TRANSACTIONS

AND

PROCEEDINGS

OF THE

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TRANSACTIONS

OF THE

NEW ZEALAND INSTITUTE, 1912.

Art. I.—*The Chemistry of Flesh Foods.—(1) The Putrefaction of Flesh Foods; (2) the Ripening of Flesh Foods; (3) the Influence of Cold Storage on the Composition of Flesh Foods.*

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[*Read before the Philosophical Institute of Canterbury, 4th December, 1912.*]

Introduction.

This paper gives the results of a series of experiments that were carried out to determine the character of the changes in the composition of flesh foods during putrefaction, and during the ripening or maturing of meats, in addition to the results secured from a study of the influences of cold storage upon meats held in cold storage at 2° to 19° Fahr. for varying periods up to 160 days.

Historical.

In order to make the problem more intelligible, it is desirable that we should know something of the previous work published on the subject under consideration, and its value in relation to the problems we are now investigating. The following is a brief summary of the hitherto-published scientific work on the influence of cold storage upon flesh. It is only fair to add that much additional work has been recorded, and, without in any way reflecting upon such work, it is obviously the work of men unskilled in close and accurate observation; that they have reached the degree of skill shown is greatly to their credit.

In 1872 M. Tellier found that meat stored at from $-2°$ to $+3°$ C. retained its fresh qualities.

In 1874 Bouley, in using Tellier's process of refrigeration, noted that meat would keep indefinitely at $-2°$ to $+3°$ C. as far as putresibility was concerned, but developed a peculiar fatty odour and taste at the end of two months.

In 1889 Pogzaile confirmed Bouley's conclusions.

In 1889 a Commission appointed by the French Minister of War also confirmed Bouley's work.

In 1892 Grassman observed no harmful change or any loss in nutritive value in pork and beef due to cold storage at temperatures $-2°$ to $-4°$ C.

In 1897 Gautier reported his investigations on mutton and beef stored for five to six months at below zero. He found a slight loss of moisture and increase of peptones and albuminoid material, and by means of artificial-digestion experiments with pepsin found that there was no difference in digestibility between fresh and frozen meats.

In 1900 Glaze stated that the maturation of meat preserved in chilled rooms was due to certain bacteria.

In 1901 C. Mai claimed that, by proper cold storage, putrefactive changes could be prevented, but that the action of enzymes would still continue to some extent, causing the changes which take place in the so-called ripening of meats.

In 1903 Müller reported that if the temperature in cold storage is 2° to 3° C. the maturation of meat due to ferments went on, but putrefaction was prevented.

In 1903 König reported the analyses of chicken meats.

In 1905 Brittels stated that Australasian chilled meats are slightly frozen, and do not compare with American chilled meats.

In 1906 S. Rideal made a report of a chemical investigation carried out for Weddel and Co., England, and concluded from his results, which confirmed an earlier one in 1896, that no incipient decomposition or hydrolysis takes place under cold storage, and that the differences in nutritive value and digestibility of fresh and frozen beef, mutton, and lamb are too slight to be of any economic importance.

In 1906, following the agitation regarding the packing-houses of America, the question relating to the proper preservation of food products was brought before the U.S.A. Congress, and a bacteriological and chemical study of the effect of cold storage upon the wholesomeness of food products was authorized.

In 1906 Grindley reported to the Chicago City Council regarding the refrigerated poultry, and found that it was similar to fresh fowl except in one respect—namely, a characteristic flavour, which was not due to putrefaction, but, as Müller stated, to the ripening of the meat.

In 1906, 1907, and 1908 followed papers by Bird, Eckhard, C. Harringon, Wiley and his associates in the U.S.A. Bureau of Chemistry, and Higley on the effects of cold storage on poultry, eggs, and game.

In 1908 Richardson and Scherubel made histological, bacteriological, and chemical investigations upon fresh beef and beef stored at $-9°$ to $-12°$ C. As the results found by these workers are of great importance in relation to the conditions affecting beef, they will be referred to at greater length than the earlier-recorded results. The histological data showed that the physical changes in frozen meats were due to either the evaporation of the water or to the pressure produced by the expansion in the freezing of the water; that the formed ice which was outside of the cell might produce abrasion of the cell-wall, depending upon the rapidity of the freezing and the subsequent thawing; and that the solidifying point does not occur at any specific temperature, but that it depends upon the soluble solids. From the bacteriological examination it was found that in the freezing the bacteria became surrounded by solid ice barriers through which they could not penetrate, and hence would cease to grow. In the chemical study a comparison of the composition of the frozen sample was made with that of the fresh meat; there appeared to be no general tendency for the free ammonia, coaguable proteids, or the albumoses to increase or decrease, and hence chemically the products of bacterial growth, if there were any, were inappreciable.

The authors concluded from their results that frozen meats can be held in cold storage under proper conditions for a period of 551 days or longer.

It must be noted that in the above investigation the fresh samples were not examined chemically until an average of 3·7 days had elapsed after slaughter, and that in comparing the fresh and frozen results they are from material from different animals. In a second paper Richardson and Scherubel have made a study of beef stored at 2° to 4° C.—that is, above freezing-point. Tests were also made to ascertain whether chemical methods could detect any changes due to known bacterial decomposition of meat. It was found that the total nitrogen, the total solids in the cold-water extract, the coaguable proteids, albumoses, meat-bases, and free ammonia all increased.

The experiments with samples kept at 2° to 4° C. were not, on the whole, satisfactory, but showed that decomposition took place.

In 1909 Emmett and Grindley investigated the effect of cold storage on beef and poultry stored twenty-two to forty-three days, and concluded that the slight changes that occurred did not alter the nutritive value of the meat.

In 1911 Houghton found that chicken meat stored for five months at $-21°$ to $-14°$ C. showed certain physical and chemical changes which demonstrated that it is not identical with the fresh material; they also detected the enzymes peroxydase, catalase, protase similar to trypsin, invertase, and a nitrate-reducing enzyme.

From a review of the above work it would appear that, with the exception of the investigations of Wiley and his associates, Richardson and Scherubel, Emmett and Grindley, and of Houghton, either the conditions as to temperature and methods of preparing meats for cold storage do not correspond with those in common usage of refrigeration, or else in most comparable cases the chemical constituents determined and reported are few; and outside of Emmett and Grindley's and Houghton's work no one, as far as can be discerned, has published any results where fresh and frozen meats were all procured from the same animal, and hence, as far as our present knowledge shows, the differences reported could have been still more, less, or of a different nature, and therefore, outside the work of Emmett and Grindley on beef and of Houghton on poultry, the influence of cold storage upon the chemical composition of flesh has not been definitely determined.

EXPERIMENTAL.

A carcase each of lamb and of mutton, weighing respectively 34 lb. and 48 lb., and graded C.M.C. 2 and 7, was chosen by the author immediately after slaughter; each carcase was split, and, from one half of each, portions of the flesh were removed; the excessive fat was trimmed off, and all bone removed; the portions of the resulting lean meat were finely minced to obtain a uniform sample, and then analysed. The remainder of the carcases were placed in cold storage, and similar samples drawn from time to time up to 160 days, when the experiment ceased.

The methods of analysis used were chosen after careful consideration of the latest literature on the subject; in each determination two or more results were obtained and the average figure recorded.

It was found necessary to determine what changes occurred in fresh meat held at ordinary temperatures to ascertain the effect of ripening on the chemical composition of the meats, no such data for mutton or lamb having hitherto been recorded. With this in view, portions of the meat from the freshly killed material were held at laboratory temperatures for seven days, and examined periodically. It was also necessary to ascertain what changes took place in the known absence of bacterial interference; for this purpose samples of the freshly killed material were mixed with thymol and chloroform to inhibit the growth of bacteria without interfering with enzyme action. Samples of the material thus prepared were examined periodically up to seven days.

Lastly, it was necessary to know what changes take place as the result of known bacterial decomposition, and, as suggested by Richardson and Scherubel, portions of the freshly killed materials were mixed with a putrefying meat-infusion. These materials were kept for fourteen days at laboratory temperatures, and examined periodically.

The chemical results, in addition to being expressed on the basis of the original meat (Table A of each chemical experiment), are also recalculated to the moisture-, ash-, and fat-free basis (Table B of each chemical experiment), because owing to the impossibility of removing exactly the same amount of adhering fat from the meat, and also because of the variations of the moisture-content (which will be discussed later), the results expressed on the basis of the original meat cannot be directly compared as to the chemical changes which have taken place during cold storage. Therefore, in order to put the data on a fair basis for comparison, all the results of the chemical experiments are recalculated to the moisture-, ash-, and fat-free basis. It is needless to say that the variation in the amount of fat found has no bearing on the present investigation, and the figures are used merely as a basis in calculating the results. The amounts of nitrogen found in the cold-water extract are also recalculated in their relation to the total nitrogen (Table C of each chemical experiment) for the purpose of showing more clearly the changes taking place in the nitrogenous constituents of the meats.

Owing to the influence of enzymic activity in animal tissues, the chemical experiments also included the separation and detection of the common enzymes. The results of this examination are shown in Chemical Experiment No. 5. Determinations of the acidity of the fat, both fresh and cold storage, were made, and are recorded in Chemical Experiment No. 6.

Bacteriological experiments were carried out to determine the presence or absence of bacteria on the surface and the interior of both the fresh and frozen materials, and also to determine the influence of cold storage upon bacterial life. The results are shown in Bacteriological Experiments 1, 2, and 3. An examination of the physical appearance and structure of the frozen meats was also made.

Discussion.

The Changes due to Putrefaction.

In order to determine the nature of the changes caused by bacterial decomposition, a series of experiments were carried out to demonstrate these.

The decomposition of flesh by bacterial activity involves putrefaction, which is indicated by the production of ill-smelling compounds and the formation of the simpler organic compounds, and if the changes reach the limit the final products are water, ammonia, and carbon-dioxide. The sulphur and phosphorus will be converted into sulphides and phosphates.

Besides the chemical changes, there will be alteration in the structure of the tissues.

The deterioration of flesh foods is mainly a bacterial process, characterized in its initial stage by the conversion of the proteids insoluble in water into water-soluble ones. The coaguable proteids are converted into proteoses, peptones, meat-bases, and ammonia. This tendency is noticeable almost at the beginning of the bacterial decomposition, the final end of the process being the formation of the simpler compounds, such as ammonia.

To determine the conditions of bacterial decomposition portions of the finely minced lamb and mutton were placed in flasks, mixed with water, and an infusion of putrefying meat was added. The contents of the flasks were examined at the end of two, four, seven, and fourteen days, and the results are shown in Chemical Experiment No. 1 (lamb and mutton), Tables A, B, and C. A consideration of the figures shows a progressive increase in the amounts of soluble matter in the flesh, in the case of the lamb the total solids increasing from 5·18 per cent. to 9·12 per cent., the total soluble nitrogen increasing from 0·708 per cent. to 2·461 per cent.; or if we turn to Table B, which shows the figures calculated to the moisture-, ash-, and fat-free basis, we see that the organic extractives, which include the soluble proteids, increase from 21·4 per cent. to 40·01 per cent.; the total soluble nitrogen, from 3·51 per cent. to 12·31 per cent. Still referring to Table B, which shows the results in a more comparable form, we see that the coaguable proteids increase from 11·14 per cent. to 17·55 per cent., and then decrease to 14·22 per cent. Similar changes are noted in the contents of proteoses and peptones. The amount of meat-bases commences at 4·25 per cent., rises to 5 per cent., and then drops to 1·88 per cent.

It is, however, when we examine the ammonia figures that the most striking alteration in the composition of the material is seen: commencing with 0·158 per cent. ammonia, it increases to 0·51 per cent. on the second day, and to 10·58 per cent. (Table B).

At the very outset, whenever bacterial decomposition occurs, there is a formation of volatile ammonia, and it is to the presence of this constituent in relatively large amounts more than to any other that we must look for evidence of decomposition, incipient or advanced.

Thus we find in the case of the lamb that 75·37 per cent. (Table C) of the total nitrogen has been rendered soluble, as against 21·68 per cent. in the fresh sample; and 53·35 per cent. of the total nitrogen is present in the ammonia, as against 0·80 per cent. in the fresh sample. Similar results are noted in the case of the mutton, the ammonia, commencing at 0·173 per cent. (Table B) in the fresh sample, increases to 10 per cent. after fourteen days, while 78·98 per cent. (Table C) of the total nitrogen is soluble at the end of fourteen days, whereas 23·20 per cent. was soluble in the fresh material, the percentage of nitrogen as ammonia rising from 0·91 per cent. to 52·69 per cent. of the total nitrogen in fourteen days.

We thus have before us a definite study of the changes we may expect when bacterial decomposition ensues.

Chemical Experiment No. 1 (Lamb).

Days.	Moisture.	Ash.	Fat.	Total Nitrogen.	Cold-water Extract. Total Solids.	Ash.	Organic Extractives.	Total Nitrogen.	Coagulable Proteids.	Proteoses.	Peptones.	Meat-bases.	Ammonia.	Acidity as Lactic Acid.
Table A.—Figures on Basis of Original Meat.														
0	73·68	1·08	5·29	3·265	5·18	0·91	4·27	0·708	2·22	0·26	0·07	0·85	0·031	0·54
2	..	..	..	..	5·92	0·98	4·94	0·926	2·67	0·34	0·22	1·00	0·106	..
4	..	..	..	..	7·20	1·14	6·06	1·120	3·51	0·64	0·30	0·50	0·299	..
7	..	..	..	..	8·62	1·10	7·52	2·164	3·01	0·70	0·15	0·39	1·73	..
14	..	..	..	..	9·12	1·12	8·00	2·461	2·83	0·68	0·24	0·34	2·12	..
Table B.—Figures calculated to Moisture-, Ash-, and Fat-free Basis.														
0	..	..	..	..	..	..	21·40	3·54	11·14	1·31	0·38	4·25	0·158	..
2	..	..	..	..	..	..	24·69	4·63	13·38	1·69	1·12	5·00	0·51	..
4	..	..	..	..	..	..	30·45	5·60	17·55	3·19	1·51	2·50	1·49	..
7	..	..	..	..	..	..	37·71	10·82	15·05	3·50	0·75	1·97	8·64	..
14	..	..	..	..	..	..	40·01	12·31	14·22	3·39	1·19	1·88	10·58	..
Table C.—Nitrogen Figures as Percentages of Total Nitrogen.														
0	..	..	..	..	..	..	..	21·68	10·90	1·28	0·37	8·33	0·80	..
2	..	..	..	..	..	..	..	28·63	13·11	1·65	1·10	9·87	2·63	..
4	..	..	..	..	..	..	..	34·30	17·20	3·13	1·47	4·96	7·54	..
7	..	..	..	..	..	..	..	66·27	14·76	3·43	0·73	3·86	43·49	..
14	..	..	..	..	..	..	..	75·37	13·87	3·31	1·16	3·68	53·35	..

The above results show the changes in composition of lamb due to putrefaction.

Chemical Experiment No. 1 (Mutton).

