of two hard stones, the *aurr* being quite different—a decided guttural. The pitch was quite distinctly *e* and *a*. These sounds took the place of the *kree kraw krurr* heard last year. The *tsrr* was like the sound of a corkscrew being forced through a stiff cork, and it, with the *aurr* preceding it, was very emphatic. The high, sweet, slurred note following was sometimes succeeded by a very soft, melodious, canary-like phrase, which bubbled, like honey transformed to sound, in the throat of the bird, so softly that it could only be heard at close quarters. I several times heard (4) sung the full length; more often it broke off after the *tsrr*, or after the slurred note.

The note in (5) was repeated alone. It is "explosive," but very clear and bell-like. It was only sounded once—that is, it was neither preceded nor succeeded by any other note; and if a cork could be imagined as a clear sound, it was as if the note popped like a cork from a bottle.

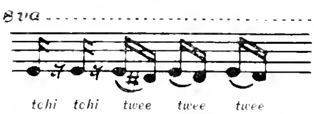
The notes of (6) were also very bell-like in tone, but were of quite a different nature from (5). They were deliberately sounded, an average of two seconds separating them. The variation (7) was as often heard as (6).

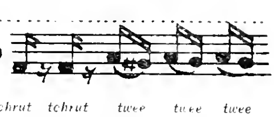
The sounds of (8) are merely part of (4) repeated without any notes: one would suppose they would rasp the bird's throat to pieces. They were varied—*tiu tiu aurr, tiu tiu tiu aurr,* and *tiu tiu tiu aurr, tiu tiu tiu aurr.*

Weka: One other call was heard; it calls for no comment:—

(3) 

Fantail: The following notes were obtained:—

(2) 

(3) 

The note is not clearly sounded; it is uttered more as if forced through a constricted passage, and it is rather a twitter than a whistle. It varies not only in pitch, but in sound, so that it may be represented by different letters at different times, as above. Whilst singing, the bird flits restlessly about the bough.

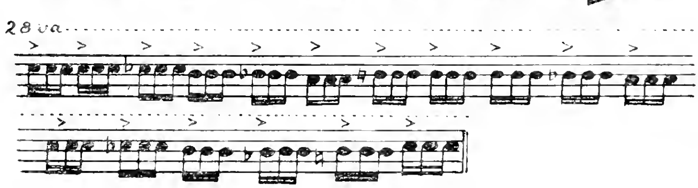
Morepork (ruru; *Ninox novæ-zealandiæ*):—

(1) 

The cry is more commonly heard without the five introductory notes. It was muffled, as one might imagine the cry of the hokio, the ominous bird of battle. The Maori represented the latter part of the cry as *kia koa,* and the sound might well be given as *koa,* pronounced like *caw* with a slight vibration of the uvula.

Grey-warbler: Two complete songs were obtained:—

(3) 

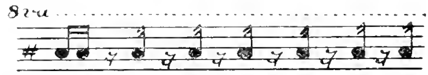
(4) 

It will be noticed that the phrase of five notes is this year replaced by three triplets. The falling sequence in semitones is similar to that recorded last year, and again it will be noted that there is nothing determinate in the song. The termination of (3) is effective: I heard it only once.

Wren: The note of the wren was this year *c* sharp as against *e* last year. The only variation, if it can be called variation, was in the suppression or insertion of rests. The notes might be single, or broken into groups of two, three, four, or more, or they might be uttered up to fifteen times without a break in the sequence.

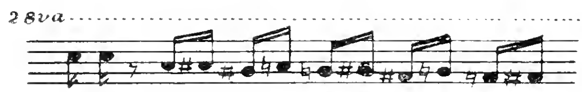
Robin (toutouwai; *Miro albifrons*): This bird's note, a sharp, clear whistle, was of a very simple nature, being a repetition of one note, *a* sharp.

(1)



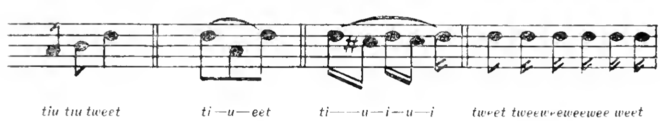
Yellow-breasted tit (ngiru-ngiru: *Petroeca macrocephala*): This song is simple, but very pretty and plaintive. It is a soft twitter, nearer a whistle than the twitter of the fantail, and is uttered during flight as well as when the bird is stationary; in the latter case the throat and tail quiver slightly.

(1)



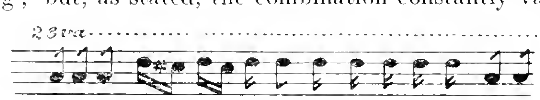
Blight-bird, silver-eye, or wax-eye (tauhou: *Zosterops cærulescens*): Setting aside the rambling melody of the grey-warbler, the blight-bird has the longest definite song of the native birds—so long, indeed, that the name of "tauhou" (the stranger) is justified; for the songs of the true natives are all short. I heard the song of one bird only, but as it sang away, with slight intervals, for from five to ten minutes, I was able to take down the various phrases which it employed:—

(1)



The bird was very obliging: whilst it paused it allowed me to take the pitch and intervals of the various notes of the phrases in (1). Whilst it sang it sat quite still, holding its bill in the air; its throat throbbed, especially when sounding the notes represented by *tiu*. As in the case of the fantail, most of the notes could be represented by letters. The song was very quiet and sweet, somewhat like that of a canary, but not nearly so shrill nor vigorous. The songster was quite alone: I heard no other blight-birds near at the time. The phrases were employed in all sorts of sequences: there may have been others which I did not catch, for at first I was content to sit still and listen: other individuals, too, may have different phrases. The following combination is an approximate representation of the song; but, as stated, the combination constantly varied:—

(2)



ART. XLIV.—*The Great Wairarapa: A Lost River.*

By H. HILL, B.A., F.G.S.

[*Read before the Hawke's Bay Philosophical Society, July,* 1908.]

SOME time ago, when dealing with the artesian beds forming the Heretaunga Plain, passing reference was made to a large river that at one time flowed through what is now a portion of the ocean, and known as Hawke's Bay. At that time the extent of the river towards the north and west had not been determined, but, as further information has now been obtained, a description of the river and the physical changes throughout the district that have taken place since then are here summarised.

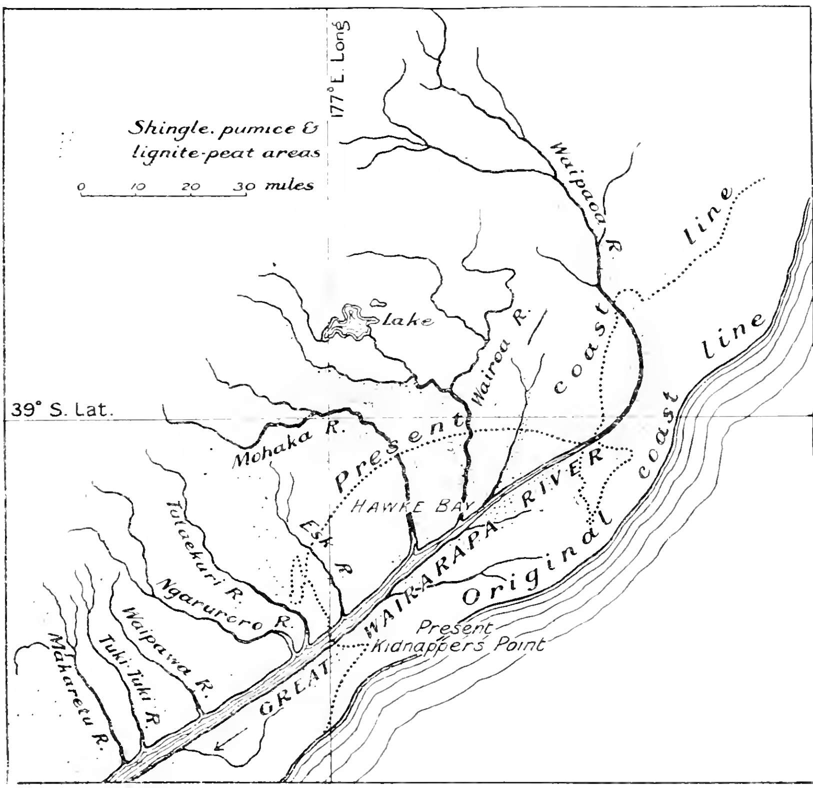


FIG. 1.—EAST COAST BETWEEN 38° AND 40° S. BEFORE SUBSIDENCE.

The description will be limited to the upper portion of the river, from its source as far as the northern end of what is known as the Forty-mile Bush, some miles to the south of the parallel of 40° south latitude.

The east coast of this Island from East Cape to Castle Point presents features that imply important physical changes at no distant date. Hawke's Bay water-area is a deep bight, with Portland Island and the Mahia Peninsula at the northern entrance, and Cape Kidnappers at the southern. The bay itself, in reality, is a portion of the more inland plain-area that has been filled in by the material brought down by rivers such as the present Tukituki, Maraetotara, Ngaruroro, Tutaekuri, and Esk, all of which now flow from the westward, some as far back as the Ruahine Mountains and the Kaweka. The plain known as the Heretaunga Plain is a late formation; in fact, the process of growth is still going on, and the action of floods on the waters of the bay is such as to bring about a slow sedimentation of the area that was at one time a land-area connected in structure and formation with the hills forming Scinde Island, Napier, and the rocks exposed along the northern and southern ends of the bay. What is here said of the growth and changes connected with Hawke's Bay can also be said of the plain-area

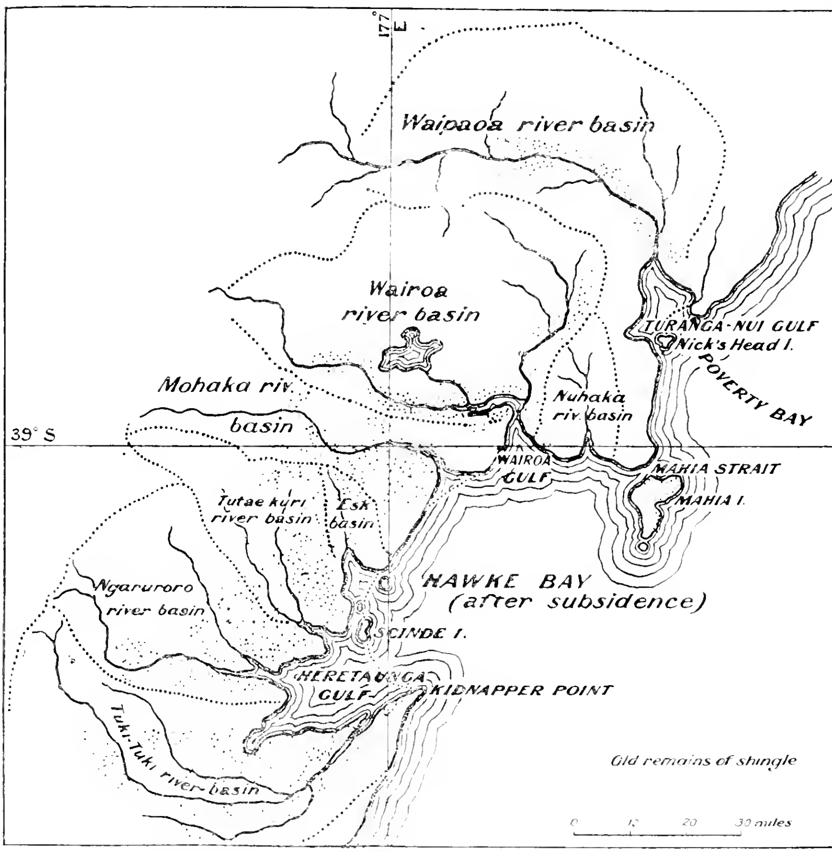


Fig. 2.—East Coast after Subsidence; New River-basins.

between the mouth of the Wairoa River and Te Kapu or Frasertown, some ten miles inland. So, too, the Poverty Bay plain forms a part of the water-area, and both of them occupy the place once occupied by hills that united Young Nick's Head with the hills that now bound the coast along what is known as the Kaiti side of Poverty Bay.