Days.	Moisture.	Ash.	Fat.	Total Nitrogen.	Cold-water Extract. Total Solids.	Ash.	Organic Extractives.	Total Nitrogen.	Coagulable Proteids.	Proteoses.	Peptones.	Meat-bases.	Ammonia.	Acidity as Lactic Acid.
Table A.—Figures on Basis of Original Meat.														
0	71·49	1·04	7·00	3·198	5·16	0·80	4·36	0·742	2·40	0·35	0·09	0·81	0·036	0·61
2	..	..	..	..	5·87	0·92	4·95	0·931	2·76	0·38	0·16	0·98	0·109	..
4	..	..	..	..	7·04	1·10	5·94	1·098	3·76	0·77	0·32	0·15	0·329	..
7	..	..	..	..	8·52	1·04	7·48	2·224	3·82	0·61	0·24	0·39	1·64	..
14	..	..	..	..	9·46	1·08	8·38	2·526	3·53	0·71	0·25	0·38	2·03	..
Table B.—Figures calculated to Moisture-, Ash-, and Fat-free Basis.														
0	..	..	..	..	..	..	21·29	3·62	11·67	1·71	0·42	4·00	0·173	..
2	..	..	..	..	..	..	24·14	4·54	13·43	1·86	0·77	4·78	0·534	..
4	..	..	..	..	..	..	28·98	5·35	18·34	3·79	1·58	0·75	1·600	..
7	..	..	..	..	..	..	36·49	10·85	18·60	2·99	1·16	1·90	8·010	..
14	..	..	..	..	..	..	40·88	12·32	17·20	3·47	1·22	1·86	10·00	..
Table C.—Nitrogen Figures as Percentages of Total Nitrogen.														
0	..	..	..	..	..	..	..	23·20	11·97	1·75	0·44	8·13	0·91	..
2	..	..	..	..	..	..	..	29·04	13·81	1·91	0·78	9·78	2·81	..
4	..	..	..	..	..	..	..	34·31	18·81	3·88	1·62	1·53	8·47	..
7	..	..	..	..	..	..	..	69·50	19·13	3·06	1·19	3·90	42·22	..
14	..	..	..	..	..	..	..	78·98	17·62	3·56	1·25	3·81	52·69	..

The above results show the changes in the composition of mutton due to putrefaction.

The Changes due to the Ripening of Meat.

In order to study the effect of the process of ripening upon meat, experiments were carried out to determine the changes occurring during seven days when the meat was held at laboratory temperatures in flasks, the meat being examined at the end of one, two, three, five, and seven days. The results are shown as Chemical Experiment No. 2, Tables A, B, and C.

In the case of lamb we find a progressive increase of the organic extractives and soluble nitrogen, as shown in Table B. These increase from 21·4 per cent. to 26·21 per cent., and from 3·54 per cent. to 4·42 per cent. respectively. From the same table we see that the coaguable proteids decrease from 11·14 per cent. to 8·86 per cent. on the third day, followed by an increase to 12·25 per cent. on the seventh day. The proteoses increase from 1·31 per cent. to 2·62 per cent.; the peptones increase from 0·38 per cent. to 1·31 per cent. and then fall to 0·68 per cent.; the meat-bases increase from 4·25 per cent. to 5·57 per cent. on the third day, and then fall to 5·07 per cent. on the seventh day. The amount of ammonia remains fairly constant till the third day, and then increases considerably, and on the seventh day there is 0·360 per cent.

In the main, similar changes take place in the mutton, and it is concluded that certain progressive changes due to the ripening of the meat take place up till the third day, and then, owing to the increase of bacteria, incipient decomposition takes place. This is evidenced by the marked increase of the ammonia, organic extractives, and coaguable proteids, and the decrease of the meat-bases after the third day.

Changes due to bacterial influence were to be expected, as under normal conditions bacterial infection will take place in all meat unless specially guarded against.

CHEMICAL EXPERIMENT NO 2 (LAMB).

Days.	Moisture.	Ash.	Fat.	Total Nitrogen.	Cold-water Extract.									
					Total Solids.	Ash.	Organic Extractives.	Total Nitrogen.	Coagulable Proteids.	Proteoses.	Peptones.	Meat-bases.	Ammonia.	Acidity as Lactic Acid.
Table A.—Figures on Basis of Original Meat.														
0	73·68	1·08	5·29	3·265	5·18	0·91	4·27	0·708	2·22	0·26	0·07	0·85	0·031	0·54
1	..	..	..	..	5·26	0·90	4·36	0·712	2·15	0·31	0·10	0·85	0·034	..
2	..	..	..	..	5·42	0·93	4·49	0·726	1·90	0·34	0·25	0·94	0·031	..
3	..	..	..	..	5·60	0·98	4·62	0·758	1·76	0·35	0·22	1·11	0·032	..
5	..	..	..	..	5·86	1·02	4·84	0·798	2·02	0·41	0·26	1·03	0·046	..
7	..	..	..	..	6·24	1·01	5·23	0·884	2·45	0·53	0·14	1·01	0·075	..
Table B.—Figures calculated to Moisture-, Ash-, and Fat-free Basis.														
0	..	..	..	..	..	..	21·40	3·54	11·14	1·31	0·38	4·25	0·158	..
1	..	..	..	..	..	..	21·81	3·56	10·75	1·58	0·53	4·25	0·183	..
2	..	..	..	..	..	..	22·57	3·63	9·48	1·70	1·27	4·72	0·159	..
3	..	..	..	..	..	..	23·13	3·79	8·86	1·76	1·14	5·57	0·164	..
5	..	..	..	..	..	..	24·21	3·99	10·12	2·06	1·31	5·13	0·232	..
7	..	..	..	..	..	..	26·21	4·42	12·25	2·62	0·68	5·07	0·360	..

Chemical Experiment No. 2 (Lamb)—*continued.*

Days.	Moisture.	Ash.	Fat.	Total Nitrogen.	Cold-water Extract.									
					Total Solids.	Ash.	Organic Extractives.	Total Nitrogen.	Coagulable Proteids.	Proteoses.	Peptones.	Meat-bases.	Ammonia.	Acidity as Lactic Acid.
Table C.—Nitrogen Figures as Percentages of Total Nitrogen.														
0	..	..	..	..	..	..	..	21·68	10·90	1·28	0·37	8·33	0·80	..
1	..	..	..	..	..	..	..	21·81	10·53	1·53	0·52	8·36	0·86	..
2	..	..	..	..	..	..	..	22·23	9·31	1·65	1·22	9·25	0·80	..
3	..	..	..	..	..	..	..	23·20	8·64	1·71	1·10	10·93	0·82	..
5	..	..	..	..	..	..	..	24·44	9·92	2·02	1·28	10·05	1·17	..
7	..	..	..	..	..	..	..	27·07	12·00	2·57	0·68	9·92	1·90	..

The above results show the changes in the composition of lamb due to the ripening of meat.

Chemical Experiment No. 2 (Mutton).

Days.	Moisture.	Ash.	Fat.	Total Nitrogen.	Cold-water Extract.									
					Total Solids.	Ash.	Organic Extractives.	Total Nitrogen.	Coagulable Proteids.	Proteoses.	Peptones.	Meat-bases.	Ammonia.	Acidity as Lactic Acid.
Table A.—Figures on Basis of Original Meat.														
0	71·49	1·04	7·00	3·198	5·16	0·80	4·36	0·742	2·40	0·35	0·09	0·81	0·036	0·61
1	..	..	..	..	5·32	0·84	4·48	0·760	2·38	0·34	0·13	0·87	0·034	..
2	..	..	..	..	5·38	0·82	4·56	0·772	2·10	0·39	0·23	0·96	0·037	..
3	..	..	..	..	5·76	0·86	4·90	0·803	1·75	0·39	0·30	1·20	0·032	..
5	..	..	..	..	6·06	1·00	5·06	0·886	2·30	0·34	0·35	1·14	0·051	..
7	..	..	..	..	6·42	1·04	5·38	0·928	2·66	0·40	0·32	0·94	0·102	..
Table B.—Figures calculated to Moisture-, Ash-, and Fat-free Basis.														
0	..	..	..	..	..	..	21·29	3·62	11·67	1·71	0·42	4·00	0·173	..
1	..	..	..	..	..	..	21·85	3·71	11·58	1·64	0·64	4·21	0·172	..
2	..	..	..	..	..	..	22·24	3·76	10·27	1·88	1·12	4·65	0·177	..
3	..	..	..	..	..	..	23·90	3·91	8·51	1·88	1·46	5·83	0·159	..
5	..	..	..	..	..	..	24·68	4·32	11·23	1·64	1·71	5·57	0·249	..
7	..	..	..	..	..	..	26·24	4·52	12·99	1·95	1·58	4·60	0·498	..
Table C.—Nitrogen Figures as Percentages of Total Nitrogen.														
0	..	..	..	..	..	..	..	23·20	11·97	1·75	0·44	8·13	0·91	..
1	..	..	..	..	..	..	..	23·75	11·88	1·69	0·65	8·65	0·88	..
2	..	..	..	..	..	..	..	24·12	10·50	1·94	1·15	9·59	0·94	..
3	..	..	..	..	..	..	..	25·09	8·75	1·94	1·50	12·06	0·84	..
5	..	..	..	..	..	..	..	27·69	11·50	1·69	1·75	11·44	1·31	..
7	..	..	..	..	..	..	..	29·00	13·31	2·00	1·63	9·44	2·62	..

The above results show the changes in the composition of mutton due to the ripening of meat.

The Changes due to the Ripening of Meat in the Absence of Bacterial Interference.

In Chemical Experiment No. 3 portions of the minced meat were treated with a mixture of thymol and chloroform to inhibit bacterial action, and the changes due to the ripening of meat allowed to proceed in the known absence of bacterial interference. (Bacteriological Experiment No. 2 shows this.)

Referring to Chemical Experiment No. 3, Tables A, B, and C, we find in the case of the lamb that there is a progressive increase of the organic extractives for three days (see Table B) from 21·4 per cent. to 23·35 per cent., then a drop to 23·10 per cent. and an increase to 23·50 per cent. The total soluble nitrogen increases from 3·54 per cent. to 3·86 per cent. on the fifth day, and then falls to 3·82 per cent. Throughout the experiment changes occur which reach a maximum between the third and fifth days, and the figures remain stationary or slightly revert. It is noted especially that the amounts of ammonia remain about the same throughout, there being no increase which can be attributed to bacterial influence. Similar results are found in the case of the mutton.

It is therefore concluded that during the ripening of meat, in the absence of bacterial infection, changes involving the increase of the organic extractives, soluble nitrogen, meat-bases, proteoses, and peptones, and a decrease of the coaguable proteids take place to between the third and fifth days, and then further changes cease.

CHEMICAL EXPERIMENT NO. 3 (LAMB).

					Cold-water Extract.									
Days.	Moisture.	Ash.	Fat.	Total Nitrogen.	Total Solids.	Ash.	Organic Extractives.	Total Nitrogen.	Coaguable Proteids.	Proteoses.	Peptones.	Meat-bases.	Ammonia.	Acidity as Lactic Acid.
Table A.—Figures on Basis of Original Meat.														
0	73·68	1·08	5·29	3·265	5·18	0·91	4·27	0·708	2·22	0·26	0·07	0·85	0·031	0·5
1	..	..	..	..	5·24	0·91	4·33	0·714	2·12	0·31	0·14	0·84	0·037	..
2	..	..	..	..	5·36	0·90	4·46	0·730	2·01	0·38	0·24	0·89	0·031	..
3	..	..	..	..	5·68	1·01	4·67	0·764	1·82	0·34	0·24	1·09	0·038	..
5	..	..	..	..	5·62	1·00	4·62	0·770	1·80	0·36	0·25	1·11	0·036	..
7	..	..	..	..	5·72	1·02	4·70	0·764	1·81	0·38	0·21	1·09	0·038	..
Table B.—Figures calculated to Moisture-, Ash-, and Fat-free Basis.														
0	..	..	..	..	..	..	21·40	3·54	11·14	1·31	0·38	4·25	0·158	..
1	..	..	..	..	..	..	21·65	3·57	10·62	1·59	0·73	4·21	0·183	..
2	..	..	..	..	..	..	22·30	3·66	10·09	1·88	1·18	4·47	0·158	..
3	..	..	..	..	..	..	23·35	3·82	9·12	1·68	1·18	5·48	0·188	..
5	..	..	..	..	..	..	23·10	3·86	8·98	1·81	1·25	5·57	0·176	..
7	..	..	..	..	..	..	23·50	3·82	9·04	1·94	1·06	5·44	0·188	..

CHEMICAL EXPERIMENT NO. 3 (LAMB)—*continued.*

Days.	Moisture.	Ash.	Fat.	Total Nitrogen.	Cold-water Extract.									
					Total Solids.	Ash.	Organic Extractives.	Total Nitrogen.	Coagulable Proteids.	Proteoses.	Peptones.	Meat-bases.	Ammonia.	Acidity as Lactic Acid.
							Table C.—Nitrogen Figures as Percentages of Total Nitrogen.							
0	..	..	..	..	..	..	..	21·68	10·90	1·28	0·37	8·33	0·80	..
1	..	..	..	..	..	..	..	21·87	10·41	1·56	0·71	8·27	0·92	..
2	..	..	..	..	..	..	..	22·35	9·84	1·84	1·14	8·73	0·80	..
3	..	..	..	..	..	..	..	23·39	8·94	1·65	1·16	10·69	0·95	..
5	..	..	..	..	..	..	..	23·58	8·82	1·78	1·22	10·87	0·89	..
7	..	..	..	..	..	..	..	23·39	8·88	1·87	1·04	10·65	0·95	..

The above results show the changes in the composition of lamb due o the ripening of meat in the absence of bacterial interference.

CHEMICAL EXPERIMENT NO. 3 (MUTTON).

Days.	Moisture.	Ash.	Fat.	Total Nitrogen.	Cold-water Extract.									
					Total Solids.	Ash.	Organic Extractives.	Total Nitrogen.	Coagulable Proteids.	Proteoses.	Peptones.	Meat-bases.	Ammonia.	Acidity as Lactic Acid.
							Table A.—Figures on Basis of Original Meat.							
0	71·49	1·04	7·00	3·198	5·16	0·80	4·36	0·742	2·40	0·35	0·09	0·81	0·036	0·61
1	..	..	..	..	5·30	0·86	4·44	0·752	2·44	0·32	0·19	0·79	0·032	..
2	..	..	..	..	5·42	0·90	4·52	0·780	2·03	0·36	0·26	1·01	0·038	..
3	..	..	..	..	5·80	0·91	4·89	0·810	1·71	0·40	0·20	1·28	0·037	..
7	..	..	..	..	5·90	1·02	4·88	0·806	1·76	0·35	0·24	1·25	0·037	..
							Table B.—Figures calculated to Moisture-, Ash-, and Fat-free Basis.							
0	..	..	..	..	..	..	21·29	3·62	11·67	1·71	0·42	4·00	0·173	..
1	..	..	..	..	..	..	21·66	3·66	12·72	1·58	0·91	3·83	0·159	..
2	..	..	..	..	..	..	22·05	3·80	9·88	1·77	1·28	4·92	0·183	..
3	..	..	..	..	..	..	23·85	3·95	8·38	1·95	0·97	6·23	0·177	..
7	..	..	..	..	..	..	23·80	3·93	8·60	1·71	1·16	6·10	0·177	..
							Table C.—Nitrogen Figures as Percentages of Total Nitrogen.							
0	..	..	..	..	..	..	..	23·20	11·97	1·75	0·44	8·13	0·91	..
1	..	..	..	..	..	..	..	23·50	12·22	1·62	0·94	7·88	0·84	..
2	..	..	..	..	..	..	..	24·37	10·12	1·81	1·31	10·16	0·97	..
3	..	..	..	..	..	..	..	25·31	8·56	2·00	1·00	12·81	0·94	..
7	..	..	..	..	..	..	..	25·18	8·84	1·75	1·18	12·50	0·94	..