The east coast between East Cape and Cape Turnagain at one time extended much farther seaward. The map marked fig. 1 shows some of the extension. At the time when this condition existed the general slope and river system of the Island were very different from what is now the case. The slope was generally to the east by south, and the Ruahine, Kaweka, and Titiokura Ranges had not then reached their present elevation. The volcanic district was directly associated in slope and drainage with the east side, and numerous tributary streams carried their burdens of shingle, pumice, and vegetable material from the back inland country, and spread them broadcast over basin-like areas in a river-valley of great length that was in process of making by the slow elevation of what now constitutes the chief axial structure of the Island.

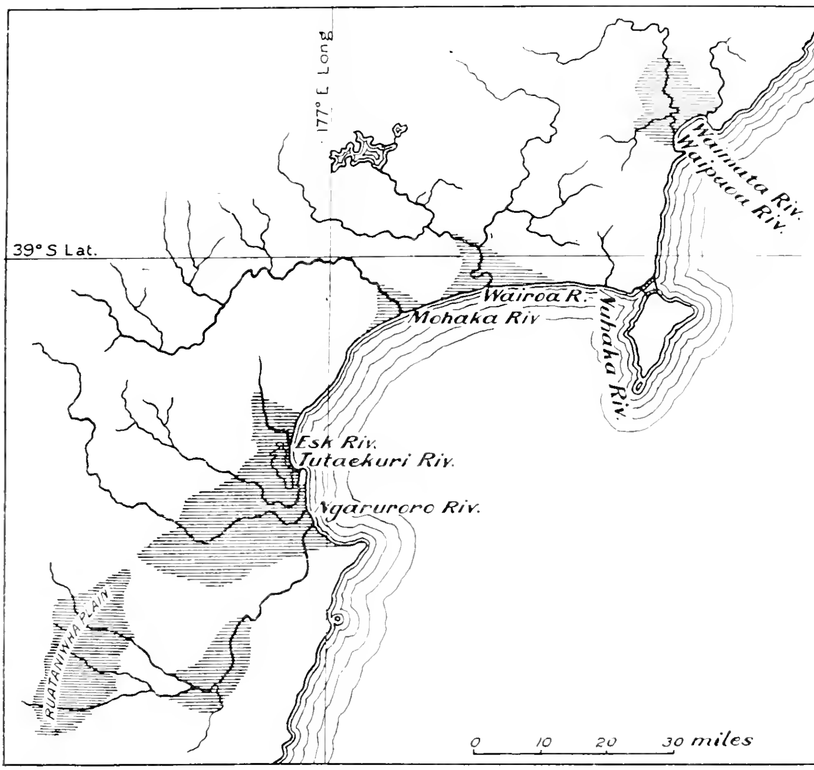


FIG. 3.—EAST COAST, SHOWING PLAIN-GROWTH SINCE SUBSIDENCE. SHADING SHOWS PLAIN-GROWTH—THE PLAINS FILLED AND FORMED SINCE SUBSIDENCE SHOWN ON FIG. 2.

In order to obtain a clear idea as to the surface features of the country at the time under notice, map fig. 1 should be studied. It shows the probable extension of the coast eastward beyond what can be seen in the dotted lines of the present coast, and the various streams that now constitute different river systems are seen to form one river that had its head-waters in the back country to the westward of Poverty Bay. Out in the ocean to the south-east of Poverty Bay the river made a bend to the south by west, and proceeded past the Mahia, through Hawke Bay, and south-west into the valley now known as the Heretaunga Plain, and thence west by south onward to the Wairarapa. On its course it received from the back country a large number of tributary streams, most of them being heavy shingle and pumice carriers. By means of the network of tributaries from the west, the country was bared of a large part of the limestone that covered it at the close of the Pliocene period, being replaced by heavy deposits of shingle and pumice of great thickness, and of a kind that is now characteristic of the country between the Kaimanawa Mountains and Tauranga-Taupo.

Towards the close of the Pliocene and the opening of the Pleistocene periods great and important changes took place. Great volcanic activity was experienced in the interior of this Island, and the east coast was shaken to its foundations. It was during this period of activity that a large portion

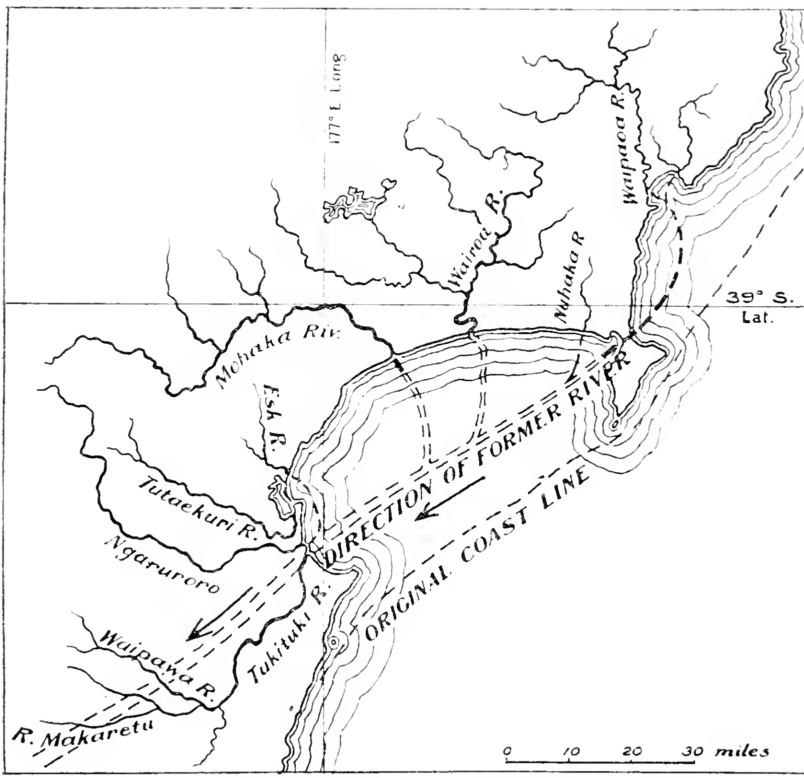


Fig. 4.—East Coast, showing River Systems as at Present.

of the coast disappeared and sank beneath the ocean. Hawke Bay, Heretaunga Gulf, Wairoa Gulf, Poverty Bay, and Turanganui Gulf were formed at this time.

The Great Wairarapa disappeared as a river, and the entire aspect of the water drainage was modified. A reference to map fig. 2 shows the condition of the coast and the physical features of the land following the subsidence and the disappearance of the Great Wairarapa river-basin.

What had formerly been tributaries of a great river now began to form separate basins of their own, and we have the interesting fact that by ordinary earth-movements new rivers and river systems may be brought into existence and the facies of a country completely changed.

An inspection of the areas that now form the river-basins shown in map fig. 2 will supply the fullest evidence of a contemporaneous past in the shingle, pumice, sand, and vegetable deposits that are found within them. In Poverty Bay, the Kaiti Hills, the lower hills on the Whataupoko, the hills near Ormond, Te Karaka, and numerous others abound with facts to show the state of the country before the present plain and river-valley were in existence. Similar evidence is forthcoming in the case of the Wairoa, Mohaka, and the other river-basins of Hawke Bay. At the entrance to the Wairoa and Mohaka Rivers, and on the hills towards Frasertown and the Wairoa Hospital, shingle and pumiceous deposits occur, and in the inner portion of Cape Kidnappers, extending from the Black Reef, sections 200 ft. in vertical height display the same characteristic beds such as are met with,

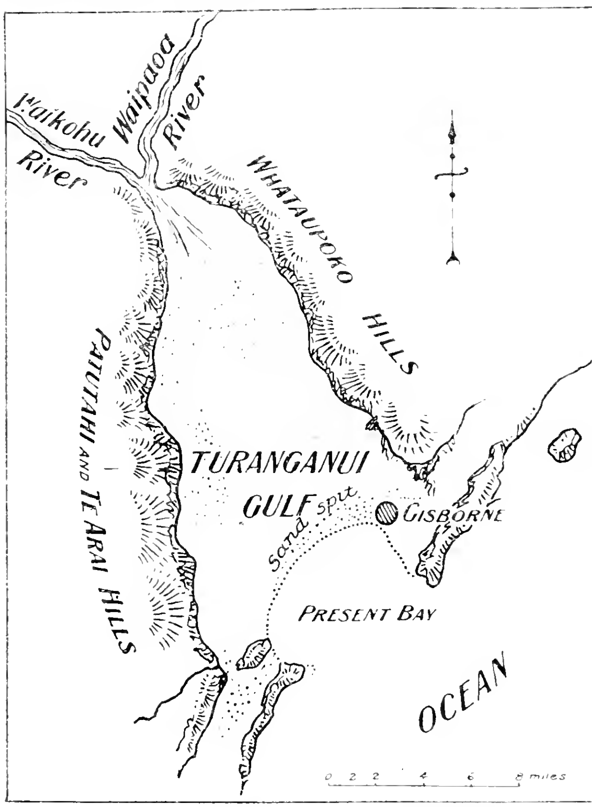


FIG. 5.—TURANGANUI GULF, AFTER SUBSIDENCE.

though less developed, in Poverty Bay. To the north-west and south-west of the Kidnappers, through Maraekakaho, and thence past the Gwavas Station on to the Ruataniwha Plains, the hills both to the right and left are made up solely of the Kidnapper and Poverty Bay shingle series, and these continue through Takapau, Ormondville, Matamau, and Dannevirke in varying thickness and extent.