The above results show the changes in the composition of mutton due to the ripening of meat in the absence of bacterial interference.

The Changes occurring during Cold Storage.

With the previously recorded data regarding the putrefaction of and ripening of meats, it is now possible to consider the nature of the changes which take place during cold storage, and to determine the causes thereof. These are shown as Chemical Experiment No. 4, Tables A, B, and C.

Moisture.—In the case of both the mutton and the lamb there is a progressive decrease in the moisture-contents, the lamb from 73·68 per cent. to 70·08 per cent., the mutton from 71·49 per cent. to 69·06 per cent. This calls for little comment, although it is not in agreement with the results on beef found by Richardson and Scherubel, who report neither gain nor loss of moisture in the cold-stored samples. Emmett and Grindley, on the other hand, report differences from 0 per cent. to 1·30 per cent. lost during a thirty-seven days' experiment on beef. It should be noted in this connection that the desiccation or otherwise will depend very largely upon the humidity of the air of the chamber in which the meats are stored.

Ash.—This varies from 1·08 per cent. to 1·19 per cent. in the lamb, and from 1·04 per cent. to 1·23 per cent. in the mutton. Potassium-phosphate and probably the secondary potassium-phosphate are the chief constituents of the ash. The ash-contents are in general agreement, and call for no special comment. It is not expected that cold storage would materially affect the ash-content of meats.

Fat.—As is to be expected, this varies more than any other constituent, it being impossible to quantitatively separate all the adhering fat by trimming away the fatty tissue in preparing the meats for analysis. As has already been pointed out, the amount of fat found has no bearing upon the present investigation.

Total Nitrogen.—This varies with the proportion of moisture-, ash-, and fat-free material, and when calculated to this basis shows reasonably constant results.

Total Solids in the Cold-water Extract.—The figure for these results is the total of the organic extractives, and the ash constitituents soluble in cold water; and, as the figures for the ash soluble in water are in close agreement, we need consider only the organic extractives present.

Organic Extractives. — In order to fairly compare these figures it is necessary to refer to Table B, where the results are calculated to the moisture-, ash-, and fat-free basis. Thus, in the case of the lamb the organic extractives increase from 21·4 per cent. to 23·35 per cent. in sixty days, followed by a slight fall, which recovers to 23·57 per cent. on the 160th day. Similar results are noted in the case of the mutton, but it is noted that the organic extractives progressively increase throughout the 160 days from 21·29 per cent. to 23·50 per cent., but reach 23·37 per cent. on the 90th day.

Total Soluble Nitrogen.—For lamb a progressive increase from 3·54 per cent. to 3·85 per cent. on the 60th day, followed by a fall and subsequent rise. In the case of the mutton the increase from 3·62 per cent. reaches its maximum on the 120th day with 4 per cent., although 3·97 per cent., a very close result to the former, is found on the 90th day. In the main the figures for the total soluble nitrogen follow those of the organic extractives.

Coaguable Proteids.—These decrease for the lamb from 11·14 per cent. to 8·51 per cent. on the 90th day, followed by a negligible rise thereafter; in the mutton we find a decrease from 11·67 per cent. to 8·55 per cent. on the 120th day, followed by a rise at the 160th day.

Proteoses.—The lamb shows an increase from 1·31 per cent. to 1·77 per cent. on the 60th day, followed by a slight fall and subsequent rise;

similarly, the mutton figures increase, and reach their maximum on the 120th day, with 2·24 per cent.

Peptones.—For the lamb we note a rise from 0·38 per cent. to 1·39 per cent. on the 90th day, followed by a decrease and a subsequent rise on the 160th day to 1·53 per cent. The mutton figures show the maximum at the 120th day, although the figure for the 90th day is approximately the same.

Meat-bases.—A progressive rise for the lamb from 4·25 per cent. to 5·70 per cent. on the 60th day is found followed by a slight subsequent fall and rise. For the mutton the maximum increase is reached on the 120th day, with a subsequent fall.

Ammonia.—As previously pointed out, it is to this figure we look for indication of bacterial decomposition, and, while there are slight variations, no change in composition is indicated thereby, and consequently no bacterial decomposition is found in either the lamb or mutton from 0 to 160 days' cold storage.

Acidity.—While some slight degree of variation is noted in these figures, they are slight, and the figures do not rise or fall progressively. Little importance is attached to this figure.

It is concluded from a consideration of the data secured in this experiment that changes similar to those found in the ripening of meat, in the absence of bacterial interference, take place; in the case of the lamb they reach the maximum in about sixty days, while with the mutton the maximum is not reached until between the 90th and the 120th days.

The changes found are probably due to enzyme action, for, as will be shown in the bacteriological experiments, there is little possibility of bacterial infection or decomposition.

Chemical Experiment No. 4 (Lamb).

Table A.—Figures on Basis of Original Meat.

Days.	Moisture.	Ash.	Fat.	Total Nitrogen.	Cold-water Extract.									
					Total Solids.	Ash.	Organic Extractives.	Total Nitrogen.	Coagulable Proteids.	Proteoses.	Peptones.	Meat-bases.	Ammonia.	Acidity as Lactic Acid.
0	73·68	1·08	5·29	3·265	5·18	0·91	4·27	0·708	2·22	0·26	0·07	0·83	0·031	0·54
14	72·70	1·12	4·52	3·545	5·70	0·96	4·74	0·772	2·10	0·35	0·17	1·01	0·032	0·62
28	73·30	1·12	4·74	3·525	5·86	0·94	4·92	0·812	1·99	0·38	0·30	1·12	0·034	0·62
60	72·54	1·17	5·82	3·366	5·68	0·90	4·78	0·789	1·80	0·36	0·26	1·17	0·032	0·60
90	70·24	1·14	4·86	3·839	6·52	1·08	5·44	0·898	2·02	0·40	0·33	1·33	0·034	0·69
120	70·36	1·19	4·92	3·618	6·24	1·06	5·18	0·856	1·93	0·38	0·29	1·29	0·034	0·66
160	70·08	1·16	5·04	3·866	6·58	1·09	5·49	0·907	2·05	0·41	0·35	1·33	0·038	0·66

Table B.—Figures calculated to Moisture-, Ash-, and Fat-free Basis.

Days.	Moisture.	Ash.	Fat.	Total Nitrogen.	Total Solids.	Ash.	Organic Extractives.	Total Nitrogen.	Coagulable Proteids.	Proteoses.	Peptones.	Meat-bases.	Ammonia.	Acidity as Lactic Acid.
0	..	..	..	16·36	..	..	21·40	3·54	11·14	1·31	0·38	4·25	0·158	2·71
14	..	..	..	16·37	..	..	21·88	3·56	9·70	1·61	0·81	4·70	0·150	2·86
28	..	..	..	16·14	..	..	22·52	3·71	9·13	1·66	1·37	5·13	0·155	2·84
60	..	..	..	16·44	..	..	23·35	3·85	8·86	1·77	1·28	5·70	0·160	2·93
90	..	..	..	16·16	..	..	22·89	3·77	8·51	1·71	1·39	5·61	0·143	2·90
120	..	..	..	16·06	..	..	22·99	3·80	8·55	1·66	1·27	5·75	0·150	2·93
160	..	..	..	16·30	..	..	23·57	3·82	8·60	1·74	1·53	5·57	0·159	2·78

CHEMICAL EXPERIMENT NO. 4 (LAMB)—*continued.*

Days.	Moisture.	Ash.	Fat.	Total Nitrogen.	Cold-water Extract.									
					Total Solids.	Ash.	Organic Extractives.	Total Nitrogen.	Coagulable Proteids.	Proteoses.	Peptones.	Meat-bases.	Ammonia.	Acidity as Lactic Acid.
Table C.—Nitrogen Figures as Percentages of Total Nitrogen.														
0	..	..	..	..	..	..	..	21·68	10·90	1·28	0·37	8·33	0·80	..
14	..	..	..	..	..	..	..	21·80	9·47	1·58	0·79	9·17	0·79	..
28	..	..	..	..	..	..	..	23·03	9·02	1·70	1·36	10·15	0·80	..
60	..	..	..	..	..	..	..	23·44	8·56	1·72	1·25	11·11	0·80	..
90	..	..	..	..	..	..	..	23·39	8·44	1·69	1·38	11·15	0·73	..
120	..	..	..	..	..	..	..	23·65	8·52	1·65	1·27	11·44	0·77	..
160	..	..	..	..	..	..	..	23·46	8·49	1·70	1·45	11·02	0·80	..

The above results show the changes in the composition of lamb occurring during cold storage.

CHEMICAL EXPERIMENT NO. 4 (MUTTON).

Days.	Moisture.	Ash.	Fat.	Total Nitrogen.	Cold-water Extract.									
					Total Solids.	Ash.	Organic Extractives.	Total Nitrogen.	Coagulable Proteids.	Proteoses.	Peptones.	Meat-bases.	Ammonia.	Acidity as Lactic Acid.
Table A.—Figures on Basis of Original Meat.														
0	71·49	1·04	7·00	3·198	5·16	0·80	4·36	0·742	2·40	0·35	0·09	0·81	0·036	0·61
14	71·68	1·04	5·27	3·552	5·63	0·85	4·78	0·812	2·24	0·42	0·17	1·03	0·034	0·65
28	70·64	1·16	5·42	3·662	5·80	0·82	4·98	0·848	2·18	0·44	0·24	1·12	0·038	0·66
60	69·26	1·21	6·38	3·710	6·13	0·91	5·22	0·887	2·14	0·48	0·26	1·23	0·038	0·65
90	69·86	1·20	4·98	3·895	6·62	1·02	5·60	0·952	2·11	0·53	0·34	1·40	0·036	0·69
120	68·98	1·23	5·24	3·986	6·79	1·01	5·78	0·983	2·09	0·55	0·44	1·47	0·039	0·74
160	69·06	1·18	6·02	3·779	6·52	0·94	5·58	0·948	2·16	0·50	0·31	1·38	0·037	0·68
Table B.—Figures calculated to Moisture-, Ash-, and Fat-free Basis.														
0	..	..	..	15·62	..	..	21·29	3·62	11·67	1·71	0·42	4·00	0·173	2·98
14	..	..	..	16·14	..	..	21·71	3·69	10·18	1·93	0·79	4·70	0·154	2·95
28	..	..	..	16·08	..	..	21·86	3·72	9·48	1·95	1·03	4·93	0·163	2·90
60	..	..	..	16·03	..	..	22·54	3·83	9·26	2·07	1·13	5·31	0·165	2·81
90	..	..	..	16·26	..	..	23·37	3·97	8·78	2·18	1·40	5·83	0·147	2·88
120	..	..	..	16·21	..	..	23·51	4·00	8·55	2·24	1·43	6·01	0·158	3·02
160	..	..	..	15·96	..	..	23·50	3·99	9·04	2·11	1·31	5·80	0·154	2·87
Table C.—Nitrogen Figures as Percentages of Total Nitrogen.														
0	..	..	..	..	..	..	..	23·20	11·97	1·75	0·44	8·13	0·91	..
14	..	..	..	..	..	..	..	22·86	10·08	1·91	0·79	9·29	0·79	..
28	..	..	..	..	..	..	..	23·16	9·50	1·94	1·04	9·83	0·85	..
60	..	..	..	..	..	..	..	23·90	9·25	2·07	1·13	10·62	0·83	..
90	..	..	..	..	..	..	..	24·44	8·65	2·16	1·39	11·50	0·74	..
120	..	..	..	..	..	..	..	24·66	8·40	2·21	1·41	11·84	0·80	..
160	..	..	..	..	..	..	..	25·08	9·16	2·12	1·32	11·69	0·79	..

The above results show the changes in the composition of mutton occurring during cold storage.

Chemical Experiment No. 5.—For Detection of Enzymes.

Dr. Rideal, in a paper before the first Refrigeration Congress, suggests that the tenderness and maturing of cold-storage meats are due to the gradual and limited work of natural enzymes, such as pepsin and trypsin, present in the flesh, which cause a certain amount of predigestion similar to that occurring when fresh meats are kept or "hung." In the chemical experiments under review the enzymes detected were peroxydase, catalase, and an enzyme similar to trypsin, a protase. These were found in both the mutton and lamb from 0 to 160 days in cold storage, and were also found in the thymol- and chloroform-treated material.

Negative results were found in testing for invertase, lipase, and diastase.

Importance is attached to these results, for while enzyme activity goes on slowly at low temperatures, yet the action is not prevented by cold, and undoubtedly the changes found in cold-storage meats are due to the action of the enzymes, especially the trypsin-like protase. The experiments are recorded as Chemical Experiment No. 5.

CHEMICAL EXPERIMENT NO. 5.—FOR DETECTION OF ENZYMES.

Days in Cold Storage.	——	Peroxydase.	Catalase.	Protase similar to Trypsin.	Invertase.	Lipase.	Diastase.
0	Lamb	×	×	×	—	—	—
0	Mutton	×	×	×	—	—	—
60	Lamb	×	×	×	—	—	—
60	Mutton	×	×	×	—	—	—
160	Lamb	×	×	×	—	—	—
160	Mutton	×	×	×	—	—	—
0 thymol and chloroform	Lamb	×	×	×	—	—	—
Treated seven days	Mutton	×	×	×	—	—	—

× = present. — = absent.

Chemical Experiment No. 6.—To determine the Acidity of the Fat.

The development of acidity in fat is a delicate indication of the decomposition of flesh, and one that can be observed long before the senses can detect any alteration. Applying this test to the fat of the mutton and lamb, we find from the results shown in Chemical Experiment No. 6 that no material rise in the free fatty acidity is observed; consequently we can infer that no decomposition has taken place.

CHEMICAL EXPERIMENT NO. 6.—SHOWING ACIDITY OF FATS.

Days in Cold Storage.	——	Acidity as Oleic Acid.	
		Per Cent.	Per Cent.
0	Lamb	0·22	
0	Mutton	..	0·26
14	Lamb	0·24	
14	Mutton	..	0·26

CHEMICAL EXPERIMENT NO. 6.—SHOWING ACIDITY OF FATS—*continued.*

Days in Cold Storage.	——	Acidity as Oleic Acid.	
		Per Cent.	Per Cent.
28	Lamb	0·24	
28	Mutton	..	0·28
60	Lamb	0·24	
60	Mutton		0·26
90	Lamb	0·28	
90	Mutton	..	0·28
120	Lamb	0·26	
120	Mutton	..	0·28
160	Lamb	0·28	
160	Mutton	..	0·30

Bacteriological Experiments.

It is now recognized that the flesh of healthy animals is free from bacteria, but as soon as death ensues, if no measures are taken to guard against bacterial infection, the flesh becomes a suitable field for bacterial invasion and growth.

As bacteria are almost universally present in the air, it is expected that on the surface of meat there will be found bacteria, and that if the meat is allowed to remain unprotected the bacteria will spread to the interior of the meat.

The method of the experiments was to remove portions of the meat from the surface and the interior, using every precaution to prevent contamination. The portions of meat so removed were dropped into flasks containing sterilized bouillon, which were carefully sealed and incubated at 21° C. for fourteen days. These were examined from time to time, and a note made when growth was found to have occurred. In the event of no growth at the end of fourteen days, the contents of the flask were contaminated artificially to show that bacterial growth was possible.

Bacteriological Experiment No. 1 was carried out with fresh lamb and mutton, to determine how soon the bacteria, which were invariably present on the exterior of the meat, could penetrate to the interior of the meat, which was previously found to be free from bacterial infection. It was found that in from five days in the case of lamb to seven days in the case of mutton bacteria could invade the interior of meat when exposed to ordinary temperatures.

Bacteriological Experiment No. 2 was carried out to verify the absence of bacterial infection in the meat used for Chemical Experiment No. 3, where the ripening of meat was allowed to proceed in the known absence of bacteria. In no case did bacteria develop, although it was shown that after contamination the bouillon was a suitable medium for bacterial development.

Bacteriological Experiment No. 3 was carried out to ascertain whether bacterial growth and invasion of the interior of the meat proceeded during cold storage.

In every case it was found that the surface of the meat, even after 160 days of cold storage, was infected with bacteria, but that the interior was free from bacterial infection. Certainly in two cases the experiments show that bacteria developed in the culture-flasks, but in view of the other results it is probable that accidental contamination took place in spite of the care taken to prevent such. It is the general testimony of other investigators that perfect technique in bacteriological work is extremely difficult, and that the obtaining of cultures does not necessarily prove the presence of bacteria in the material examined.

The cultures which showed no growth at the end of fourteen days were, as already indicated, contaminated to show the possibility of growth, and in no case did they fail to show bacterial growth under these conditions. The conclusion arrived at is that the meats held in cold storage as described up to 160 days are in the same condition bacterially as the fresh meats.

Bacteriological Experiment No. 1.—On Fresh Lamb and Mutton.

(Temperature of incubation, 21° C.)

Age of Meat in Days.	——	Growth Days.							After Exposure.
		1	2	3	5	7	10	14	
0	Lamb (surface) ..	—	×	×	×	×	×	×	×
0	Mutton ,, ..	—	×	×	×	×	×	×	×
0	Lamb (interior)..	—	—	—	—	—	—	—	×
0	Mutton ,, ..	—	—	—	—	—	—	—	×
2	Lamb (surface) ..	×	×	×	×	×	×	×	×
2	Mutton ,, ..	×	×	×	×	×	×	×	×
2	Lamb (interior) ..	—	—	—	—	—	—	—	×
2	Mutton ,, ..	—	—	—	—	—	—	—	×
3	Lamb ,, ..	—	—	—	—	—	—	—	×
3	Mutton ,, ..	—	—	—	—	—	—	—	×
5	Lamb ,, ..	×	×	×	×	×	×	×	×
5	Mutton ,, ..	—	—	—	—	—	—	—	×
7	Lamb ,, ..	×	×	×	×	×	×	×	×
7	Mutton ,, ..	×	×	×	×	×	×	×	×

× = growth. — = no growth.

Bacteriological Experiment No. 2.—On Mutton and Lamb treated with Thymol and Chloroform.

(Temperature of incubation, 21° C.)

Age of Meat in Days.	——	Growth Days.							After Exposure.
		1	2	3	5	7	10	14	
1	Lamb	—	—	—	—	—	—	—	×
1	Mutton ..	—	—	—	—	—	—	—	×
2	Lamb	—	—	—	—	—	—	—	×
2	Mutton ..	—	—	—	—	—	—	—	×
5	Lamb	—	—	—	—	—	—	—	×
7	Lamb	—	—	—	—	—	—	—	×
7	Mutton ..	—	—	—	—	—	—	—	×

× = growth. — = no growth.

Bacteriological Experiment No. 3.—On Cold-storage Meats.
(Temperature of incubation, 21° C.)

Days in Cold Storage.	—	Growth Days.							After Exposure.
		1	2	3	5	7	10	14	
14	Lamb (surface) ..	×	×	×	×	×	×	×	×
14	Mutton ,, ..	×	×	×	×	×	×	×	×
28	Lamb ,, ..	×	×	×	×	×	×	×	×
28	Mutton ,, ..	—	—	×	×	×	×	×	×
60	Lamb ,, ..	—	×	×	×	×	×	×	×
60	Mutton ,, ..	—	×	×	×	×	×	×	×
90	Lamb ,, ..	—	—	×	×	×	×	×	×
90	Mutton ,, ..	—	×	×	×	×	×	×	×
120	Lamb ,, ..	—	—	×	×	×	×	×	×
120	Mutton ,, ..	—	×	×	×	×	×	×	×
160	Lamb ,, ..	—	—	×	×	×	×	×	×
160	Mutton ,, ..	—	—	×	×	×	×	×	×
14	Lamb (interior) ..	—	—	—	—	—	—	—	×
14	Mutton ,, ..	—	—	—	—	—	—	—	×
28	Lamb ,, ..	—	—	—	—	—	—	—	×
28	Mutton ,, ..	—	—	—	—	—	—	—	×
60	Lamb ,, ..	×	×	×	×	×	×	×	×
60	Mutton , ..	—	—	—	—	—	—	—	×
90	Lamb ,, ..	—	—	—	—	—	—	—	×
90	Mutton ,, ..	—	—	—	—	—	—	—	×
120	Lamb ,, ..	—	—	—	—	—	—	—	×
120	Mutton ,, ..	×	×	×	×	×	×	×	×
160	Lamb ,, ..	—	—	—	—	—	—	—	×
160	Mutton ,, ..	—	—	—	—	—	—	—	×

× = growth. — = no growth.

Histological Note.

As might be expected from a consideration of the chemical and bacteriological data presented above, little or no change was to be observed in the structure of the lamb or mutton held in cold storage up to 160 days, as compared with the freshly killed meats.

An important factor to be considered when studying the appearance of cold-storage meats is the rate at which the meats are frozen and thawed out. If rapidly frozen and thawed a certain amount of distortion and abrasion of the tissues is inevitable; but where the freezing and subsequent thawing are slowly conducted little or no alteration of the structure of the tissues can be found.

In the absence of change in the chemical composition of the lamb and mutton due to bacterial decomposition, the slight alteration of the structure of the tissues sometimes noted is of no importance from the standpoint of nutrition.

For permission to publish these results the author desires to express his thanks to the Christchurch Meat Company (Limited), in whose laboratory the work has been carried out.

Art. II.—*The Direction of Motion of Cirrus Clouds.*

By H. B. Devereux, F.R.Met.Soc.

[*Read before the Auckland Institute, 11th December, 1912.*]

Over four years of systematic observation of cirrus clouds at Waihi, and their direction of motion, has shown not only their value as an adjunct to amateur forecast work, but an invaluable key to the study of those westerly waves of low pressure which are the predominant type of cyclonic systems which transit the Dominion in rear of the anticyclones.

By a strange coincidence, the writer was engaged on this paper when the Australian Monthly Weather Report for December, 1910, came to hand, containing therein a paper by Mr. E. T. Quayle, B.A., on the "Annual and Seasonable Variation in the Direction of Motion of Cirrus Clouds over Melbourne." In this paper the term "cirrus" means cirrus and cirro-stratus. The daily observations of these high-level clouds have not been confined to any particular hour, as the appearance has been generally found to be coincident with time about or after the early morning or afternoon diurnal barometric minimum.

In these investigations the first seven months of 1912 are included, as this year has been unusually favourable for cirrus observations, fifty-eight being recorded, or over 20 per cent. of the total under review.

The following table shows not only the principal points of the compass from which cirri moved, but the seasonal variation.

Table showing for each Month the Total Number of Days on which Cirrus Clouds were observed moving from the Principal Compass-points during the $4\frac{7}{12}$ Years 1st January, 1908, to 31st July, 1912.

—	N.	N.N.W.	N.W.	W.N.W.	W.	W.S.W.	S.W.	S.S.W.	S.	S.S.E.	S.E.	E.S.E.	E.	E.N.E.	N.E.	N.N.E.	Total Obs.
January	0	0	7	1	2	1	1	2	2	0	2	0	2	0	0	0	20
February	1	2	1	4	6	4	3	1	1	0	1	1	0	0	1	0	26
March	2	0	9	4	4	1	0	0	1	0	1	0	3	0	0	0	25
April	0	0	8	5	5	1	1	1	2	0	0	0	1	0	0	0	24
May	0	0	7	6	7	1	3	0	1	0	0	0	1	0	0	1	27
June	1	1	3	4	6	7	1	3	2	0	1	0	0	0	0	0	29
July	0	1	5	2	6	4	3	0	2	0	0	0	1	0	0	0	24
August	2	0	0	1	0	1	0	0	0	0	0	0	0	1	0	1	6
September ..	0	0	10	2	4	1	0	0	0	0	0	0	0	0	0	1	18
October	3	1	3	5	6	3	1	0	4	0	0	0	0	0	0	0	26
November ..	1	0	11	3	11	4	1	0	2	0	0	0	0	0	0	0	33
December ..	1	0	4	3	6	4	0	0	0	0	1	1	1	0	0	0	21
Total ..	11	5	68	40	63	32	14	7	17	0	6	2	9	1	1	3	297
Percentage of Obs...	4	2	24	14	23	11	5	2	6	0	2	1	4	0	0	1	..

In the above table no observations have been entered of cirri whose direction of motion was not determinable.

By inspection of this table we find the following:—

(*a.*) Cirrus is most frequently observed in November, with the least frequency in August.

(*b.*) The seasonal variation shows maxima in the spring and autumn. In the former season the greater frequency is undoubtedly accounted for by the known greater energy and magnitude of the antarctic disturbances which transit the Dominion; whilst in the autumn season the greater frequency can be attributed to those monsoonal systems which affect all that portion of the North Island lying between about longitudes 173° and 178° E. and north of the parallel of 38° S.

(*c.*) Cirri are usually moving from some westerly point. From due west, 23 per cent. of the total number observed; from W.N.W., 14 per cent.; from N.W., 24 per cent.; and from W.S.W., 11 per cent.: these four points accounting for 72 per cent. of total observations. The mean direction computed from all observations is W. 7° 16′ S., or nearly west. In Mr. Quayle's investigations of the movement of cirri at Melbourne the mean direction of motion is shown to be a little north of west; but his investigations cover a period of sixteen years, or four times the scope of this paper, so that the longer period would naturally give a truer mean, and would in a measure eliminate any variation due to cyclical movements. Both results, however, demonstrate the west-to-east drift of the upper currents in these latitudes. Melbourne and Waihi lie almost on the same parallel of latitude.

It is perhaps necessary to refer to the few observations of cirrus with an easterly component. During the passage of low pressures to the eastward of the Bay of Plenty, those which approach from the northward or north-east, cirrus is frequently observed; but owing to the prevalence of lower clouds at these times the true direction of motion of the cirri is often very difficult of determination: their direction is usually from the eastward.

In the "Transactions of the New Zealand Institute," vol. 37, p. 563, 1905, Captain Edwin refers to cirri-movements during the passage of cyclones to the northward or eastward of East Cape, and the drift from the eastward.

General Remarks as to Cirrus Formations.

Frequently the first appearance of cirrus is peculiar. A patch is projected above the horizon a little south of west, in shape not unlike a fan-shell, the radiations answering to the radial lines on the latter. The formation is sometimes striated, and when this happens a westerly wave-depression not infrequently follows, with wintry weather and electrical disturbances.

If a wave-depression is of greater extent than usual, detached cirrus plumes are frequently observed travelling eastward, with heavy showers of thunder type following, often accompanied by hail. They may be described as miniature cyclones, or swirls, traversing the country, integrals of an extensive system. Their passage is marked by frequent rise and fall of the barograph-trace, the amplitude being about $\frac{3}{100}$ in.

Cirrus and cirro-stratus may often be observed low down on the W.S.W. horizon, of a distinct "smoky" coloration, the ends being frequently brushed back, as it were, and recurving on themselves. If cirrus main tains this direction for twenty-four or thirty-six hours, the advent of an antarctic depression is portended.

Sometimes when the lowest pressure of an antarctic "low" has passed the meridian of the Bluff great cirrus plumes, moving fast, appear to the S. or S.S.W.: the barometer then rises slowly, and later very rapidly, a southerly storm following up the east coast of the South Island. If the rise of the barometer is due to the advent of the anticyclone following in rear of the antarctic system, the "southerly" usually extends to the latitude of East Cape, and a rough sea makes into the Bay of Plenty.

These westerly wave-pressures are usually most pronounced in the spring of the year, and they have been very fully described by Captain Edwin in the Transactions.

Occasionally cirrus, frequently striated, is seen moving very rapidly from the N.W.: a change in the weather then occurs shortly, winds from between N.E. and E., and heavy rain on the northern coastal districts.

Art. III.—*Harmonic Tidal Constants of New Zealand Ports—Wellington and Auckland.*

By C. E. Adams, M.Sc., F.R.A.S., Government Astronomer of New Zealand.

[*Read before the Wellington Philosophical Society, 23rd October, 1912.*]

The harmonic tidal constants given in columns (1) and (4) of the attached schedule were obtained from an harmonic analysis of the hourly ordinates from the automatic tide-gauges at Wellington and Auckland. For each port the tidal abacus of Sir G. H. Darwin was used, and the whole of the calculation has been carried out in duplicate. For the additions the Mercedes adding-machine has been found to be of the greatest assistance, while the Brunsviga calculating-machine, with printing attachment, and the Millionaire calculating-machine have been invaluable in the numerous calculations. For the fine plotting of curves the Coradi co-ordinatograph has been very useful.

From the constants given in columns (1) and (4) the tides for Wellington and Auckland have been predicted, and are published in the "British Admiralty Tide-tables" and in the "New Zealand Nautical Almanac." Comparisons between the predictions and actuality prove the correctness of the constants. For these comparisons see New Zealand Tidal Survey: Report of Department of Lands and Survey, Wellington, 1910–11 and 1911–12.

Other values of the tidal constants—(1) by the United States Coast and Geodetic Survey, and (2) by Mr. T. Wright—are given in columns (2) and (5) and (3) and (6) respectively.

In the United States tide-tables, predictions for Wellington and Auckland are also given, but these do not agree so closely with actuality as those depending on the constants in columns (1) and (4).