All the deposits within the limits of the areas named bear witness to the fact that the supply of materials was from the westward. There was a general similarity in the physical conditions of the whole district at the time, and the flora and fauna were much like those of to-day. Over the whole area there are usually traces of lignite-beds of varying thickness. These occur along with what appears a pumice-mud deposit. In these beds fossil specimens of leaves occur of many kinds. I have collected more than a hundred kinds in a state of perfect preservation. In the same beds are specimens of fossil fish vertebrates, insects, flowers, and ferns, and a single specimen of a fossil feather.

The beds have not been by any means carefully explored, and a rare garnering awaits the young geologist who is anxious to make a collection representing the animal and vegetable life of an interesting period in the geological history of this country. Kidnappers, Whataupoko, and Ormond are the best collecting-grounds at the present time.

An inspection of map fig. 2 will show that the rivers which were suddenly brought into independent being had to carve out a destiny for themselves. The country was high, and covered with deposits of shingle, limestone, and in some places blue-clay marls. Each river-mouth was miles from where it is now to be found. Denudation was great, and loose material was easily removed seaward, and deposited in the small gulfs and

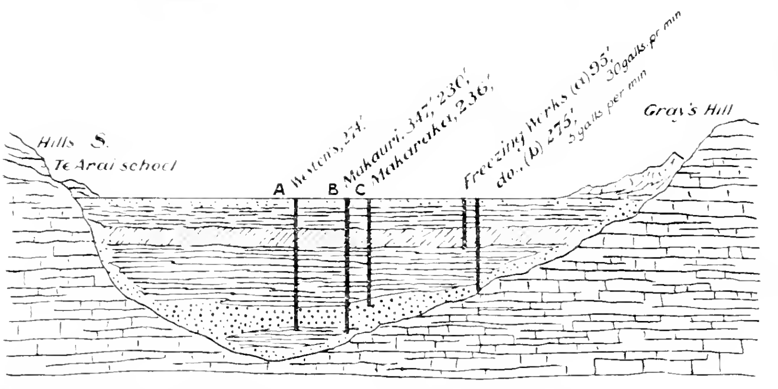


Fig. 6.—Cross-section showing Filling-in of Beds.

bays along the coast. The Tukituki had to carve out a way for itself, but this took a long while to accomplish, for, with the Makaretu and Waipawa Rivers as helpers, a place had to be worn through the limestones at the spots known as the Waipawa Gorge and the Waipukurau Gorge respectively. Lakelets were formed, to be broken through from time to time as the river kept finding its course to the sea. The Ngaruroro and Tukaekuri Rivers began to pour their waters into the area now occupied by the important Heretaunga Plain, which grew at a rapid rate, as soon as the Tukituki began to pour its burden of shingle into the bay in the vicinity of the gorge behind Havelock.

Map fig. 3 shows the work that has been done by the several rivers since they came into existence, following the great subsidence along the coast. Ruataniwha, Heretaunga, Wairoa, and Poverty Bay Plains have all been formed by means of the materials that the several rivers have carried down in time of flood. Slowly the mouths of the rivers have extended seawards as the deltoid areas have grown year by year, and rich lands have taken the place of the once water-area, and the same process of growth is going on to-day. The rivers are still carrying down their treasures of material to the lowlands, and these latter are being aided by man's intelligence and industry. Since the formation of new drainage-areas and river

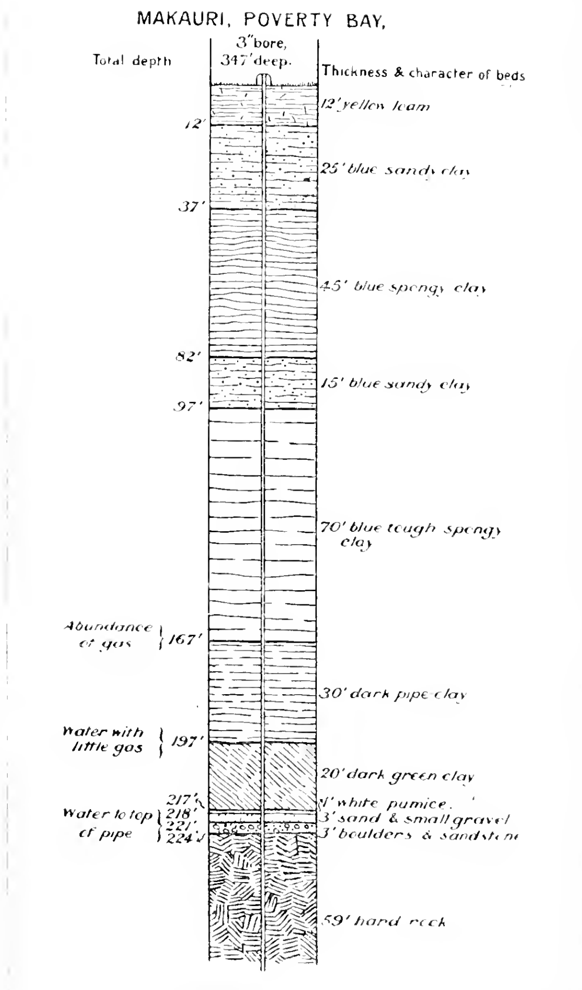


FIG. 7.—ARTESIAN-WELL SECTION, SHOWING DETAILS OF BEDDING.

systems, as shown in map fig. 2, the "made land" along the coast, as won from the sea, must amount to over 150,000 acres, and carries a population of about forty thousand persons. It would be interesting to know the annual value of the products of the land that has been made by deposition from flooded rivers, but the facts are not available.

Map fig. 1 shows the east coast as it is to-day, with the several rivers running into Poverty Bay and Hawke Bay respectively. The plains are not to be distinguished from the other portions of the land-area, for nature heals wounds, and only leaves remnants of a past, after the manner of a camping-ground in the case of Natives or a party of picknickers.

In a former paper on "Artesian-water Basins of Heretaunga Plain" (Trans. N.Z. Inst., vol. xxxvii, p. 432), sections are shown to illustrate the growth of the plain, and reference is made to the Great Wairarapa that flowed over the area long before the plain was formed. At that time my inquiries had not extended to Poverty Bay, but the sections (figs. 5, 6, 7, and 8) give in regular sequence the geological events and proofs such as are given in the above paper with respect to the Heretaunga Plain.

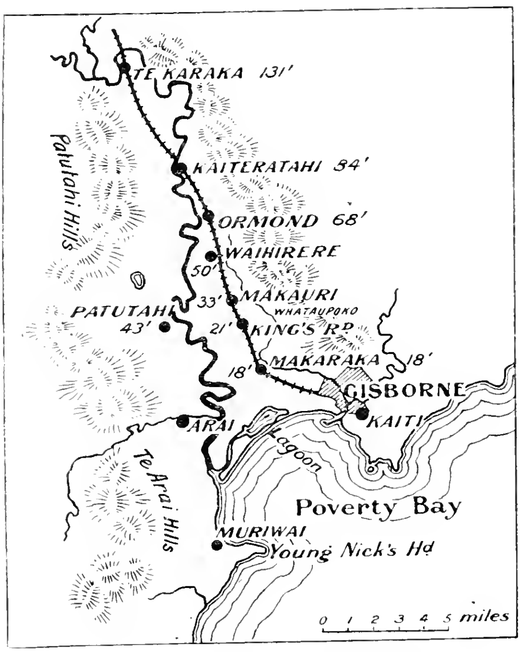


FIG. 8.—PRESENT PLAIN-SLOPE AND PHYSICAL FEATURES.

At the time of subsidence a gulf extended inland of the present Poverty Bay even beyond Kaiteratahi, and into this gulf, which is named Tauranganui, several important rivers flowed. As in the case of Heretaunga Plain, the rivers were and are great carriers of *débris*, and the plain as a deltoid changing area has grown in a manner almost identical to that of Heretaunga, so that the work of growing is still in progress.

The cross-section (fig. 6) shows the bedding of the present plain from the hills near the school at Te Arai, and the hills over which the road passes to the Waimata. Along the plain is shown the location and depth of artesian wells that have been put down from time to time, and fig. 7 shows a complete section of one such well. The present slope of the Poverty Bay Plain is shown in fig. 8, which gives heights, and river-drainage, and railway-line.

It is not necessary here to refer in detail to the interesting questions suggested, as my purpose is merely to show how two districts, separated so far apart, when placed side by side illustrate identical conditions in their changes, their growth, and structure. Nature works on similar lines, although the final results may be dissimilar; but here, over a district extending through two degrees of latitude covered by these remarks, the geology can be read without difficulty.

Thus the past can easily be dovetailed with the present. Construction and destruction are ever in operation, and all the forces of nature have one of these two ends in view. A whole district like that along the east coast may suddenly disappear, but upon the ruins new foundations at once begin to be built that in the end show sufficient growth as to become suitable as man's dwelling-place. The geologist cannot say how long it will take to fill up the waters that were once land-areas, but the process that immediately followed the disappearance of the Great Wairarapa still continues, and will continue unless there should come another period of volcanic activity and earth-movements such as was experienced at the going-out of the Pliocene and the coming-in of the Pleistocene periods in the geological history of this country.

ART. XLV.—*On* Dactylanthus Taylori.

By H. HILL, B.A., F.G.S.

[*Read before the Hawke's Bay Philosophical Society, 13th August, 1907.*]

IN vol. xxviii of the "Transactions of the New Zealand Institute," p. 493, there is an article by the late T. Kirk, F.L.S., on *Dactylanthus Taylori*. It contains all the information which was known up to that time concerning the life-history of this interesting and solitary(?) New Zealand genus of the order *Balanophoreæ*, which includes a variety of root-parasites. Kerner and Oliver, in their "Natural History of Plants," vol. i, p. 161, state that "the distinctive property of true parasites resides exclusively in the withdrawal of nutrient substances from the living vegetable or animal bodies which they invade." Based upon this definition, parasites are classed into three groups, the first including "generally all microscopic forms which live in the interior of human beings and animals, chiefly in the blood"; the second including "fungi possessing mycelia which have the power of withdrawing by the entire surface of their filamentous cells or by clavate outgrowths of the same nutritive material from the tissues of the host invaded by them"; and the third comprising "flowering-plants wherein the seedling upon emerging from the seed penetrates into the host by means of suction roots, or some other part which subserves the function of a suction root, so as to absorb juices from the host." It is to the latter group that *Dactylanthus Taylori* belongs.

The order *Balanophoreæ* contains about forty species, belonging to fourteen genera. They are mostly tropical or subtropical in their distribution over the Old and New Worlds, and are usually found in the deep recesses of the forest.

In the first edition of "New Zealand and its Inhabitants," by the Rev. R. Taylor, published in 1855, there appears on page 430 a picture of a new plant, "fam. *Balanophoreæ*," that is evidently intended to represent the *Dactylanthus*, but no word is mentioned in the botanical notes about the plant. It may be that Mr. Taylor, at the time when the book was first issued, had merely seen or been shown an imperfect specimen of the plant, as in the second edition, which was issued in 1870, or fifteen years from the time of the first issue, Sir Joseph Hooker's description of the *Dactylanthus* is given, with several fine illustrations of the plant from specimens supplied by Mr. Taylor.