Tide.	Wellington, N.Z. (Lat. 41° 17′ S., Long. 174° 46′ E.)						Auckland, N.Z. (Lat. 36° 50′ S., Long. 174° 49′ E.)					
	H. in English Feet.			κ in Degrees.			H. in English Feet.			κ in Degrees.		
	(1.)	(2.)	(3.)	(1.)	(2.)	(3.)	(4.)	(5.)	(6.)	(4.)	(5.)	(6.)
S_1 ..	0·005	..	..	151	..	..	0·006	..	..	50	..	..
S_2 ..	0·112	0·089	0·108	333	325	308	0·583	0·626	0·633	264	265	266
S_4 ..	0·005	..	..	181	..	..	0·018	..	..	341	..	..
S_6 ..	0·005	..	..	299	..	..	0·002	..	..	27	..	..
M_1 ..	0·007	0·007	..	31	106	..	0·011	0·011	..	144	144	..
M_2 ..	1·594	1·598	1·702	134	137	123	3·814	3·782	3·826	204	205	205
M_3 ..	0·022	..	..	184	..	..	0·052	..	..	202	..	..
M_4 ..	0·030	0·045	..	276	332	..	0·113	0·200	..	127	74	..
M_6 ..	0·013	0·015	..	77	135	..	0·026	0·100	..	283	67	..
O ..	0·110	0·099	0·121	34	36	194	0·059	0·071	..	149	121	..
K_1 ..	0·078	0·085	0·071	78	81	275	0·233	0·241	0·265	169	167	169
K_2 ..	0·042	0·060	0·029	312	339	308	0·145	0·171	0·172	255	265	266
P ..	0·023	0·028	0·023	53	67	275	0·068	0·079	0·088	166	169	169
J ..	0·007	..	..	143	..	..	0·017	..	..	196	..	..
Q ..	0·036	0·019	..	26	13	..	0·008	0·018	..	57	85	..
L ..	0·093	0·034	..	142	71	..	0·221	0·144	0·164	210	209	196
N ..	0·431	0·353	0·449	95	104	83	0·797	0·760	0·778	174	174	175
ν ..	0·125	0·068	..	107	108	..	0·236	0·147	..	153	178	..
μ ..	0·082	..	..	81	..	..	0·126	0·091	..	178	144	..
R ..	0·024	..	..	170	..	..	0·024	..	..	237	..	..
T ..	0·056	..	..	317	..	..	0·058	0·037	..	103	265	..
MS ..	0·039	..	..	138	..	..	0·169	..	..	195	..	..
2SM ..	0·039	..	..	20	..	..	0·064	..	..	305	..	..
Mm ..	0·116	..	..	260	..	..	0·127	..	..	292	..	..
Mf ..	0·048	..	..	172	..	..	0·072	..	..	205	..	..
MSf ..	0·161	..	..	61	..	..	0·075	..	..	123	..	..
Sa ..	0·049	0·241	0·073	202	54	295	0·091	0·357	0·354	63	88	139
Ssa ..	0·073	0·035	0·204	166	240	212	0·028	0·185	0·224	57	266	242

(1.) New Zealand Tidal Survey: Report of Department of Lands and Survey, Wellington, for 1910–11.—Hourly ordinates for the calendar year 1909.

(2.) United States Coast and Geodetic Survey, Washington: Tide-tables for the Year 1911, p. 456.—Hourly ordinates for one calendar year, 1894.

(3.) Thomas Wright, Proc. Royal Soc., London, A. Vol. 83, p. 127: Harmonic Tidal Constants for certain Chinese and New Zealand Ports.—High and low waters for the year 1901.

(4.) New Zealand Tidal Survey: Report of Department of Lands and Survey, Wellington, for 1911–12.—Hourly ordinates for year beginning 1908, December 1.

(5.) United States Coast and Geodetic Survey, Washington: Tide-tables for Year 1912, p. 460.—High and low waters for two calendar years, 1896 (Service Hydrographique de la Marine, Paris) and 1900 (The Admiralty, London).

(6.) Thomas Wright, Proc. Royal Soc., London, A. Vol. 83, p. 127: Harmonic Tidal Constants for certain Chinese and New Zealand Ports.—High and low waters for one year beginning 1900, May 1.

Art. IV.—*Descriptions of New Zealand* Lepidoptera.

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

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

[*Read before the Wellington Philosophical Society, 23rd October, 1912.*]

I have again to thank Mr. G. V. Hudson for a further contribution of interesting material. It is evident that there must be a large number of species still awaiting discovery, and New Zealand entomologists should lose no time in searching them out. Many are obscure and easily overlooked from their resemblance to others; some are probably very retired in habit; and some also are doubtless now rare, and verging on extinction. There must also be large areas of promising ground where no entomologist has yet set foot, especially on the west coast of the South Island and towards the northern extremity of the North Island.

Caradrinidae.

Aletia fibriata n. sp.

♂. 44–46 mm. Head and thorax whitish-fuscous mixed with fuscous hairs. Antennae brownish-ochreous, bipectinated almost to apex, pectinations *a* 3, *b* 4. Forewings elongate-triangular, costa almost straight, apex obtuse, termen obliquely bowed, somewhat waved; light fuscous, irregularly strewn with whitish-ochreous and brownish or fuscous scales; costa somewhat marked with fuscous and dark fuscous; first and second lines very fine, dentate, formed of fuscous and dark-fuscous irroration, first very indistinct, second fairly distinct, dentations sometimes tipped with pale dots; orbicular and reniform somewhat paler, partially edged with dark-fuscous irroration, which sometimes forms a spot between them, orbicular oval, reniform narrow-transverse, somewhat oblique; claviform obsoletely indicated; a terminal series of indistinct dark-fuscous dots: cilia pale fuscous, tips whitish. Hindwings light fuscous; cilia whitish-fuscous.

Mount Richmond, 4,500 ft., in December (F. G. Gibbs); two specimens. An inconspicuous species, but apparently quite distinct.

Hydriomenidae.

Phrissogonus laticostatus Walk.

> *Larentia laticostatus* Walk., 1196; *Scotosia canata*, ib., 1357; *Phrissogonus laticostatus* Meyr., Proc. Linn. Soc. N.S.W., 1890, 801.

♂♀. 16–18 mm. Forewings triangular, costa in ♂ moderately arched, bent and protuberant at $\frac{1}{3}$, with a projecting tuft on protuberance, in ♀ gently arched; grey-whitish, with numerous curved waved cloudy dark-grey transverse lines sprinkled with black; anterior edge of median band marked by a slightly curved blackish line mixed with ochreous-brown, posterior edge more or less marked with black, upper $\frac{2}{3}$ rather strongly curved and forming two slight angles, indented on fold, on upper half partially preceded by ochreous-brown suffusion: cilia whitish obscurely barred with grey. Hindwings with termen rounded, in ♂ grey-whitish, in ♀ pale whitish-grey, marked towards dorsum with numerous short grey lines; in ♂ a large patch of black irroration extending along costa from $\frac{1}{3}$ to near apex, and reaching nearly half across wing.

Nelson (Hudson). Very common throughout Australia, whence it has probably been recently introduced by artificial means.

Chloroclystis Hüb.

Mr. Hudson has of late years supplied me very liberally and judiciously with specimens of this genus, so that I have now long series of some of the most variable species, and am enabled to comprehend them better. As a result I have perceived that I possess several undescribed species, and, having discriminated these, I compared the whole afresh with Walker's types in the British Museum, and believe all are now satisfactorily determined. I therefore take the opportunity to give a full list of the species, correcting two or three errors that have arisen. Hudson's *Chloroclystis rectilineata* (N.Z. Moths, 45, pl. 6, 22, *bis*) is not a species of this genus at all, but is a synonym of *Microdes quadristrigata* Walk. *C. maculata* Huds. (N.Z. Moths, 44, pl. 6, 18) is not known to me, but I doubt if it belongs here.

Sect. A. Antennae in ♂ simple.

1. C. semialbata Walk., 1708; indicataria, *ib.*, 1708.

This is the species hitherto known as *bilineolata*. I use the name *semialbata*, as the type is a ♂, and therefore certain; moreover, there is another species of the genus, *indicata* Walk., from India.

2. C. inductata Walk., 1322; subitata, *ib.*, 1362.

Sect. B. Antennae in ♂ with long fasciculate ciliations.

3. C. sandycias Meyr., Trans. Ent. Soc. Lond., 1905, 219.

A variable and very delicately coloured species, received in plenty.

4. C. plinthina Meyr., Trans. N.Z. Inst., 1888, 49.

5. C. melochlora Meyr., Trans. N.Z. Inst., 1911, 58.

6. C. muscosata Walk., 1246; cidariaria Guen., Ent. Mo. Mag., 5, 62; aquosata Feld., pl. 132, 38.

7. C. paralodes n. sp.

♂♀. 23–25 mm. Palpi 2. Antennal ciliations 4. Abdomen with blackish antemedian band. Forewings triangular, termen obliquely bowed; varying from pale greyish-ochreous to dull light green, always more or less greenish-tinged towards termen, sometimes thinly sprinkled with dark fuscous; basal area with some curved blackish striae; median band limited anteriorly by a curved fuscous fascia edged with waved blackish striae, posterior edge more or less marked with black, especially on a crescentic supramedian mark edged posteriorly with white, band itself sometimes suffusedly striated with white; praesubterminal blotches of blackish irroration or suffusion on costa and above middle, and sometimes indications of one towards tornus, subterminal stria sometimes white: cilia whitish-ochreous or greyish-ochreous, with grey bars narrowed and blackish towards base. Hindwings rather elongate, more so in ♂, termen unevenly rounded; whitish-grey, on dorsal third sprinkled with grey and sometimes with green, with striae of blackish irroration; a dark-grey discal dot: cilia as in forewings, sometimes rosy-tinged.

Wellington, Lake Wakatipu (Hudson); seven specimens.

8. C. zatricha n. sp.

♂. 22 mm. Palpi $1\frac{3}{8}$. Antennal ciliations $3\frac{1}{2}$. Abdomen with blackish subbasal band. Forewings elongate-triangular, termen obliquely rounded; light brownish-ochreous partially suffused with dull-greenish; a curved blackish stria near base; rear beyond this a fascia of light red-brownish suffusion, marked with black on costa; median band margined anteriorly by a light brownish-tinged fascia edged with blackish striae, and posteriorly by a blackish spot on costa, a black subcrescentic mark above middle, and some black dots below this; a blackish transverse discal dot on end of cell; praesubterminal fascia tinged with brownish on upper half, marked with black towards costa, and with a spot of black suffusion above middle, above tornus narrowly brownish; an interrupted black terminal line: cilia light-greyish, basal half pale-brownish spotted with blackish. Hindwings elongate. unusually narrow, termen rounded; lower half of disc anteriorly clothed more densely than usual with long hairs; ochreous-grey-whitish, dorsal half suffused with light ochreous, edges of median band indicated on dorsal half by striae of blackish irroration; a round dark-grey discal dot; a blackish-grey terminal line: cilia whitish-grey, basal half crimson-tinged and spotted with dark grey.

Wellington (Hudson); one specimen.

9. C. lacustris n. sp.

♂. 24–25 mm. Palpi 2. Antennal ciliations 4. Abdomen with blackish antemedian band. Forewings triangular, termen bowed, rather oblique; dull light-greenish, sometimes finely sprinkled with black specks; basal and subbasal brown-reddish fasciae marked with blackish; median band broad, brown-reddish, marked with black on veins and edges; in one specimen these brown-reddish markings are mostly replaced by blackish irroration; brownish blotches marked with black on costa before subterminal stria, on termen above middle, and on tornus, two latter cut by greenish subterminal stria: cilia greenish-grey, towards base reddish-tinged, at base whitish, spotted towards base with blackish. Hindwings rather elongate, termen unevenly rounded; pale grey, on dorsal third irrorated with blackish-grey and sometimes tinged with reddish, a grey discal dot: cilia as in forewings.

Lake Wakatipu (Hudson); three specimens.

10.* C. bilineolata Walk., 1246; antarctica Huds., N.Z. Moths, 42, pl. 6, 20.

Walker's type is a ♀, but a ♂ has subsequently been placed with it; both are correctly referable to the species described and figured by Mr. Hudson as *antarctica*. Later Mr. Hudson has been regarding as varieties of *antarctica* some of the forms described above as new.

11. C. lunata Philp., Trans. N.Z. Inst., 1912, 115.

I have two ♀ specimens received from Mr. Hudson, but no ♂ that I can identify with the description; it seems, however, to be undoubtedly a good species.

12. C. cotinaea n. sp.

♂. 23 mm. Palpi $2\frac{1}{2}$. Antennal ciliations $3\frac{1}{2}$. Abdomen with dark-fuscous subbasal band. Forewings triangular, termen bowed, oblique, sinuate just above tornus; light pinkish-fuscous, striated with fuscous, towards costa and termen suffused with pale dull green, veins pale-greenish marked with dark fuscous; median band hardly defined; a narrow dark-fuscous spot preceding subterminal stria above tornus: cilia fuscous, base spotted with dark fuscous. Hindwings moderate, termen rather unevenly rounded, sinuate above tornus; light grey, towards dorsum tinged with pale-greenish and striated with dark-fuscous irroration; a dark-grey roundish discal dot: cilia whitish-grey.

Masterton, in March, one specimen taken by myself in 1883; I have never seen another.

13. **C. dryas** Meyr., Trans. N.Z. Inst., 1891, 97.

14. **C. aristias** Meyr., Trans. Ent. Soc. Lond., 1897, 385.

15. **C. halianthes** Meyr., Trans. N.Z. Inst., 1907, 107.

16. **C. charybdis** Butl., Cist. Ent., 2, 503; **calida**, *ib.*, 504.

Sect. C. Antennae in ♂ shortly and evenly ciliated.

17. **C. malachita** n. sp.

♂♀. 19–25 mm. Palpi $1\frac{2}{3}$–$1\frac{3}{4}$. Antennal ciliations 1. Abdomen with blackish antemedian band. Forewings triangular, termen bowed, rather oblique; bright moss-green, sometimes partially tinged with yellowish, in one specimen partly brownish on basal area; some indistinct darker-green transverse striae, partially marked with blackish, especially towards costa; posterior edge of median band marked above middle with a black lunule edged with white posteriorly, and irregularly marked with black towards dorsum; a well-defined blackish blotch on costa towards apex; well-defined blackish blotches on termen above middle and on tornus, cut by a fine waved greenish subterminal stria, tornal blotch more or less suffused with dark brown-reddish: cilia brownish, base greenish, suffusedly barred with blackish. Hindwings with termen somewhat unevenly rounded; pale-greyish, towards dorsum tinged with brown-reddish and striated with dark grey: cilia pale-greyish, more or less rosy-tinged, and indistinctly spotted with dark-grey suffusion.

Lake Harris and Lake Wakatipu (Hudson); four specimens.

18. **C. lichenodes** Purd., Trans. N.Z. Inst., 1887, 70.

19. **C. sphragitis** Meyr., Trans. N.Z. Inst., 1888, 51.

20. **C. nereis** Meyr., Trans. N.Z. Inst., 1888, 51.

Xanthorhoe cymozeucta n. sp.

♂♀. 23–25 mm. Head and thorax whitish-ochreous, face with conical tuft. Palpi $2\frac{3}{4}$. Antennal pectinations in ♂ *a* 5, *b* 6. Abdomen whitish-ochreous sprinkled with fuscous, with double dorsal row of blackish spots. Forewings triangular, costa sinuate, apex obtuse, termen rather obliquely rounded, waved, subconcave on upper half; greyish-ochreous, irregularly sprinkled with fuscous and dark fuscous, towards costa and termen whitish-ochreous; first two fasciae each formed of two or three striae of blackish irroration; third and fourth fasciae of two and three blackish striae respectively, more or less suffused with fuscous, third preceded and fourth followed by a white stria, fourth irregular and forming an obtuse obliquely bidentate projection in middle ; a black transverse-linear discal mark between these ; a waved white subterminal stria edged anteriorly with more or less dark-fuscous suffusion, space between this and fourth fascia more or less suffused with dull brown-reddish ; a spot of dark-fuscous suffusion before apex : an interrupted blackish terminal line : cilia whitish, barred with dark fuscous. Hindwings somewhat elongate, termen rounded, somewhat waved ; grey-whitish ; median band indicated by traces of grey striae ; a blackish linear discal dot : cilia whitish, with a series of small dark-grey spots.