The claim set up by the Rev. Mr. Taylor as the discoverer of the *Dactylanthus* has been recently called in question by the son of the late Mr. Francis Williamson, of Wanganui, who writes as follows: "DEAR SIR.—The *Dactylanthus Taylori* was first discovered by the late Francis Williamson, of Wanganui, who arrived in the colony in the early forties. It was found at the root of a *Pittosporum* tree, at a place called Putotara, a property owned by him. The plant was about the size of a large pine-apple; but, instead of having the top as a pine has, it had five flowerlike stalks, three of which were in bloom, and very sweet-scented. The other two were just buds. My father, being a botanist, knew this to be a new plant, and packed it to send home to England; however, as he heard the Rev. R. Taylor was about leaving for the Old Country, he took the specimen to him, who promised to do him the favour, and to give all particulars as to who found it, &c., Mr. Taylor saying it appeared to be quite a new plant. The next my father heard was that the new plant was named *Dactylanthus Taylori*.—D. H. WILLIAMSON, Havelock N., 30/7/07."

In Mr. Kirk's paper it is stated that the plant was discovered by the Rev. Richard Taylor, about 1857, growing on the roots of *Pittosporum*, *Fagus*, and other trees, at an estimated altitude of 4,000 ft. This may be true as far as Mr. Taylor himself was concerned, as he probably had not seen the plant growing before 1857, although there is a picture of the *Dactylanthus* flower in his work published in 1855.

"Pua reinga" is the name by which the plant is said to have been known to the Natives; but I have never heard it so called, nor do I understand why it should be known as the leaping, or springing, or jumping flower. When found by me many years ago a Native was with me. The place was Matarau, near to Hicks Bay, beyond the East Cape, and the Native without any hesitation called the plant "wae-wae-atua." Since then I have found the plant growing in many localities in the deep recesses of the bush, but whenever seen by Natives the same name has been given, and a very old Native of Taupo—Paul Rokino—gave me an old *waiata* referring to the flower. The name "wae-wae-atua," or the fingers, the foot, or toes of the *atua*, seems an appropriate one, for the appearance of a number of fruiting specimens, as shown in Plate XXXI, fig. 1, as they appear above the surface of the ground, generally on the slope of a bank in a deep gully, is curious and strange.

Mr. Kirk, in his notes, gives localities where the plant was first discovered by various collectors. The earliest-known specimens were taken from within the basin of the Wanganui River; but Mr. A. Hamilton, Director of the Dominion Museum, was the first to find specimens along the east coast, at Tarawera, and subsequently at Nuhaka. It has not been observed by myself at the latter place, but in the vicinity of the East Cape and Hicks Bay it is fairly common, the parasite being of very large size. At Matarau many specimens collected were as large as a good-sized cabbage, and the smell of the flowers in bloom was very sweet. It has been found by Mr. Frank Hutchinson at Hawkestone and Patoka, in the Puketitiri country; and I have found many specimens at Runanga and Opepe, in the Taupo plateau country.

During the past ten years the *Dactylanthus* has been under fairly close observation by me, and the following notes are the result of inquiries made with living and dead specimens. The specimens in my possession, both wet and dry, are of various sizes. In every instance the rhizome is terminal in respect to the particular portion of the root on which it is found (Plate XXX, fig. 1). *Panax* and *Pittosporum* are the only two kinds of trees upon the roots of which it can be stated with certainty that the parasites grow. The ends of the most delicate roots are selected by the parasite. Here a swelling appears, having the appearance of a small wart on the human hand. This is very marked in the smaller specimens, where the host portion can be distinguished from the growing rhizome of the parasite by a smoother surface, a different swelling, and a difference of colour. The swelling at the end of a root host looks as if the tissues had been disturbed and cramped during growth, and near the place of junction the root thickens somewhat, as is clearly shown in Plate XXX, fig. 2. In the latter figure the junction of the rhizome with the host can be seen as flowerlike radiations on the lower part of the rhizome, and by corresponding radiations and depressions at the end of the host root. The latter does not cease to grow after being attacked; in fact, the root appears to grow stronger near the place of attachment with the rhizome, and this becomes more pronounced in the larger and older specimens. When a fresh rhizome is cut into halves so as to trace the root host, the latter, in large specimens, spreads out fanlike and in cuplike depressions, twisted on the outside, and appearing as if the ends of the root had been subjected to great pressure. The depressions or cups are filled mostly with a pithy substance, which, when dry, shrinks and leaves several hollow spaces. On the outside of the terminal roots of the host a similar pithy substance underlies the ordinary bark, and it appears as if the rhizome was fed or nourished in the places indicated.

The rhizome in a growing state presents the appearance of a large potato covered over with warts. When cut through there is a bluish-purple line not unlike that seen in the blue potato, formerly in common use by the Maoris along the east coast. It is not difficult to cut, and resembles a Swedish turnip except in colour. The taste is neutral, or perhaps slightly sweetish, and when bitten is crisp but somewhat dry, and leaves behind a slight raspy or acrid taste. As the flesh portion of the rhizome approaches the cortical layer it is covered over with pimple-like growths. These eventually push their way through a mass of cortical layer, and form flowering-shoots over the entire surface of the rhizome. If the tubercular growths which cover a rhizome-like wart be cut across, they show a distinct arrangement of parts. First come the scales, then a yellowish-white band made up of strands resembling resin. Within this, but touching the inner portion, are ten or twelve horseshoe-like forms, some of a rich orange colour and others a deep purple; but they always present one or other of these characteristics. If the two ends of a horseshoe were joined loosely so as to bend inwards somewhat, the similarity would be complete. I have cut many of the fresh growing tubercles, and have separated the scales one by one so as to get at the central growing portion. This consists of minute growths, not unlike in appearance one of the ripening flowers of a fig, except that each part is made up of two lip-like growths, one being a little larger than the other. It would seem that the purple tubercles give rise to the female spadices, and the orange to the male. They certainly present similar appearances to what are seen in the complete flowers.

The female peduncle is usually shorter than the male, but each varies in size according to conditions of growth and development. The pistillate flowers surround each spadix. They are very small, are less numerous below, and increase in number upwards, although fewer seeds mature at the top than below. The flower is of two parts, forming a closely fitting perianth as the ends appear above the ovary, and, like the pistil, are permanent, and can be seen in the ripened fruit, as illustrated in Plate XXXII, fig. 2. The lower part of the perianth is pale yellow, the upper purple, as are likewise the style and stigma. As the seed ripens the ovary swells somewhat, and when ripe the yellow part has changed to a bluish-green, that passes above into a deep purple. This has reference to the perianth only, for when the covering is removed a tiny nut of a deep-purple colour is seen, and within this nut there occurs a white structureless substance like wax.

The male or staminate flowers have a peduncle that is similar to that of the female, except that it is larger, as are likewise the scales. As the flower expands the scales are symmetrical, and the whole when fully developed is ringent and not unlike a small dahlia (Plate XXXII, fig. 1). The colour of the surrounding scales varies from a straw-yellow in the outer whorl to a deep orange with purple stripes in the case of the petal-like scales that surround the spadices. The latter vary in number from 16 to 28. About each spadix staminate flowers wind from left to right. They are connected with the spadix by short filamentary attachments. Each staminate flower is of a yellowish-grey colour, fleshy, and presenting the appearance of a tiny disc, with a deep depression running from top to bottom. The pollen appears to be developed along the margin of the anther, and is abundant. As soon as the spadices are fully developed the scales fall back, and the flower eventually dies down and falls off.

The flowering takes place between February and April. Until Easter Monday, 1907, I had not seen a male flower in full bloom. Plate XXXII, fig. 1, shows a male flower just opening. As the development of the flower proceeds the scales droop, and the spadices present a straggling appearance.

I have made numerous experiments both with rhizomes and seed, but up to the present time the results have not been satisfactory.

EXPLANATION OF PLATES XXX–XXXII.

Plate XXX.

Fig. 1. *Dactylanthus*; root of host, and parasites forming like small tubers.
Fig. 2. Root of host, showing mode of attachment of parasite.

Plate XXXI.

Fig. 1. *Dactylanthus* flowers growing on a bank.
Fig. 2. Flowers (female), showing attachment to root.

Plate XXXII.

Fig. 1. Male *Dactylanthus* flower unfolding.
Fig. 2. Flowers — male, female — and fruit: *a*, staminate spadix; *b*, pistillate spadix; *c*, ripe seeds from *b*.

2681

Fig. 1.

2682

Fig. 2.

DACTYLANTHUS TAYLORI.—Hill.

Face p. 440.

Fig. 1.

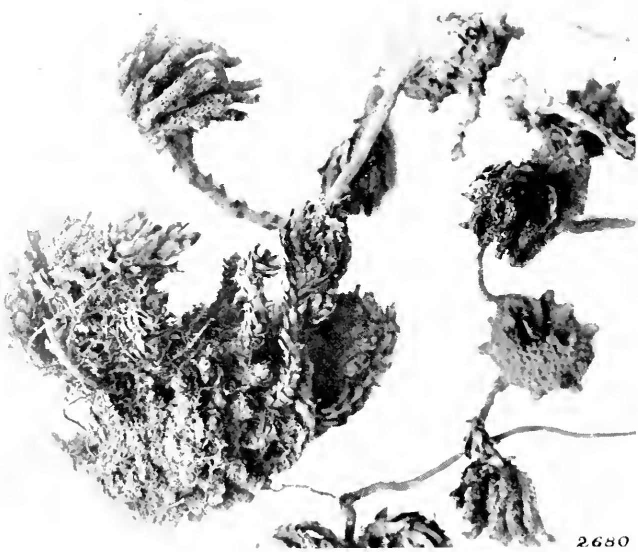


Fig. 2.

DACTYLANTHUS TAYLORI.—Hill.

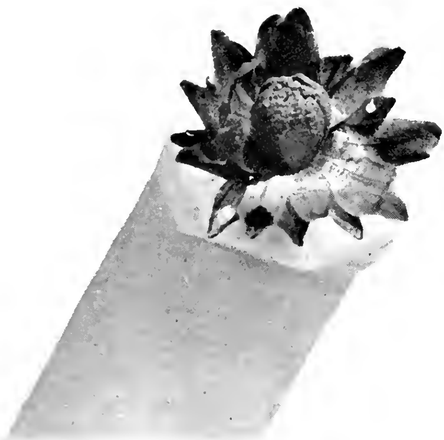


FIG. 1.

FIG. 2.

DACTYLANTHUS TAYLORI.—Hill.

NEW ZEALAND INSTITUTE.

NEW ZEALAND INSTITUTE.

ADJOURNED SIXTH ANNUAL MEETING.

The adjourned meeting was held in the Dominion Museum, Wellington, on Thursday, 4th February, 1909, at 10.30 a.m.

Present: Mr. G. M. Thomson, President (in the chair); Mr. A. Hamilton, Mr. M. Chapman, Professor Easterfield, Mr. T. H. Gill, Mr. J. W. Joynt, Mr. W. Wilson, Mr. H. Hill, Mr. E. Tregear, Mr. John Young, Dr. L. Cockayne, Professor W. B. Benham, Mr. R. Speight, and the Secretary (Mr. Thomas King).

A letter, dated 29th December, 1908, was received from the Department of Internal Affairs, notifying the appointment (published in the *New Zealand Gazette* of the 23rd December) of Messrs. J. W. Joynt and E. Tregear as members of the Board of Governors of the New Zealand Institute under "The New Zealand Institute Act, 1908."

The President welcomed Mr. Speight on taking his seat on the Board for the first time.

An apology from Mr. James Stewart for non-attendance was read.

The minutes of the last annual meeting were confirmed; the minutes of the Standing Committee meetings held on the 12th November, the 24th July, the 4th December, 1908, and the 25th January, 1909, were read; and the minutes of the annual meeting of the 28th January last were read and confirmed.

The Secretary explained the circumstances connected with the telegraphic advices of the postponement of the annual meeting. The explanation was considered satisfactory.

The annual report and annual statement of receipts and expenditure were then read. The report and statement were as follows:—

The fifth annual meeting of the Board of Governors under "The New Zealand Institute Act, 1903," was held in the Dominion Museum, Wellington, on the 30th January, 1908, and was attended by fourteen members.

The President, Mr. G. M. Thomson, F.L.S., F.C.S., was in the chair.

It was reported that Messrs. John Young and Augustus Hamilton, the two retiring nominees of the Government, had been reappointed, and that the following representatives had been elected by the societies affiliated to the Institute: Messrs. D. Petrie and J. Stewart (Auckland Institute); Professor T. H. Easterfield and Mr. Martin Chapman, K.C. (Wellington Philosophical Society); Professor Charles Chilton and Dr. C. C. Farr (Philosophical Institute of Canterbury); Professor W. B. Benham and Mr. G. M. Thomson (Otago Institute); Mr. H. Hill (Hawke's Bay Philosophical Institute); Dr. L. Cockayne (Nelson Institute); Mr. T. H. Gill (Westland Institute); and Mr. Kenneth Wilson (Manawatu Philosophical Society).

The following officers were elected for 1909: President, Mr. G. M. Thomson, F.L.S., F.C.S.; Hon. Treasurer, Mr. Martin Chapman, K.C.; Secretary, Mr. Thomas King; Hon. Editor of Transactions, Mr. G. M. Thomson; Hon. Librarian, Mr. Augustus Hamilton; Publications Committee, Professor C. Chilton, Professor W. B. Benham, Dr. C. C. Farr, and the Hon. Editor.

The honorary members elected were Dr. L. Diels, of Berlin; the Rev. T. R. R. Stebbing, F.R.S., of Tunbridge Wells; and Mr. E. Meyrick, B.A., F.R.S., of Marlborough College, Wilts. There are now twenty-nine honorary members on the roll, and the meeting will therefore be asked to elect one new member.

In accordance with resolutions passed at last annual meeting, Professor T. W. E. David, Professor W. A. Haswell, and Mr. J. H. Maiden, all of Sydney, were asked to act as a committee to suggest a suitable recipient of the Hutton Memorial Medal. The two last-mentioned gentlemen have consented to act, but no reply has yet been received from Professor David, who is absent in the far south as a member of the "Nimrod" Antarctic Expedition. The dies for the medal, and several specimens of the medal, have been received from England, and (by permission) have been lodged by the Secretary in the Dominion Museum for safe keeping.

The Committee set up at last annual meeting "to examine the books of the library with a view to determining their ownership" has never met, two of the members being resident in the South Island; consequently the position remains unaltered.

The same committee was set up to revise the exchange list; and Professors Benham and Chilton submitted suggestions to Mr. A. Hamilton, the Wellington member of the committee, as to the alterations required in the list. The matter is dealt with in the report of the Hon. Librarian, presented at this meeting.

At the last meeting a committee was set up to go into the matter of the delay in the issue of the 39th volume of the Transactions. This committee interviewed the Hon. J. A. Millar, Minister in charge of the Printing Department, and the Government Printer, and obtained a promise from those gentlemen that steps would be taken to expedite the issue of future volumes. The delay in the past year was in part attributed to the unprepared manner in which papers intended for publication were sent in; and the Government Printer undertook to supply a memorandum on the subject for the guidance of Secretaries of affiliated societies and of authors of papers. This memorandum was received by the Editor in February last, and copies were forwarded to the Secretaries of the several affiliated societies. It is, however, evident that the delay was largely due to the block of parliamentary business; and to obviate this in future it is advisable that the volume should be printed as early in the year as possible.

The committee appointed to make arrangements for the preparation of an index to the forty volumes of the Transactions has not been able to come to a final decision as to the course to be pursued. The committee has obtained specifications from two persons qualified to undertake the work, and is in communication with a third, but so far is unable to report definitely.

A geographical difficulty similar to the one spoken of in the paragraph referring to the Ownership of Books Committee has prevented the Hector Memorial Committee of the Institute from meeting. The members of the committee live in different parts of the Dominion, and have not found it practicable to assemble in Wellington. They are, however, co-operating with the main Hector Memorial Committee, which has the matter in hand. That committee has been reconstituted, and is in correspondence with the other bodies which are acting in the interests of the movement. The amount so far collected by the committees is, unfortunately, too small for the end in view. The main Hector Memorial Committee, at the instance of the Standing Committee of the Board of Governors, has therefore suggested to the Memorial Committee of the Institute, and to the allied committees in Auckland, Wellington, Christchurch, and Dunedin, that a joint circular should be issued, signed by representatives of all the committees, appealing for further subscriptions to the fund. This suggestion has been adopted. A draft circular has been drawn up by the main Memorial Committee and submitted to the other committees, and its terms are now being discussed. Members of the Christchurch and Dunedin committees have stipulated for one or two fundamental changes in the wording of the circular. This has temporarily delayed matters: but it is hoped that agreement will shortly be arrived at upon the points at issue, and that as soon as the circular is ready for distribution all the committees will make a vigorous effort to raise a sum of money sufficient for the establishment of a worthy memorial.

The volumes of the Transactions remaining on hand are—Vol. I (second edition), 313; Vol. V, 30; Vol. VI, 21; Vol. VII, 143; Vol. IX, 214; Vol. X, 138; 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, 450; 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, 684; Vol. XXXI, 695; Vol. XXXII 517; Vol. XXXIII, 611; Vol. XXXIV, 563; Vol. XXXV, 525; Vol. XXXVI, 686; Vol. XXXVII, 604; Vol. XXXVIII, 750; Vol. XXXIX, 192; Vol. XL, 91.

The advance copies of the new volume (XL, 1907) were not received from the printers until the first week of September, 1908, and the main supplies were not available for distribution until towards the end of that month. The volume contains 608 and xvi pages, and 34 plates. The contents of the last two volumes are compared as follows:—

	Vol. XXXIX (1906). Pages.	Vol. XL (1907). Pages.
Miscellaneous	76	185
Zoology	210	124
Botany	189	126
Geology	47	95
Chemistry	Nil	10
Proceedings	31	44
Appendix	23	24
	576	608

Copies of Vol. XL were presented to Parliament on the 8th September, 1908.

In accordance with resolutions passed at the last annual meeting, the volumes of the Transactions now stored in the vault of Parliament Buildings have been insured for the sum of £500, and the Institute's books stored in the Dominion Museum, Wellington, have been insured for £2,000.

As decided at last annual meeting, the Standing Committee has given consideration to the question of reprinting papers which have appeared in the Transactions. After going carefully into the subject, the committee has come to the conclusion that it is not desirable for the Board in the meantime to undertake the reprinting of papers.

A question which has engaged the attention of the Standing Committee, and which seems deserving of consideration by the Board as a whole, is that of the constitution of the committees which are sometimes appointed by the Board for the conduct of special business. Several such committees were set up at last annual meeting. These were composed of members residing in widely separated districts of the colony, but in no instance was a convener or an executive officer appointed. The result has been unsatisfactory. Each member of a committee has been in doubt as to who was to take the initiative, and in consequence great difficulty has been experienced by the committees in getting to work.

The Standing Committee has found it impracticable to make the arrangements necessary for holding, in terms of the resolution passed at the last annual meeting, a special general meeting of the members of the Institute on the 29th January, 1909, and, in consequence, the meeting in question must lapse.

It seems advisable that the practice of granting diplomas of membership to gentlemen who are elected honorary members of the Institute should be revived. Such diplomas were regularly issued under the original Act, and were appreciated by the recipients; but the passing of the Act of 1903 rendered the wording of the old form of diploma obsolete, and no diplomas have been given during the past five years. With a few unimportant alterations the phraseology of the old form could be adapted to present-day requirements, and the supply of amended forms could be printed for a trifling sum.

On the 16th December, 1908, the Philosophical Institute of Canterbury gave notice that Professor Charles Chilton had resigned his seat on the Board, and that Mr. R. Speight, of Christchurch, had been elected in his place to represent the Christchurch society.

The Secretary, Mr. Thomas King, has explained to the Standing Committee that he finds that the secretarial work takes up very much more time than he anticipated, or than he can spare, and that he has therefore, with regret, decided not to seek re-election.

The amount standing at the credit of the Carter Bequest Fund with the Public Trustee on the 31st December, 1908, including interest accrued to the 31st December, 1908, was £2,735 16s. 5d. The Public Trustee also holds on account of the bequest scrip in the New Zealand Loan and Mercantile Agency Company (Limited) of the total face value of £32 5s. 5d. His certificate accompanies the present report. At the last annual meeting it was decided that the Hon. Treasurer should be asked to endeavour to arrange with the Public Trustee for the payment of interest on this money at 4½ per cent., instead of 4 per cent. per annum. On inquiry, however, the Treasurer ascertained that as a matter of fact 4½ per cent. was being allowed on the deposit, that being the rate paid by the Public Trust Office on sums not exceeding £3,000. There was therefore no occasion for the Treasurer to take action.

A duly audited statement of the Institute's receipts and expenditure for the past year, showing a credit balance of £392 10s. 11d., is presented with this report.

GEO. M. THOMSON, President.

Statement of Receipts and Expenditure.

Receipts.