Ohakune (Hudson) ; three specimens. Allied to *chorica* and *obarata.*

Xanthorhoe frivola n. sp.

♂. 28 mm. Head and thorax ferruginous-ochreous. Palpi $2\frac{1}{2}$. Antennal pectinations *a* 4, *b* 6. Abdomen whitish-ochreous mixed with brownish-ochreous. Forewings triangular, costa posteriorly arched, apex obtuse, termen somewhat bowed, rather oblique ; whitish-ochreous tinged with grey, towards costa light yellow-ochreous ; costa suffused with fuscous towards base ; first two fasciae faintly indicated with fuscous on dorsal half ; third and fourth fasciae slender, fuscous, third curved, fourth stronger, shortly angulated-prominent in middle ; a dark-fuscous discal dot between these ; a faint fuscous praesubterminal shade, and oblique subapical mark ; a fuscous terminal line : cilia ochreous-whitish tinged with brownish. Hindwings rather elongate, termen rounded ; pale-yellowish, towards base faintly greyish-tinged : cilia as in forewings.

Invercargill (Philpott) ; one specimen. Apparently intermediate between *imperfecta* and *recta*, but distinct from either.

Tortricidae.

Capua polias n. sp.

♂. 14 mm. Head grey-whitish, sides of crown grey. Palpi $2\frac{1}{2}$, grey, suffused with white above. Antennal ciliations 1. Thorax light grey, shoulders mixed with dark fuscous. Abdomen grey mixed with whitish. Forewings elongate, rather narrow, somewhat dilated posteriorly, costa gently arched, fold reaching from base to $\frac{2}{5}$, apex tolerably pointed, termen faintly sinuate, rather strongly oblique ; whitish, with a few scattered fuscous and black scales ; markings dark grey ; a short streak along base of costa ; a transverse spot in disc at $\frac{1}{5}$, marked with black on posterior edge ; a suffused spot on dorsum before middle ; central fascia moderate, oblique, rather irregular posteriorly, marked in middle with a spot of blackish suffusion mixed with ochreous ; costal patch elongate-flattened-triangular, trifid on costa ; a spot on costa before apex, and another before termen in middle : cilia whitish, on outer half tinged with pale-yellowish, on termen with a blackish basal line. Hindwings grey ; cilia whitish-grey.

Wellington (Hudson) ; one specimen. Allied to *semiferana.*

Oecophoridae.

Atomotricha exsomnis n. sp.

♂. 24 mm. Head and thorax whitish-ochreous, collar dark fuscous. Palpi whitish-ochreous, second joint sprinkled and towards base suffused with fuscous. Abdomen whitish-ochreous, segments yellowish-ochreous towards the base. Forewings elongate, somewhat dilated posteriorly, costa moderately arched, apex obtuse, termen very obliquely rounded; whitish-ochreous, somewhat sprinkled with fuscous and dark fuscous; a suffused dark-fuscous streak running from base of costa to plical stigma; stigmata large, dark fuscous, pale-centred, especially second discal, plical obliquely beyond first discal; a spot of dark-fuscous suffusion on costa above second discal stigma, and a larger spot on costa at $\frac{3}{4}$, whence an indistinct angulated dark-fuscous line runs to dorsum before tornus: cilia whitish-ochreous, on upper half of termen spotted with fuscous at base. Hindwings whitish-ochreous; a grey discal dot: cilia whitish-ochreous.

Ohakune (Hudson); one specimen.

Glyphipterygidae.

Descriptions of the three following species have already appeared elsewhere, as I am preparing the family for the "Genera Insectorum."

Hierodoris Meyr.

Head smooth; ocelli present; tongue developed. Antennae $\frac{4}{5}$, in ♂ minutely ciliated, basal joint elongate, without pecten. Labial palpi moderately long, curved, ascending, with appressed scales, terminal joint $\frac{2}{3}$ of second, pointed. Maxillary palpi obsolete. Posterior tibiae with scales somewhat rough above. Forewings with 1*b* furcate, 2 from towards angle, 7 absent, 11 from middle. Hindwings over 1, ovate, cilia $\frac{1}{3}$; 3 and 4 connate, 5–7 somewhat approximated towards base.

Hierodoris iophanes Meyr., Exot. Micr., 1, 42.

♂. 13 mm. Head deep bluish-bronze. Palpi bronzy-fuscous. Thorax deep bronze suffused with purple. Antennae and abdomen dark fuscous. Forewings elongate, posteriorly slightly dilated, costa slightly arched, faintly sinuate in middle, apex obtuse, termen rounded, somewhat oblique; dark bronzy-fuscous; a shining purple fascia from base of costa almost to dorsum at $\frac{1}{4}$, followed by a spot of blackish suffusion beneath costa, beyond which is a short metallic-blue oblique strigula; a narrow shining purple fascia from a silvery-whitish dot beneath costa before middle to a pale-ochreous spot on middle of dorsum; a pale blue-metallic linear mark on end of cell; triangular shining purple spots above and below middle beyond this, their anterior angles tending to meet in disc; an undefined shining purple spot before middle of termen: cilia deep purplish-bronze. Hindwings blackish; cilia fuscous, with blackish basal shade.

Wellington, in January (Hudson); one specimen. A fine and interesting species.

Heliostibes callispora Meyr., Exot. Micr., 1, 41.

♂. 17 mm. Head deep metallic-green, with purple reflections, collar ferruginous-orange. Palpi ferruginous-orange, terminal joint rather more than half second, blackish anteriorly. Antennae dark fuscous, ciliations $\frac{1}{2}$. Thorax shining deep greenish-purple-bronze. Abdomen dark fuscous. Forewings elongate, posteriorly dilated, costa slightly arched, faintly sinuate in middle, apex obtuse, termen straight, little oblique, rounded beneath; dark indigo-fuscous, closely strewn with pale greenish-yellowish hair-scales: cilia fuscous, basal third dark fuscous mixed with deep ferruginous. Hindwings blackish; cilia fuscous, with blackish basal shade.

Wellington, in January (Hudson); one specimen.

Glyphipteryx aerifera Meyr., Exot. Micr., 1, 57.

♀. 11 mm. Head and thorax shining bronze. Palpi on basal and second joints with three whorls of black white-tipped scales, terminal joint white with black anterior and interior streaks. Abdomen grey. Forewings elongate, costa gently arched, apex tolerably pointed, termen somewhat rounded, rather strongly oblique; bright shining bronze; markings pale golden-metallic; five slender streaks from costa, first from middle, short, oblique, indistinct, others edged with a few blackish scales, second and third rather oblique, reaching half across wing, fourth and fifth short, transverse; a transverse mark from tornus, not reaching half across wing, lying between second and third costal streaks and not meeting either; small spots on termen above and below middle: cilia bronzy, on outer half grey, with pale golden-metallic basal spots on terminal markings. Hindwings rather dark grey; cilia grey, towards tips paler.

Mount Ruapehu, 4,500 ft., in January (Hudson); one specimen.

Plutellidae.

Orthenches saleuta n. sp.

♀. 9–10 mm. Head, palpi, and thorax grey mixed with whitish. Abdomen light grey. Forewings elongate, rather narrow, costa gently arched, apex tolerably pointed, termen very obliquely rounded; grey, strewn with dark-fuscous scales tending to form small spots and strigulae, and irregularly suffused with white between these, especially in disc and towards apex: cilia white, with dark-fuscous basal line, tips round apex bright coppery, on lower half of termen with outer third bronzy-grey. Hind-wings grey; cilia whitish-grey, with grey basal line.

Waiouru, in February (Hudson); two specimens.

Tineidae.

Endophthora roseata n. sp.

♀. 12 mm. Head whitish. Palpi whitish, laterally streaked with blackish towards apex of second and base of terminal joints. Antennae grey-whitish. Thorax light rosy-brownish, shoulders marked with dark fuscous. Abdomen whitish-ochreous, ovipositor surrounded with a dense tuft of ochreous-whitish hairs. Forewings narrowly elongate-lanceolate, acute; light rosy-purple-brownish; about eight small blackish costal marks; an irregular brown mark on fold towards base, terminated by a few blackish scales, and edged with some whitish suffusion; a narrow oblique brown fascia from before middle of costa to beyond middle of dorsum, partially edged with blackish posteriorly; a streak of brown suffusion from middle of disc to middle of termen, including a line of black scales, and edged above posteriorly by a fine white streak: cilia pale yellow-ochreous, sprinkled with blackish. Hindwings grey; cilia ochreous-whitish.

Wadestown, in November (Hudson); one specimen.

Thallostoma n. g.

Head densely rough-haired; ocelli present; tongue absent. Antennae $\frac{5}{6}$, basal joint elongate, compressed, with slight pecten. Labial palpi moderately long, porrected, slightly rough-scaled beneath, terminal joint shorter than second, obtuse-pointed. Maxillary palpi moderate, curved, ascending, apparently three-jointed, loosely scaled, tolerably pointed. Posterior tibiae shortly rough-scaled. Forewings with cell very long, 2–4 short, 2 tolerably remote from angle, 3 from angle, 7 to costa, 11 from much before middle. Hindwings under 1, narrowly elongate-ovate, cilia 1; 2–4 remote, 5 and 6 short-stalked, approximated to 7 at base.

Allied to *Tinea*, but characterized by the peculiar maxillary palpi.

Thallostoma eurygrapha n. sp.

♂♀. 18–19 mm. Head and palpi ochreous-whitish, palpi externally blackish except towards apex. Thorax dark fuscous, patagia whitish except shoulders. Forewings elongate, narrow, costa gently arched, apex obtuse-pointed, termen very obliquely rounded; dark purplish-fuscous; markings pale whitish-ochreous; a rather broad irregular streak along dorsum and termen throughout, just reaching costa at base, triangularly prominent upwards before middle of wing, narrowed to a point at tornus, thence expanded to apex; a semioval blotch extending on costa from before middle to near $\frac{3}{4}$, and reaching nearly half across wing: cilia pale whitish-ochreous. Hindwings grey; cilia ochreous-whitish.

Wadestown, in November (Hudson); two specimens, both damaged.

Trithamnora n. g.

Head with dense rough projecting scales; ocelli absent; tongue absent. Antennae $\frac{4}{5}$, in ♂ ciliated, basal joint moderate, stout, with slight pecten. Labial palpi moderate, porrected, stout, considerably expanded with dense rough scales projecting beneath, second joint with a few short lateral bristles, terminal joint short, obtuse. Maxillary palpi moderately long, slender, filiform, drooping. Posterior tibiae clothed with long hairs above and beneath. Forewings with subdorsal tufts of raised scales; cell long, 2 tolerably remote from angle, 3 from angle, 7 to costa, sometimes stalked with 8, 11 from $\frac{1}{4}$. Hindwings 1, elongate-ovate, cilia $\frac{3}{4}$; 2–4 remote, 5 and 6 approximated towards base, 7 nearly parallel.

Trithamnora improba n. sp.

♂. 16 mm. Head and antennae fuscous. Palpi dark fuscous mixed with black, apex of joints pale ochreous. Thorax dark purplish-fuscous. Abdomen dark fuscous. Forewings elongate, narrow, costa gently arched, apex tolerably pointed, termen very obliquely rounded; dark purplish-fuscous, sprinkled with blackish scales and whitish specks, dorsal and terminal areas lighter; a series of four raised tufts of rough pale greyish-ochreous scales beneath fold: cilia dark fuscous sprinkled with ochreous-whitish, beneath tornus with a patch of whitish-ochreous suffusion. Hindwings dark purplish-fuscous, lighter anteriorly; cilia fuscous, with dark fuscous subbasal line.

Wellington (Hudson); two specimens. Easily confused with dark forms of *Tinea certella*, and therefore probably hitherto overlooked; it may, however, be immediately distinguished by the subdorsal tufts of scales. It is likely that the larva would feed in dead wood, and the imago be found on the trunks in dark forests.

Art. V.—*A Revision of New Zealand* Pyralidina.

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

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

[*Read before the Wellington Philosophical Society, 23rd October, 1912.*]

At the request of Mr. G. V. Hudson I have here revised the genera of *Pyralidina* occurring in New Zealand.

The representation of this group in New Zealand presents the same features as that of the *Caradrinina*, but in a still more exaggerated form. The group contains about ten families, and a vast number of genera and species, being most largely developed in tropical regions; but in New Zealand most of the principal divisions are either absent or barely represented by a very few stragglers or immigrants, whilst at the same time the groups of *Crambus* and *Scoparia* are so disproportionately developed that the *Pyralidina* as a whole form 22 per cent. of the entire lepidopterous fauna, probably a larger proportion than in any other region.

The geographical origin of these numerously developed sections is, as set forth in my paper on the *Caradrinina*, undoubtedly to be traced to South America. This is remarkably borne out by the curious circumstance that *Crambus* is virtually absent from the Australasian region, though otherwise cosmopolitan and dominant, and therefore could only have entered from the south. It is probable that *Crambus* and *Scoparia*, which are tolerant of cold climates, and feed in the larval state on grasses and moss, attained considerable development in an antarctic continent under conditions similar to those now prevailing in the Falkland Islands (which seem to be actually a remnant of such a continent, and should exhibit a similar lepidopterous fauna), the remnants of this fauna being now isolated in a few last refuges, of which New Zealand is the chief.

The fragmentary and scantily developed portion of the fauna represents the results of accidental wind-borne immigration over a wide sea, and might reasonably have been expected to be larger than it is, for many of the Pyrales are great travellers; perhaps in no other group are there so many species of very wide distribution. Many species range through most of Asia, Africa, Australia, and the Pacific islands, and yet have failed to reach New Zealand.

The *Pterophoridae* present some difficulty, and seem at first to stand on a different footing from either of the above sections of the fauna. The larvae of the New Zealand species are not known (they ought to be), but, according to all experience of the family in other regions, they should feed on highly developed dicotyledonous plants, especially *Compositae* and *Gentianaceae*.* These natural orders are well represented in New Zealand, and the character of the genera is such that most of them seem to have been derived from an antarctic continent, such as is described above. I therefore have no doubt that the *Pterophoridae* may be reckoned to have entered by this route. If flower-heads of *Celmisia*, *Senecio*, and *Gentiana* are examined or collected in early summer, there would be every probability of breeding some of the species.

* The larva of *Alucita monospilalis* feeds on *Nothopanax Edgerleyi*, and that of *A. lycosema* on *Coprosma grandifolia*. *Platyptilia aeolodes* feeds on *Juncus*, and *P. falcatalis* almost certainly on *Veronica*.—G. V. H.

1. Phycitidae.

Maxillary palpi not triangular. Forewings with vein 7 absent. Hindwings with defined pecten of hairs on lower margin of cell.

A very large and highly developed family of recent origin, barely represented in New Zealand; it is not improbable that none of the three species is truly indigenous.

1. Sporophyla Meyr.

Sporophyla Meyr., Trans. Ent. Soc. Lond., 1905, 224; type, *oenospora* Meyr.