			£ s. d.
1908.			
Jan.	31.	Balance brought forward	361 5 11
April	14.	W. Wesley and Sons, Transactions	0 16 10
May	5.	A. Bathgate, Maori Art	4 5 0
Sept.	2.	Champtaloux and Cooper, Transactions	0 16 10
		„ Maori Art	3 7 0
„	12.	Friedlander and Sons, Transactions	5 17 5
„	26.	Contribution by Wellington Philosophical Society	16 9 0
Oct.	15.	G. E. Stechert and Co., Transactions	0 15 10
Nov.	5.	Lieut.-Colonel Gaskell, Maori Art and posting	8 14 0
„	18.	A. H. Turnbull, Transactions	1 1 0
„	24.	Whitcombe and Tombs, Transactions	0 16 9
Dec.	15.	Government grant	500 0 0
1909.			
Jan.	7.	W. Wesley and Sons, Transactions	0 16 10
„	14.	Friedlander and Sons, Transactions	0 16 9
„	27.	Transactions	0 16 9
			£906 15 11

Expenditure.

			£ s. d.	£ s. d.	£ s. d.
1908.					
Feb.	13.	Petty cash, Secretary			2 0 0
Mar.	14.	W. Benham, travelling-expenses			4 0 10
		Dr. Chilton, „			2 7 0
		James Stewart, „			9 13 8
		H. Hill, „			2 9 8
		K. Wilson, „			1 0 4
		C. Coleridge Farr, „			2 7 0
		G. M. Thomson, „			4 0 10
		Hotel Cecil			0 15 0
		Whitcombe and Tombs			1 3 3
		W. A. McKay, services			1 1 0
		D. Petrie, travelling-expenses			5 4 10
Mar.	31.	Bank charge			0 5 0
April	29.	G. M. Thomson, petty cash			5 0 0
July	2.	„ „			5 0 0
„	25.	Whitcombe and Tombs			1 2 0
		L., L., and G. Insurance Company			9 0 0
		Miss Millais, services			3 0 0
		Colonial Carrying Company			0 19 11
		New Zealand Express Company			0 12 0
		Government Printer			0 15 0
		C. Freyberg, services			5 0 0
		Secretary, petty cash			9 19 0
Sept.	30.	Bank charge			0 5 0
Dec.	10.	Petty cash, Secretary			0 7 0
„	15.	„ „			2 0 0
		Chapman and Tripp, law-costs			1 0 0
		W. Chalmers			1 13 0
		New Zealand Express Company			2 9 2
1909.		Whitcombe and Tombs			1 0 6
Jan.	26.	Government Printer			388 13 0
		W. A. McKay, services			5 0 0
		T. King, Secretary			25 0 0
		C. Freyberg, services			10 0 0
		Balance			392 10 11
		Balance in bank	820 6 2		
		Petty cash balance	0 1 0		
				820 7 2	
		Plus credit not in bank-book		0 16 9	
				£821 3 11	
		Less unpresented cheques		428 13 0	
		Balance		£392 10 11	
					£906 15 11

Carter Bequest.

	£	s.	d.
Balance, 1st February, 1908	2,617	11	10
Interest accrued to 31st December, 1908	118	4	7
Scrip, New Zealand Loan and Mercantile Agency Company, 1st February, 1908	17	0	0
Scrip, ditto	15	5	5
	£2,768	1	10

	£	s.	d.
Invested by Public Trustee, 31st December, 1908	2,735	16	5
Scrip in hands of Public Trustee	32	5	5
	£2,768	1	10

Martin Chapman, Treasurer.

Examined and found correct.—J. K. Warburton, Controller and Auditor-General.

Mr. Thomson moved, and Mr. Hamilton seconded, "That the President's report be received." Carried.

Mr. Chapman moved, and Mr. Hamilton seconded, "That the statement of receipts and expenditure be adopted." Carried.

The Public Trustee's certificate as to the state of the Carter Fund was read.

The report of the Editor and Publications Committee was read as follows :—

I have to report that the Publications Committee met on the 31st January, 1908, and considered the papers which had been handed over to them by Mr. Hamilton, late Editor.

Forty-two papers were passed for printing in Vol. XL, and these were at once forwarded to the Government Printer, while seven were included in the Proceedings of the societies which forwarded them. Seven were sent to experts to be reported on as to their suitability for publication, and seven were held over. Of the papers sent to experts, six were reported on favourably and sent to the Government Printer, while one was considered unsuitable.

In this connection I would point out that the work of the Editor would be simplified if the Council and Secretaries of the affiliated societies would only forward such papers as are considered to be real contributions to scientific knowledge. All papers which are only *résumés* or digests of already published work should not be sent forward, and the onus of withholding them should rest on the society with which they originate, and should not be placed on the Editor.

The committee received from the Government Printer on the 10th February a number of suggestions and recommendations, including memoranda from the Supervisor and the Chief Draughtsman. The chief of these were embodied in a memorandum for authors of papers sent out by me to the Secretaries of the affiliated societies. It is hoped that attention will be paid to the details therein specified, as both time and money will be saved thereby.

In accordance with the resolution of the last annual meeting, that the 41st volume be the first of a new series, the Publications Committee has gone carefully into the matter, and has come to the conclusions—(1) That the new series should be issued in royal 8vo. size ; and (2) that both Transactions and Proceedings should be of the same size. In the case of any large monographs which it is considered desirable to issue separately, it is recommended that they be printed of the same size as the "Bulletin of the Geological Survey."

Geo. M. Thomson, Editor.

Mr. Thomson moved, and Mr. Chapman seconded, "That the report of the Editor and Publications Committee be received." Carried.

Professor Benham moved, and Mr. Speight seconded, "That in future the volumes of the Transactions be published in royal 8vo. size." Carried.

The Hon. Librarian's report was then read, as follows :—

The Honorary Librarian reports that the number of pieces received during the year as exchanges and presentations amounts to 923.

No binding has been done during the year, and I desire to point out that there is still a large amount of binding that requires attention. As mentioned in my last report, the present arrangement of the books is perhaps the most inconvenient that could be suggested, and it would be a great improvement if a sum of money could be provided for modern iron bookcases, to be arranged in bays.

I have again to report that very little use has been made of the library, the number of entries made by those taking out books being only forty-six, the majority of these being periodicals and magazines taken out by members of the local society; in fact, a large number of the books have been taken out by a person who is not a member of the Institute, but who has permission to use the library. I think to a large extent the fact that the library is not much used is owing to the comparative inaccessibility of the books.

No progress has been made with regard to the card catalogue, as no funds are available at present for an assistant.

The stock of Transactions accumulated during the last three years has been transferred to the cellars of the Parliamentary Library.

I have had a typewritten catalogue prepared of the books belonging to the Philosophical Society. You will have before you a communication from the Mines Department relating to the geological works now in the collection.

A separate stamp has been prepared for the books belonging to the Dominion Museum, and for the future a separate binding of brown buckram will be used for the Museum books.

A set of pigeon-holes has been provided for the better keeping of the current parts of the various works, and I also had an estimate prepared for a series of shelves and pigeon-holes for the whole of the parts which are received from time to time. The cost, however, was about £60. If funds can be found for this purpose, it would probably insure the better custody of the parts which arrive from time to time.

Re exchanges: I have written to the members of the Committee of the Exchanges, and have communications from them on this matter. I have, however, been unable as yet to draft a report, as a number of matters have to be gone into first, which cannot conveniently be proceeded with until the alterations in the library now contemplated are decided on.

I think it is desirable that a small vote should be made for the purpose of carrying on a certain amount of card cataloguing and classification. I propose to ask the Standing Committee to authorise the expenditure of a small amount on further work on the catalogue.

A. Hamilton, Librarian.

Mr. Hamilton moved, and Mr. Chapman seconded, "That the Librarian's report be received." Carried.

Mr. A. Hamilton moved, and Professor Benham seconded, "That as soon as possible in each year complete copies of the Transactions shall be, in accordance with the Act, presented to Parliament, and that all other copies shall bear that date as the date of issue, and that this date shall be the 'date of publication for the purposes of determining priority of discovery.'" Carried, Professor Easterfield dissenting.

Professor Benham moved, and Mr. R. Speight seconded, "That the Editor be authorised to publish the Proceedings of the affiliated societies at intervals throughout the year, independently of the Transactions, and separately paged." Carried.

Professor Benham moved, and Mr. Chapman seconded, "That the Index Committee be reappointed, substituting the name of Mr. R. Speight for that of Dr. Chilton, and adding that of Mr. A. Hamilton as convener." Carried.

Mr. R. Speight moved, and Professor Easterfield seconded, "That the Index Committee consider the question of preparing an index to the volumes of the new series, as issued." Carried.

Carter Bequest.—A legal opinion (dated 7th December) from Mr. M. Chapman, K.C., was then read.

Mr. Hill moved, and Mr. Gill seconded, "That the legal opinion of Mr. Chapman with reference to the expenditure of certain moneys under the Carter bequest be forwarded to the Victoria College Council for their information."

Diploma of Honorary Membership.—Mr. Chapman moved, and Mr. Hamilton seconded, "That the form of diploma settled by Mr. Chapman be adopted as the form of certificate of honorary membership." Carried.

Mr. Hamilton moved, and Mr. Chapman seconded, "That the honorary members elected since 1903 be furnished with diplomas, and that diplomas be sent in future to all honorary members elected." Carried.

Formation of Special Committees.—This matter was discussed by the Board, and it was considered that in future, when Committees are set up, proper provision should be made for the members of such Committees conferring with one another.

Mr. Hamilton moved, and Professor Easterfield seconded, "That all committees appointed shall furnish in a formal report to the annual meeting an account of their year's work." Carried.

Hutton Memorial Fund.—Mr. Chapman moved, and Mr. Gill seconded, "That the seal of the Institute be affixed to the 'Hutton Memorial Deed of Declaration of Trust,' and that the seal be affixed by the President, who shall sign the deed in the presence of the Secretary as witness." Carried.

General Correspondence.—(1.) University of Missouri, dated the 21st July, 1908, asking that volumes of the Institute on exchange account preceding Vol. XXXVI, 1904, be sent to them.

Mr. Hill moved, and Mr. Wilson seconded, "That the application of the Missouri University be approved." Carried (the Librarian to decide what volumes shall be sent).

(2.) Entomological Society of Russia, dated the 5th September, 1908, requesting that the entomological publications of the New Zealand Institute be sent in exchange for their edition of the "Revue Russe d'Entomologie."

Mr. Hamilton moved, and Professor Easterfield seconded, "That, as there are no separate copies of the entomological papers, we are unable to grant the request of the Société Entomologique de Russe." Carried.

(3.) Zoological Institute of the Royal University of Naples (no date), proposing the exchange of their "Annuario del Museo Zoologico" for the Transactions of the Institute.

Professor Benham moved, and Dr. Cockayne seconded, "That in future the Zoological Institute of the Royal University of Naples be added to the list of exchanges (back numbers, Vols. I and II, to be obtained, and the corresponding numbers of the Transactions to be forwarded)." Carried.

(4.) United States Department of Agriculture, dated the 25th November, 1908, asking for back volumes of the Transactions.

Professor Easterfield moved, and Mr. Gill seconded, "That the United States Department of Agriculture library be informed that the New Zealand Institute will supply such of the specified volumes as are in stock for the sum of £10—a slight advance on the cost of publication." Carried.