Tongue developed. Antennae in ♂ simple, shortly ciliated. Labial palpi moderately long, obliquely ascending, second joint much thickened with dense scales, terminal joint short, obtuse. Maxillary palpi rudimentary. Forewings with 4 absent, 3 and 5 connate, 8 and 9 stalked. Hindwings with 2 almost from angle, 4 absent, 3 and 5 stalked, 6 and 7 connate, 8 closely approximated to cell and anterior portion of 7.

The single species is apparently endemic, but I think it may prove to be derived from Tasmania. The genus is nearly allied to the following.

1. *S. oenospora* Meyr., Trans. Ent. Soc. Lond., 1897, 388.
Castle Hill, Dunedin.

2. Crocydopora Meyr.

Crocydopora Meyr., Proc. Linn. Soc. N.S.W., 1882, 158; type, *cinigerella* Walk.

Tongue developed. Antennae in ♂ ciliated, with large tuft of scales in a sinuation at base. Labial palpi long, stout, densely scaled, porrected, terminal joint short, obtuse. Maxillary palpi rudimentary. Forewings with 4 absent, 8 and 9 stalked. Hindwings with 2 almost from angle, 4 absent, 3 and 5 stalked, 6 and 7 stalked, 8 closely approximated to cell and anterior portion of 7.

Includes only the following species, which is doubtless of Australian origin, and probably recently introduced into New Zealand.

2. *C. cinigerella* Walk., Cat., 35, 1719; Meyr., Trans. N.Z. Inst., 1888, 72: *stenopterella* Meyr., Proc. Linn. Soc. N.S.W., 1878, 200.
Whangarei, Nelson. Common and widely distributed in Australia.

3. Homoeosoma Curt.

Homoeosoma Curt., Ent. Mag., 1, 190 (1833); type, *sinuella* Fab.

Tongue developed. Antennae in ♂ ciliated, with a notch above basal joint. Labial palpi moderately long, arched, ascending with appressed scales, terminal joint rather short, tolerably pointed. Maxillary palpi moderate, loosely scaled. Forewings with 4 and 5 stalked, 9 absent. Hindwings with cell not nearly reaching middle, 4 absent, 3 and 5 approximated or connate, 7 anastomosing with 8 to near apex.

A cosmopolitan genus, but not numerous in species. As I have now undoubted examples of *vagella* from New Zealand, including an unusually large and strongly marked specimen, I am disposed to regard my *anaspila* as an obscure form of that species; but the point deserves further investigation. Larvae of this genus usually feed in heads of *Compositae*.

3. *H. vagella* Zell., Isis, 1848, 863; Meyr., Proc. Linn. Soc. N.S.W., 1878, 214: *anaspila* Meyr., Trans. Ent. Soc. Lond., 1901, 566.

Kermadec Islands, Waipukurau, Christchurch, Invercargill. Common throughout Australia.

2. Galleriadae.

Maxillary palpi not triangular. Forewings with 8 and 9 out of 7. Hindwings with defined pecten of hairs on lower margin of cell.

A rather small family of general distribution, but only represented in New Zealand by one artificially introduced species.

4. Meliphora Guen.

Meliphora Guen., Eur. Micr. Ind., 70 (1845); type, *grisella* Fab.
Achroia Hüb., Verz., 163 (1826) (praeocc.); type, *grisella* Fab.

Labial palpi very short, in ♂ ascending, in ♀ porrected. Forewings with 4 and 5 stalked, 10 absent. Hindwings in ♂ with long dorsal hair pencil, 3 and 5 stalked, 4 absent, 7 anastomosing with 8 to beyond middle.

The single species is probably of European origin, but has been carried by man over a large part of the world.

4. *M. grisella* Fab., Ent. Syst., 3, 289; Meyr., Trans. N.Z. Inst., 1888, 73: *anticella* Walk., Cat. 28, 483.

Nelson, Christchurch. Widely distributed in Australia, and occurs also in Europe, central Asia, and North America. Larva on wax in beehives, to which it is often very injurious; also on dried apples.

3. Crambidae.

Labial palpi usually very long, straight, porrected, loosely rough-scaled, attenuated forwards. Maxillary palpi well developed, strongly triangular. Forewings with 7 separate or out of 9. Hindwings with defined pecten of hairs on lower margin of cell.

A large and interesting family, found everywhere, but specially prominent in New Zealand, where they constitute one-thirteenth of the whole lepidopterous fauna; in Great Britain they form about one sixty-fifth. A remarkable feature is the absence of relationship with the Australian region, where *Talis* is the dominant genus of the family, and *Crambus* is virtually absent.

5. Orocrambus Meyr.

Orocrambus Meyr., Trans. N.Z. Inst., 1885, 133; type, *melampetrus* Meyr.

Characters of *Crambus*, but with the under-surface of thorax and coxae densely hairy; labial palpi clothed with dense rough hairs, except towards apex.

An interesting endemic genus, derived from *Crambus*.

5. *O. melampetrus* Meyr., Trans. N.Z. Inst., 1885, 133; N.Z. Journ. Sci., 2, 168.

Castle Hill, Mount Hutt, Arthur's Pass; 3,000–5,000 ft. Hampson attributes the authorship of this species to Purdie, but the names and diagnoses published by Purdie were not composed by him, but furnished by myself as an abstract of my paper.

6. *O. mylites* Meyr., Trans. N.Z. Inst., 1888, 67.
Mount Arthur; 4,000–4,800 ft.
7. *O. catacaustus* Meyr., Trans. N.Z. Inst., 1885, 134.
Arthur's Pass, Mount Arthur; 3,000–4,500 ft.
8. *O. pervius* Meyr., Trans. N.Z. Inst., 1912, 118.
Lake Wakatipu; 3,600 ft.
9. *O. subitus* Philp., Trans. N.Z. Inst., 1912, 116.
Hump Ridge; 3,500 ft.
10. *O. thymiastes* Meyr., Trans. Ent. Soc. Lond., 1901, 567.
Invercargill.
11. *O. tritonellus* Meyr., Trans. N.Z. Inst., 1885, 134.
Porter's Pass.
12. *O. machaeristes* Meyr., Trans. Ent. Soc. Lond., 1905, 224.
Mount Earnslaw; 5,300 ft.

6. Crambus Fab.

Crambus Fab., Ent. Syst. Suppl., 464 (1798).

Forewings with 4 and 5 sometimes stalked, 7 and 8 out of 9. Hindwings with 4 and 5 connate or stalked, 7 out of 6, anastomosing with 8.

A very large genus, common throughout the world, except in Australia, where there are no indigenous species, and the Indo-Malayan region, where there are comparatively few. The larvae probably nearly all feed amongst stems or roots of grass, or seldom on moss, but are little known, notwithstanding their abundance. The New Zealand species are all endemic.

13. *C. corruptus* Butl., Proc. Zool. Soc. Lond., 1877, 399, pl. 43, 9; Meyr., Trans. N.Z. Inst., 1883, 20.
Mount Hutt, Dunedin.
14. *C. heliotes* Meyr., Trans. N.Z. Inst., 1888, 68.
Mount Arthur (3,800 ft.), Lake Wakatipu.
15. *C. antimorus* Meyr., Trans. Ent. Soc. Lond., 1901, 567.
Mount Cook; 2,500 ft.
16. *C. aethonellus* Meyr., Trans. N.Z. Inst., 1883, 19; Trans. Ent. Soc. Lond., 1905, 225.
Mount Hutt.
17. *C. aulistes* Meyr., Trans. N.Z. Inst., 1909, 9.
Invercargill.
18. *C. saristes* Meyr., Trans. N.Z. Inst., 1909, 8.
Invercargill.
19. *C. heteranthes* Meyr., Trans. Ent. Soc. Lond., 1901, 568.
Mount Cook; 2,500 ft.
20. *C. melitastes* Meyr., Trans. N.Z. Inst., 1909, 9.
Invercargill.
21. *C. apselias* Meyr., Trans. N.Z. Inst., 1907, 108.
Invercargill.
22. *C. ramosellus* Doubl., Dieff. N.Z., 2, 288; Meyr., Trans. N.Z. Inst., 1883, 21: *rangona* Feld., Reis. Novar., pl. 137, 25: *leucanialis* Butl., Proc. Zool. Soc. Lond., 1877, 401.
North and South Islands, common everywhere at low levels; Chatham Islands.
23. *C. conopias* Meyr., Trans. N.Z. Inst., 1907, 109.
Dunedin.

24. *C. angustipennis* Zell., Hor. Soc. Ent. Ross., 13, 15, pl. 1, 3 (1877); Meyr., Trans. N.Z. Inst., 1883, 22.
    Christchurch, Rakaia, Castle Hill (2,500 ft.).
25. *C. ephorus* Meyr., Trans. N.Z. Inst., 1885, 135.
    Arthur's Pass; 4,800 ft.
26. *C. dicrenellus* Meyr., Trans. N.Z. Inst., 1883, 22.
    Mount Hutt, Castle Hill, Arthur's Pass, Nelson, Springfield; 2,500–5,000 ft.
27. *C. isochytus* Meyr., Trans. N.Z. Inst., 1888, 68.
    Mount Arthur; 4,000–4,500 ft.
28. *C. heteraulus* Meyr., Trans. Ent. Soc. Lond., 1905, 225.
    Humboldt Range, Lake Wakatipu; 3,600 ft.
29. *C. crenaeus* Meyr., Trans. N.Z. Inst., 1885, 135.
    Arthur's Pass, Mount Arthur, Springfield, Dunedin; to 4,000 ft.
30. *C. haplotomus* Meyr., Trans. N.Z. Inst., 1883, 23.
    Castle Hill, Bealey River, Arthur's Pass, Lake Wakatipu; 2,000–2,500 ft.
31. *C. enchophorus* Meyr., Trans. N.Z. Inst., 1885, 136.
    Castle Hill (2,500–4,000 ft.), Waikari.
32. *C. diplorrhous* Meyr., Trans. N.Z. Inst., 1885, 136.
    Mount Earnslaw, Castle Hill, Lake Wakatipu.
33. *C. callirrhous* Meyr., Trans. N.Z. Inst., 1883, 24.
    Christchurch, Castle Hill (2,500 ft.), Lake Guyon, Invercargill.
34. *C. schedias* Meyr., Trans. N.Z. Inst., 1911, 60.
    Wellington.
35. *C. pedias* Meyr., Trans. N.Z. Inst., 1885, 137.
    Wanganui, Masterton, Wellington.
36. *C. simplex* Butl., Proc. Zool. Soc. Lond., 1877, 400, pl. 43, 12; Meyr., Trans. N.Z. Inst., 1883, 24.
    Napier, Waipukurau, Wellington, Christchurch, Lake Wakatipu, Invercargill.
37. *C. siriellus* Meyr., Trans. N.Z. Inst., 1883, 25.
    Hamilton, Wellington, Mount Arthur (3,000–4,000 ft.).
38. *C. apicellus* Zell., Mon. Cramb., 31; Meyr., Trans. N.Z. Inst., 1883, 26.
    Hamilton, Wellington, Mount Hutt.
39. *C. paraxenus* Meyr., Trans. N.Z. Inst., 1885, 137.
    Lake Wakatipu; 2,000–5,000 ft.
40. *C. obstructus* Meyr., Ent. Mo. Mag., 1911, 82.
    Lumsden.
41. *C. vittellus* Doubl., Dieff. N.Z., 2, 289; Meyr., Trans. N.Z. Inst., 1883, 27: *nexalis* Walk., Cat., 27, 178: *transcissalis*, ibid., 178: *bisectellus* Zell., Mon. Cramb., 32: *incrassatellus*, ibid., 32: *vapidus* Butl., Proc. Zool. Soc. Lond., 1877, 399.
    North and South Islands, common everywhere at low levels.
42. *C. horistes* Meyr., Trans. Ent. Soc. Lond., 1902, 276.
    Chatham Islands.
43. *C. flexuosellus* Doubl., Dieff. N.Z., 2, 289; Feld., Reis. Novar., pl. 137, 32; Meyr., Trans. N.Z. Inst., 1883, 28.
    North and South Islands, common everywhere at low levels, sometimes ascending to 4,000 ft.
44. *C. thrincodes* Meyr., Trans. N.Z. Inst., 1910, 64; ibid., 1911, 61.
    Kaitoke.

45. *C. tuhualis* Feld., Reis. Novar., pl. 137, 18 ; Meyr., Trans. N.Z. Inst., 1883, 28 : *vulgaris* Butl., Proc. Zool. Soc. Lond., 1877, 400, pl. 43, 7.
Wellington, Christchurch, Castle Hill (2,500 ft.).
46. *C. sophronellus* Meyr., Trans. N.Z. Inst., 1885, 138.
Wellington.
47. *C. cyclopicus* Meyr., Trans. N.Z. Inst., 1883. 29.
Napier, Waipukurau, Wellington, Christchurch, Lake Guyon, Nelson.
48. *C. sophistes* Meyr., Trans. Ent. Soc. Lond., 1905, 226.
Dunedin.
49. *C. harpophorus* Meyr., Trans. N.Z. Inst., 1883, 30.
Mount Arthur, Arthur's Pass, Lake Wakatipu ; 2,500–4,200 ft.
50. *C. oncobolus* Meyr., Trans. N.Z. Inst., 1885, 138.
Castle Hill ; 2,300 ft.
51. *C. xanthogrammus* Meyr., Trans. N.Z. Inst., 1883, 32.
Bealey River, Castle Hill, Lake Coleridge ; 2,000–2,500 ft.

7. Protyparcha Meyr.

Protyparcha Meyr., Subantarct. Isl. N.Z., 1, 71 (1909) ; type, *scaphodes* Meyr.

Antennae in ♂ unipectinated to apex. Thorax, coxae, and femora clothed with long loose hairs beneath. Forewings with 7 separate, 8 and 9 stalked. Hindwings with 4 and 5 approximated, 7 connate with 6, anastomosing shortly with 8. At present includes only the following species : a development of *Argyria*.

52. *P. scaphodes* Meyr., Subantarct. Isl. N.Z., 71, pl. 2, 16.
Auckland Island.

8. Argyria Hüb.

Argyria Hüb., Verz., 372 (1826) ; type, *nummulalis* Hüb.

Antennae in ♂ ciliated. Forewings with 7 separate, 8 and 9 stalked. Hindwings with 4 and 5 connate or stalked, 7 out of 6, anastomosing with 8.

A genus of some extent and wide distribution, but more especially American.

53. *A. strophaea* Meyr., Trans. Ent. Soc. Lond., 1905, 226.
Wellington.
54. *A. pentadactyla* Zell., Mon. Cramb., 38 : *claviferella* Walk., Cat., 35, 1765 : *strigosus* Butl., Proc. Zool. Soc. Lond., 1877, 398, pl. 43, 10 ; Meyr., Trans. N.Z. Inst., 1883, 31.
Palmerston, Masterton, Christchurch ; also in south-east Australia and Tasmania. This is probably an indigenous New Zealand species ; it has no near ally in Australia.

9. Tauroscopa Meyr.

Tauroscopa Meyr., Trans. N.Z. Inst., 1888, 69 ; type, *gorgopis* Meyr.