(5.) Bureau of Science, Manila, dated the 10th November, 1908, suggesting an exchange of the Transactions.

Mr. Hamilton moved, and Mr. Chapman seconded, "That the Manila Bureau of Science be communicated with, and arrangements made for an exchange of publications." Carried.

(6.) Westport Free Library, Westport, dated the 13th January, 1909, applying for free copies of the Transactions.

It was resolved that the request be granted.

(7.) Mines Department, Wellington, dated the 27th January, 1909, asking that the books in the Institute library relating to geology be handed over to the Mines Department, for the purpose of being placed in the Geological Survey library.

Mr. Hill moved, and Mr. Young seconded, "That the Institute is unable to accede to the application of the Mines Department for the transference of the geological works in the reference library to the Geological Survey reference library." Carried.

(8.) A letter from Mr. Thomas King, resigning the secretaryship of the Institute, was read.

Mr. Hamilton moved, and Mr. Thomson seconded, "That the resignation of Mr. Thomas King as Secretary be accepted, and that the thanks of the Council be given to him for his services as Secretary, and it regrets that he cannot continue to act in that capacity." Carried.

Mr. Hamilton moved, and Professor Easterfield seconded, "That a certain number—say, ten—of separate copies of papers be printed for the Institute, in addition to the copies supplied to the author." Carried.

Election of Officers.—The following officers for 1909 were elected: President—Mr. A. Hamilton; Hon. Treasurer—Mr. Martin Chapman, K.C.; Secretary—Mr. B. C. Aston; Hon. Editor—Mr. G. M. Thomson; Hon. Librarian—Mr. A. Hamilton; Publications Committee—Professor Benham, Dr. C. C. Farr, Mr. R. Speight, and Mr. Thomson (Editor).

Mr. Chapman moved, and Mr. Thomson seconded, "That the President be *ex officio* a member of all committees." Carried.

Election of Honorary Member.—The meeting then proceeded to elect an honorary member to the vacancy: Proposed by the Philosophical Institute of Canterbury, Dr. Chree; proposed by the Wellington Philosophical Society, Sir George Howard Darwin; proposed by the Otago Institute, Sir Archibald Geikie. Sir George Darwin was elected.

Travelling-expenses.—Mr. Chapman moved, and Mr. Hamilton seconded, "That the travelling-expenses of members be paid as before, and that the travelling-expenses of members attending on the 28th January be also paid." Carried.

Mr. Hill moved, and Mr. Speight seconded, "That the Council of the New Zealand Institute heartily congratulate Professor Ernest Rutherford on his selection as one of those who have been deemed worthy of receiving the Nöbel Prize, and that a copy of this resolution be forwarded to Professor Rutherford, Manchester." Carried.

Mr. Speight moved, and Mr. Gill seconded, "That the Editor be the convener of the Publications Committee." Carried.

Mr. Hamilton moved, and Mr. Chapman seconded, "That the annual meeting for 1910 be fixed for Thursday, the 27th January." Carried.

Mr. Chapman moved, and Mr. Gill seconded, "That the annual meeting for 1910 be held in Wellington." Carried. (An amendment moved by Professor Benham, and seconded by Dr. Cockayne, "That the next meeting be held in Christchurch," was lost.)

Mr. Hill moved, and Mr. Young seconded, "That a hearty vote of thanks be accorded to the retiring President for the efficient manner in which he has conducted the business of the Institute during his presidency." Carried.

Professor Benham moved, and Dr. Cockayne seconded, "That the minutes of this annual meeting be included in the 41st volume of the Transactions." Carried.

The rough minutes of this meeting were then read and confirmed, on the understanding that the Secretary may make such verbal corrections as may seem to him necessary.

Geo. M. Thomson, Chairman.

APPENDIX

NEW ZEALAND INSTITUTE.

HONORARY MEMBERS.

1870.

Finsch, Otto, Ph.D., Leiden, Holland.

Hooker, Sir J. D., G C.S.I., C. ., 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.

1909.

DARWIN, Sir George, F.R.S., Cambridge.

ORDINARY MEMBERS.

WELLINGTON PHILOSOPHICAL SOCIETY.

[* Honorary and life members.]

Adams, C. E., B.Sc.
Adams, C. W.
Atkinson, Esmond 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. Cordelia
Chudleigh, E. R., Chatham Islands
Cockayne, A. H.
Crawford, Alex. D.
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.
Gill, Thomas H., M.A.
Gray, William
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.
Izard, Dr. Arnold W.
James, Herbert L.
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
Lewis, John H., Broken River, Canterbury
Lifiton, E. N., Wanganui
Litchfield, Alfred H., Blenheim
Lomax, Major H. A., Aramoho, Wanganui
Ludford, Ernest J.
MacDougall, Alexander
Maclaurin, Dr. J. S., F.C.S.
McKay, Alexander, F.G.S.
McLeod, H. N.
Marriner, George, Wanganui
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
Patterson, Hugh, Horopito
Pearce, Arthur E.
Petherick, E. W.
Phillips, Coleman, Carterton
Phipson, Percy B.
Picken, Professor D. K., M.A.
Pollen, Hugh
Pomare, Dr. M.
Powles, Charles P.
Poynton, J. W.
Reid, Frank
Reid, W. S.
Richmond, Professor M. W.
Roy, R. B., Taita*
Skinner, H. D.
Stewart, John T., Wanganui
Stuckey, F. G. A., B.A.

Sunley, R. M.
Swan, W. G. Collington
Tennant, J. S.
Thompson, John
Tripe, Joseph A.
Turnbull, Alexander H.
Turnbull, John Ure
Vickerman, Hugh
Wallis, Rt. Rev. Dr. Frederic, Bishop of Wellington
Wilton, G. W.
Woodhouse, Alfred James, London

AUCKLAND INSTITUTE.

[* Honorary and life members.]

Aickin, G.
Aldis, M.
Allsop, G. W.
Arnold, C.
Aubin, E. D., M.B.
Bagnall, L. J.
Ball, W. T.
Bankart, A. S.
Bartley, E.
Bates, T. L., Newcastle, N.S.W.*
Batger, J.
Beere, D. M., Melbourne
Benjamin, E. R.
Best, Elsdon, Ruatoki
Birks, L., C.E., Rotorua
Brett, H.
Briffault, R., M.B.
Broun, Major T.
Brown, E. C., Taumarunui
Brown, Professor F. D.
Buchanan, J.
Buddle, J. H.
Buddle, T.
Burgess, E. W.
Burnside, W.
Burton, Colonel.*
Bush, W. E., C.E.
Buttle, J.
Cameron, R.
Campbell, Sir J. L., M.D.*
Carr, R. A.
Casey, M.
Cheal, P. E.
Cheeseman, T. F., F.L.S.
Ching, T.
Clark, A.
Clark, A., M.B.
Clark, H. C.
Clark, M. A.
Clarke, E., Wellington
Coates, T., Orakei
Cochrane, W. S.
Combes, F. H.
Cooper, C.
Cooper, Mr. Justice, Wellington
Cottrell, A. J.
Cousins, H. G.
Cozens, G.
Craig, J. J.
Crosher, J.
Cuff, J. C.
Darby, P.
De Clive Lowe, G. T. H., L.R.C.P.
Devereux, H. B., Waihi
Devore, A. E. T.
Douglas, W. S.
Duthie, D. W.
Earl, F.
Edson, J.
Egerton, Professor C. W.
Ewington, F. G.
Florance, R. S., Russell
Fowlds, Hon. G., M.P.*
Fox, Rev. E. E., Norfolk Island
Garrard, C. W.
George, G.
Gibb, R.
Gilbert, T.
Girdler, Dr.
Goldie, D.
Gordon, H. A.
Gorrie, W.
Grant, Miss J.
Gray, S.
Griffin, Miss E. M.
Guinness, W., M.D.
Haines, H., F.R.C.S.
Hamer, W. H., C.E.
Hansen, P. M.
Hardie, J.
Haszard, H. D. M.
Hazard, N. H.
Heaton, F.
Herbert, T.

Hodgson, J.
Horton, H.
Houghton, C. V.
Howden, J.
Hutchinson, G.
Inglis, R. T., M.B.
Jarman, Professor A.
Johnson, H. D., Te Aroha
Jones, H. W., Papakura
Kenderdine, J.
Kidd, A., M.P.
Kirker, J.
Kronfeld, G.
Lamb, C. E., M.A.
Langguth, E.
Lennox, J. M.
Lennox, N. G.
Leys, T. W.
Lundon, J. R.
McDowell, W. C.
McLachlan, J. M.
McLean, M.
McMillan, C. C.
Mahoney, T.
Mair, Captain G., Rotorua
Mair, Major W. G.
Mair, S. A. R., Hunterville
Martin, J., F.G.S.
Metcalfe, H. H., M.I.C.E.
Miller, E. V.
Milnes, H. A. E.
Mitchelson, Hon. E.
Moody, T. P., Hikurangi
Morgan, H. H.
Morton, H. B.
Moss, E. G. B.
Munro, G. C., Ruatangata
Murdoch, D. L.
Myers, A. M.
Nathan, N. A.
Newton, G. M.
Nicholson, O.
Pabst, Dr.
Paris, Rev. P. R., Invercargill
Partridge, H. E.
Patterson, G. W. S.
Peacock, T.
Petrie, D., F.L.S.
Philcox, W.
Philson, W. W.
Pond, J. A.
Powell, F. E.
Purdy, J. S., M.D.
Pycroft, A. T.
Rangihiroa, Dr.
Reid, J.
Renshaw, F.
Roberton, E., M.D.
Robertson, W. A.
Roche, H., Waihi
Rolfe, W.
Seegner, C.
Segar, Professor H. W.
Shakespear, R. H., Little Barrier Island.
Sharman, E. W., L.R.C.P.
Shaw, H.
Simson, T.
Sinclair, A.
Smeeton, H. M.
Smith, H. G. S.
Smith, S. Percy, F.R.G.S., New Plymouth
Smith, W. H.
Somerville, J. M.
Speight, W. J.
Spencer, W. C. C.
Stewart, J., C.E.
Stopford, R., M.D.
Streeter, S. C.
Stringer, H. G.
Thomas, Professor A. P. W.
Tibbs, J. W.
Tinne, H., London
Upton, J. H.
Urquhart, A. T., Karaka
Vaile, E. E.
Walsh, Archdeacon P.
Waterworth, A.
Ward, P.
Webster, J., Hokianga
Webster, W. G.
Weetman, S., F.R.G.S.
Wells, T. U.
Williams, Right Rev. W. L., Bishop of Waiapu, Napier
Wilson, A. P.
Wilson, W. R.
Withy, E., Rotorua
Wyllie, A., C.E.
Yates, E.
Young, J. L.

PHILOSOPHICAL INSTITUTE OF CANTERBURY.

[* Life members.]

Acland, Dr. H. D.
Adams, T. W.
Adamson, Rev. H.
Allison, H.
Andersen, Johannes C.
Aschmann, C. T., B.A.
Bealey, S.
Beaven, A. W.
Bell, N. M., B.A.
Bevan-Brown, C. E., M.A.
Bernstein, Rev. I. A.
Bishop, F. C. B.
Bishop, R. C.
Blunt, Professor T. G. R., M.A.
Boag, T. D
Booth, G. T.
Bowen, Hon. C. C., M.A., F.R.G.S.
Brauer, H , Ph.D.
Bridges, G. G.
Brooker, F. J.
Brown, Professor Macmillan, M.A., LL.D.*
Bruce, H. A.
Buddo, D., M.P.
Burley, W. E., B.A.
Carlisle, W. J.
Carrington, Rev. C. W., M.A.
Chappell, Rev. A. B., M.A.
Chilton, Prof. C., M.A., D.Sc., M.B., F.L.S.*
Clark, S. A., B.A.
Cockayne, L., Ph.D
Cocks, Rev. P. J., B.A.
Coles, W. R.
Cook, H. D., M.Sc.
Craddock, A. R., B.Sc.
Crooke, Dr. L.
Cross, Miss B. D., B.A.
Cull, J. E. L., B.E.
Cuthbert, E., C.E.
Dash, Charles
Denniston, Mr. Justice
Diamond, Dr.
Drummond, James, F.L.S.
English, R., F.C.S., M.I.M.E.
Enys, J. D.
Evans, Prof. W. P., M.A., Ph.D.
Farr, C. Coleridge, A.M.Inst.C.E.
Farrow, F. D., B.A.
Fisher, J. Bickerton
Florance, D. C. H., M.A.
Flower, A. E., M.A., M.Sc.
Ford, C. R., F.R.G.S.
Foster, T. S., M.A.
Freeman, Miss, B.A.
Garforth, Miss
Gibson, Dr. F. G.
Grant, Miss
Gray, G., F.C.S.
Grigg, J. C. N.
Grimes, Rt. Rev. Bishop, D.D.
Guthrie, Dr. J.
Hall, Mrs. J.
Hallenstein, P. L.
Hansen, B. E., M.Sc.
Hardie, C. D , B.A.
Hight, Dr. J., Litt.D.
Hilgendorf, F. W., M.A., D.Sc.
Hill, Mrs. Carey
Hitchings, F.
Hodgson, T. V., F.L.S.
Hogg, E. G., M.A.
Howell, J. H., B.Sc.
Humphreys, G.
Hutton, Mrs.
Inglis, Dr. H. M.
Ingram, John
Iredale, T.
Irving, Dr. W.
Jackson, T. H., B.A.
Jameson, J. O.
Jamieson, J. S.
Jekyll, H. J. C.
Kaye, A.
Keir, T.
Kidson, E. R., M.Sc.,
Kidson, G. R.
Kirkaldy, G. W.
Kitchingman, Miss, M.A.
Kohn, E.
Laing, R. M., M.A., B.Sc
Laurenson, G., M.P.
Lester, Dr. G.
Lewin, G. A.
Louisson, Hon. C.
Lowrie, W. M., B.A.
Macbeth, N. L.
Mayne, J. B., B.A.
Marshall, Mrs.
McCallum, P., M.Sc.

McKay, R. J.
Mears, H. O. D.
Merton, Mrs. A. J.
Meredith-Kaye, E. K.
Mickle, Mrs.
Mill, Dr. Thomas
Mollett, T. A.*
Molineaux, M.
Moorhouse, Dr. B. M.
Moreland, Rev. C. H., M.A.
Moreland, Mrs., M.B.
Mulgan, E. K., M.A.
Murray-Aynsley, H. P.
Nairn, R.
Olliver, W. R. B.
Olliver, Miss F. M., M.A., B.Sc.
Opie, C. H. A. T.
Page, S., B.Sc.
Pairman, Dr.
Palmer, J.
Patterson, A. M., M.R.C.V.S.
Poulsen, John
Powell, P. H., M.Sc.
Purnell, C. W.
Reece, William
Relph, E. W.
Revell, P.
Rhodes, Capt. R. Heaton, M.P.
Rhodes, A. E. G.
Ritchie, T., B.A.
Rowe, T. W., M.A., LL.B.
Scott, Henry
Scott, J. L.
Scott, Professor R. J., M.Inst.C.E.
Seager, C. A.
Sheard, Miss F., M.A.
Shrimpton, E. A.
Simmers, G. A.
Sims, A., M.A.
Skey, H. F., B.Sc.
Sloman, C. J.
Smith, J. Hartley, M.A.
Snow, Colonel
Speight, R., M.A., B.Sc., F.G.S.
Spiller, J.
Stead, E. F.
Stevenson, Dr. J.
Stone, F.
Symes, Dr. W. H.*
Talbot, Dr. A. G., M.A.
Taylor, A.
Taylor, G. J.
Terry, F. W.
Thomas, Dr. W.*
Thornton, S. W.
Tripp, C. H., M.A.*
Turner, E. Phillips
Waite, Edgar R., F.L.S.
Waller, F. D., B.A.
Wallich, M. G.
Waymouth, F.
Waymouth, Mrs. F.
Weston, G. T., LL.B.
Whitaker, C. Godfrey
Wigley, W. C. H., LL.B.
Wilding, Frank C.
Wilkins, C.
Wilkinson, Miss
Williams, C. J., M.Inst.C.E.
Wilson, Miss
Wright, A. M., F.C.S.
Wright, W. S.

OTAGO INSTITUTE.

[* Life members.]

Alexander, Dr. Edward
Allan, Dr. W., Mosgiel
Allen, James, M.A., M.P.
Armstrong, F.
Barnett, L. E., M.B., F.R.C.S.
Batchelor, F. E., M.D., M.R.C.S.
Bathgate, Alexander*
Bell, A. D., Shag Valley
Benham, Professor W. B., D.Sc., F.R.S.
Black, Alexander*
Black, Professor J. G., D.Sc.
Blair, John
Bowman, John
Braithwaite, Joseph, J.P.
Brent, Daniel, M.A.*
Brown, William
Browne, Robert
Buchanan, N. L., Collingwood*
Burnside, J. A.
Chamberlain, C. W.
Chapman, C. R.
Chapman, Judge F. R.
Chisholm, Robert
Clarke, E. S.
Collier, E. E.
Colquhoun, D., M.D., M.R.C.S.
De Beer, I. S.
Don, J. R., D.Sc.
Duncan, Peter
Evans, Dr. William
Fels, Willi
Fenwick, George
Fergus, Hon. Thomas
Ferguson, H. Lindo, M.D., F.R.C.S.I.
Fisher, Thomas R.
Fitchett, Frank, M.B.
Fulton, Robert, M.D., C.M.
Fulton, S. W., Melbourne*
Gilkison, Robert
Gould, Ven. Archdeacon
Goyen, P., F.L.S.
Graham, Thomas Sherlock
Grave, W. G., Oamaru
Hamilton, A., Wellington*
Hamilton, Harold
Hay, C. W.
Henton, James William
Herbert, E.
Hocken, T. M., M.R.C.S., F.L.S.
Hosking, J. H., K.C.
Howes, G. W., F.E.S.
James, Alfred
Jeffery, James
Johnstone, James Armour
Kempthorne, T. W.
King, F. Truby, M.D., C.M., B.Sc.
Lamb, Tompson
Lee, G.
Livingston, W.
Louden, John
Lusk, T. W.
McKellar, Dr.
McKerrow, James, F.R.A.S.
McKnight, Miss S., M.A., M.Sc.
Macleod, William
McPhee, J. H.
Malcolm, Professor John, M.D.
Marchant, Miss M. E. A., M.A.
Marshall, Professor P., D.Sc., M.A.
Mason, John Blair
Massey, Horatio, Invercargill
Matthews, H. J.
Melland, E., England*
Moore, Dr. Stuart, M.B.
Morrell, W. J., M.A.
Nevill, Most Rev. S. T., D.D.
Nisbet, Rev. Dr.
Ogston, Frank, M.D.
Oliver, F. S.
Park, Professor James
Parr, E. J., M.A., B.Sc.
Payne, Francis William
Petrie, Donald, M.A., F.L.S., Auckland*
Pickerill, Professor
Rawson, G. A.
Reid, Donald, jun.
Richards, Professor D. J., M.A.
Richardson, Charles R. D., M.A.
Riley, Frederick, M.B.
Ritchie, Dr. Russell
Ritchie, J. M.
Roberts, John, C.M.G.
Roberts, W. S., M.R.C.S.
Russell, George Gray
Sargood, Percy R.
Scott, Professor J. H., M.D.
Shacklock, John B.
Shand, Professor J., M.A., LL.D.
Shennan, Watson

Sidey, John
Sim, Judge William A.
Sise, G. L.
Skey, Henry
Smith, Joseph Crosby, Invercargill
Statham, Fr. Hadfield, A.O.S.M.
Stewart, William Downie
Stout, Sir Robert, K.C.M.G., Wellington
Theomin, D.
Thomson, G. M., F.L.S., M.P.*
Thomson, J. C.
Thomson, Robert G.
Trimble, W. H.
Waters, Daniel B., A.O.S.M.
White, David R., M.A.
Whitson, T. W.
Williams, Dr. Ernest
Williams, H. Bradley.
Williams, Judge, M.A., LL.M.*
Woodhouse, J. F.
Young, Dr. James, Invercargill

WESTLAND INSTITUTE.

(No list sent in.)

HAWKE'S BAY PHILOSOPHICAL INSTITUTE.

[* Life members.]

Andrews, E. W.
Antill, H. W., Kumeroa
Asher, Rev. J. A.
Bernau, Dr. H. F.
Burnett, H., Woodville
Chambers, J. B., Te Mata
Chambers, J., Mokopeka
Chambers, W. K., Waerengaahika, Poverty Bay
Clark, Gilbert
Clark, Thomas, Eskdale
Clarkson, R. P., M.A.
Coe, J. W.
Cooper, S. E.
Craig, J. W.
Crawshaw, George
Darton, G., Gisborne
De Lisle, Dr., Hastings
Dinwiddie, P.
Dinwiddie, W.
Donnelly, G. P., Crissoge
Duncan, Russell
Edgar, Dr. J. J.
Guthrie-Smith, H., Tutira
Hall, T.
Hamilton, A., Wellington*
Harding, J. W., Mount Vernon
Henley, Dr. E. A. W.
Hill, H., B.A., F.G.S.
Hislop, J.*
Holder, H. R., Woodville
Holdsworth, J., Havelock N.
Hutchinson, F., jun., Rissington
Hyde, Thomas
Kennedy, Dr., Meeanee
Kerr, W.
Kinder, J., M.A., Gisborne
Large, J. S.*
Large, Miss
Lawry, Rev. A. C.
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