Labial palpi, thorax, and coxae clothed with dense rough hairs beneath. Forewings with 7 separate, 8 and 9 stalked. Hindwings with 4 and 5 stalked, 6 remote from 7 at origin, 7 anastomosing shortly with 8.

An endemic derivative of *Talis*.

55. *T. trapezitis* Meyr., Trans. Ent. Soc. Lond., 1905, 227.
Mount Earnslaw; 5,300 ft.
56. *T. gorgopis* Meyr., Trans. N.Z. Inst., 1888, 69.
Mount Arthur; 4,000 ft.
57. *T. glaucophanes* Meyr., Trans. N.Z. Inst., 1907, 109.
Lake Wakatipu.

10. Scenoploca Meyr.

Scenoploca Meyr., Trans. N.Z. Inst., 1883, 9; type, *petraula* Meyr.

Labial palpi with hairs of second joint produced beneath into an obliquely projecting tuft. Wings in ♀ much abbreviated, incapable of flight. Forewings with 7 separate, 8 and 9 stalked. Hindwings with 4 and 5 connate, 6 widely remote from 7 at origin, 7 anastomosing with 8.

Also endemic and derived from *Talis*.

58. *S. petraula* Meyr., Trans. N.Z. Inst., 1883, 9.
Christchurch. Larva on lichens on rocks.

11. Talis Guen.

Talis Guen., Eur. Micr. Ind., 86 (1845); type, *quercella* Schiff.
Hednota Meyr., Trans. Ent. Soc. Lond., 1886, 270; type, *bifractella* Walk.

Forewings with 4 and 5 sometimes stalked, 7 separate, 8 and 9 stalked. Hindwings with 4 and 5 connate, stalked, or seldom coincident, 6 remote from 7 at origin, 7 anastomosing with 8.

An interesting genus, considerably developed in Australia, where it is the principal representative of the family, elsewhere apparently confined to a few widely scattered forms. Their habits are similar to those of *Crambus*.

59. *T. leucophthalma* Meyr., Trans. N.Z. Inst., 1883, 7.
Christchurch.

12. Diptychophora Zell.

Diptychophora Zell., Stett. Ent. Zeit., 1866, 153; type, *kuhlweinii* Zell.

Forewings with termen twice sinuate, 7 separate, 8 and 9 stalked, 11 usually running into 12. Hindwings with 4 rarely absent (not in New Zealand species), 5 separate, rising from above angle, 6 remote from 7 at origin, 7 anastomosing shortly with 8.

Probably Indo-Malayan in origin, being fairly represented in that region, and less numerously in South Africa, east Australia, and South America; but the New Zealand species still form the largest local group, and include the largest and handsomest species. The larvae feed on moss, and the species mostly frequent forest.

60. *D. microdora* Meyr., Trans. Ent. Soc. Lond., 1905, 227.
Wellington, Mount Arthur (3,000 ft.).
61. *D. pyrsophanes* Meyr., Trans. N.Z. Inst., 1883, 11.
Wellington, and common in the South Island.
62. *D. chrysochyta* Meyr., Trans. N.Z. Inst., 1883, 12.
Whangarei, Auckland.

63. *D. interrupta* Feld., Reis. Novar., pl. 135, 15 : *astrosema* Meyr., Trans. N.Z. Inst., 1883, 13.
Wellington, Nelson, Arthur's Pass, Christchurch.

64. *D. lepidella* Walk., Cat., 35, 1761 ; Meyr., Trans. N.Z. Inst., 1883, 14 : *gracilis* Feld., Reis. Novar., pl. 137, 26.
Wellington, and common in South Island.

65. *D. leucoxantha* Meyr., Trans. N.Z. Inst., 1883, 15.
Wellington, Lake Wakatipu.

66. *D. metallifera* Butl., Proc. Zool. Soc. Lond., 1877, 401, pl. 43, 11 ; Meyr., Trans. N.Z. Inst., 1888, 70.
Auckland, Wellington, Nelson.

67. *D. selenaea* Meyr., Trans. N.Z. Inst., 1885, 131.
Whangarei, Auckland, Wellington, Otira River, Dunedin.

68. *D. auriscriptella* Walk., Cat., 30, 976 ; Meyr., Trans. N.Z. Inst., 1883, 16.
Whangarei, Auckland, Napier, Wellington, Christchurch, Otira River.

69. *D. holanthes* Meyr., Trans. N.Z. Inst., 1885, 131.
Otira Gorge ; 1,800 ft.

70. *D. harmonica* Meyr., Trans. N.Z. Inst., 1888, 71.
Auckland.

71. *D. bipunctella* Walk., Cat., 35, 1761.
Probably North Island.

72. *D. helioctypa* Meyr., Trans. N.Z. Inst., 1883, 17.
Lake Wakatipu.

73. *D. epiphaea* Meyr., Trans. N.Z. Inst., 1885, 132.
Mount Arthur, Arthur's Pass, Lake Wakatipu.

74. *D. elaina* Meyr., Trans. N.Z. Inst., 1883, 17.
North and South Islands, generally common.

13. Gadira Walk.

Gadira Walk., Cat., 35, 1742 (1866) ; type, *acerella* Walk. *Cryptomima* Meyr., Trans. N.Z. Inst., 1883, 8 ; type, *acerella* Walk.

Forewings with tufts of scales ; 7 separate, 8 and 9 stalked. Hindwings with 4 and 5 stalked, 6 widely remote from 7 at origin, 7 anastomosing with 8.

Only includes the following species, apparently an early form.

75. *G. acerella* Walk., Cat., 35, 1742 ; Meyr., Trans. N.Z. Inst., 1883, 8 *mahanga* Feld., Reis. Novar., pl. 137, 27.
Auckland, Wellington, Bealey River, Christchurch, Dunedin.

4. Pyraustidae.

Maxillary palpi present. Forewings with 7 separate, 8 and 9 stalked. Hindwings without defined pecten of hairs on lower margin of cell, 4 and 5 closely approximated or stalked, 7 usually out of 6 near origin, anastomosing with 8.

A very large family, mainly characteristic of tropical countries, but in New Zealand very scantily represented, except for the species of the genus *Scoparia*, which by its excessive development almost compensates for all other deficiencies. The characters on which Hampson separates from this family his groups *Hydrocampinae* and *Scoparianae* appear to me to be entirely illusory; the former group is merely obtained by confounding together a number of unrelated genera which happen to agree in having vein 10 out of 8 (though even this is not constant), and is therefore unnatural and artificial, whilst the latter is nominally based on the possession of raised types of scales in the cell of forewings, whereas in my opinion these tufts are not merely sometimes, but usually, non-existent.

14. Nymphula Schranck.

Nymphula Schranck, Faun. Boic., 2, 162 (1802); type, *stagnata* Don.
Paraponyx Hüb., Verz., 362 (1826); type, *stratiotata* Linn.

Antennae $\frac{2}{3}$. Labial palpi ascending, second joint with projecting scales beneath, terminal joint slender, somewhat pointed. Maxillary palpi with apex loosely scaled. Forewings with 10 rising out of 8. Tibial outer spurs half inner.

An Indo-Malayan genus, spreading more or less into surrounding regions. Larva aquatic, sometimes breathing by branchiae. The single New Zealand species is an immigrant from Australia.

76. *N. nitens* Butl., Cist. Ent., 2, 556; Meyr., Trans. N.Z. Inst., 1885, 130.
Hamilton, Napier, Masterton, Christchurch, Lake Wakatipu. Also common in south-east Australia.

15. Musotima Meyr.

Musotima Meyr., Trans. Ent. Soc. Lond., 1884, 288; type, *aduncalis* Feld.

Antennae $\frac{3}{4}$. Labial palpi more or less ascending, second joint with evenly projecting scales beneath, terminal joint slender, rough-scaled beneath towards apex. Maxillary palpi dilated with rough scales, truncate. Tibial spurs long, almost equal. Forewings with 10 rising out of 8. Hindwings with 7 out of cell before angle, separate from 6.

Besides the New Zealand species there are a few others from Australia and the Indo-Malayan region, and one from Brazil.

77. *M. aduncalis* Feld., Reis. Novar., pl. 135, 11.
Whangarei, Auckland, Taranaki, Wellington, Nelson.

78. *M. nitidalis* Walk., Cat., 34, 1317: *timaralis* Feld., Reis. Novar., pl. 135, 23.
North and South Islands, common in forest. Also widely distributed in Australia. Larva on *Adiantum*, and perhaps other ferns. As it is sometimes very destructive to ferns in greenhouses, it might easily be spread artificially.

16. Diasemia Hüb.

Diasemia Hüb., Verz., 348 (1826); type, *litterata* Scop.

Antennae $\frac{3}{4}$, in ♂ fasciculate-ciliated. Labial palpi porrected, second joint triangularly expanded with dense projecting scales, terminal short, concealed. Maxillary palpi with apex expanded with loose scales. Tibial outer spurs $\frac{3}{4}$ of inner.

A small widely ranging genus; the New Zealand species is one of a group of representative geographical forms indicating a former single species.

79. *D. grammalis* Doubl., Dieff. N.Z., 2, 287.
Whangarei, Hamilton, Napier, Masterton, Castle Hill.

17. Sceliodes Guen.

Sceliodes Guen., Pyr., 400 (1856); type, *cordalis* Doubl.

Forehead with conical prominence. Antennae $\frac{3}{4}$. Labial palpi porrected, second joint with projecting scales beneath, terminal joint exposed, obtuse. Maxillary palpi filiform. Tibial spurs short, nearly equal.

Besides the following there is a closely allied species from Arabia and Africa.

80. *S. cordalis* Doubl., Dieff. N.Z., 2, 288: *mucidalis* Guen., Pyr., 400: *extensalis* Walk., Cat., 34, 1311: *obsistalis* Snell., Tijd. v. Ent. 1880, 206; ibid., 1883, pl. 6, 12.

Taranaki, Wanganui, Napier, Wellington. Also common in eastern Australia and Celebes. Larva in berries of *Solanum aviculare.*

18. Proternia Meyr.

Proternia Meyr., Trans. Ent. Soc. Lond., 1884, 317; type, *philocapna* Meyr.

Forehead with conical prominence. Antennae $\frac{3}{4}$, in ♂ with a somewhat thickened sinuation at $\frac{2}{3}$, containing a row of projecting scales beneath. Labial palpi porrected, second joint with dense projecting scales beneath, terminal joint almost concealed. Maxillary palpi filiform. Tibial outer spurs half inner.

Only includes the following species.

81. *P. philocapna* Meyr., Trans. Ent. Soc. Lond., 1884, 317.

Whangarei, Hamilton, Wellington, Mount Hutt.

19. Hymenia Hüb.

Hymenia Hüb., Verz., 360 (1826); type, *fascialis* Cram. *Zinckenia* Zell., Lep. Caff., 55 (1852); type, *fascialis* Cram.

Antennae $\frac{2}{3}$, basal joint in ♂ with erect apical spine or scale-projection on inner side, stalk notched above basal joint. Labial palpi arched, ascending, second joint with dense projecting scales beneath, terminal joint moderate, pointed. Maxillary palpi filiform. Tibial spurs nearly equal.

A genus of few species, of which the following is now spread by man throughout the warmer regions of the world. New Zealand is hardly warm enough for it.

82. *H. fascialis* Cram., Pap. Exot., 4, pl. 398, f. O: *recurvalis* Fab., Ent. Syst., 237.

Auckland. Also in Australia (as far south as Sydney), and throughout the warmer parts of Asia, Africa, and America. Larva feeds on *Cucurbitaceae* (melons, &c.) in gardens.

20. Nesarcha Meyr.

Nesarcha Meyr., Trans. Ent. Soc. Lond., 1884, 330; type, *hybrealis* Walk. *Adena* Walk., Cat., 27, 197 (1863); type, *hybrealis* Walk. *Deana* Butl., Ann. Mag. Nat. Hist. (5), 4, 451 (1879); type, *hybrealis* Walk.

Antennae $\frac{2}{3}$. Labial palpi very long, porrected, second joint triangularly expanded with projecting scales, terminal joint concealed. Maxillary palpi dilated with scales towards apex. Tibial outer spurs in ♂ very short, in ♀ half inner.

Besides the following, Snellen attributes to this genus a species from Java which I do not know. The generic name *Adena* Walk. is strictly preoccupied, having been used as a correction of *Hadena;* for this reason Butler proposed to substitute *Deana,* but as there was already a genus *Deanea* the suggestion was not a happy one; in these circumstances it seems better to retain *Nesarcha,* which has been generally adopted.

83. *N. hybrealis* Walk., Cat., 18, 797 (*hybreasalis*): *paronalis*, ibid., 797: *xanthialis*, ibid., 27, 198.
   Auckland, Palmerston, Nelson, Christchurch, Dunedin.

21. Mecyna Steph.

Mecyna Steph., List Brit. Mus., 5, 240 (1850); type, *polygonalis* Hüb. *Mnesictena* Meyr., Trans. Ent. Soc. Lond., 1884, 328; type, *marmarina* Meyr.

Antennae $\frac{3}{4}$. Labial palpi long or rather long, porrected, second joint triangularly expanded with projecting scales, terminal joint more or less concealed. Maxillary palpi dilated with scales towards apex. Tibial outer spurs half inner. Hindwings with some loose hairs on and beneath median vein, but without defined pecten.

A small genus, of wide distribution; the New Zealand species are of South American affinity, except the first.

84. *M. maorialis* Feld., Reis. Novar., pl. 134, 34.
   Auckland, Napier, Wanganui, Nelson, Christchurch. This is nearly allied to a group of similar species extending through Europe, the Indo-Malayan region, and Australia, and has formerly been supposed identical with one or other of them, but is now regarded as distinct. Larva on *Sophora tetraptera.*
85. *M. daiclealis* Walk., Cat., 19, 1017 (*daiclesalis*); Meyr., Trans. N.Z. Inst., 1889, 155.
   Wellington, Dunedin.
86. *M. notata* Butl., Cist. Ent., 2, 493.
   Arthur's Pass, Dunedin.
87. *M. flavidalis* Doubl., Dieff. N.Z., 2, 287: *quadralis*, ibid., 288: *dipsasalis* Walk., Cat., 18, 796: *otagalis* Feld., Reis. Novar., pl. 134, 35.
   North and South Islands, up to 4,000 ft. Common and variable.
88. *M. pantheropa* Meyr., Trans. Ent. Soc. Lond., 1902, 277.
   Chatham Islands.
89. *M. marmarina* Meyr., Trans. Ent. Soc. Lond., 1884, 329.
   Auckland, Palmerston, Wellington, Christchurch, Dunedin; also in the Chatham Islands.

22. Proteroeca Meyr.

Proteroeca Meyr., Trans. Ent. Soc. Lond., 1884, 335; type, *comastis* Meyr.

Forehead with slight conical prominence. Antennae $\frac{3}{4}$, in ♂ fasciculate-ciliated. Labial palpi porrected, clothed with long rough projecting hairs, terminal joint penicillate, partially concealed. Maxillary palpi filiform, apex penicillate. Tibial outer spurs more than half inner.

Contains only the following species.

90. *P. comastis* Meyr., Trans. Ent. Soc. Lond., 1884, 335.
Nelson, Christchurch, Castle Hill, Wedderburn.

23. Heliothela Guen.

Heliothela Guen., Pyr., 152 (1854); type, *atralis* Hüb. *Nyctarcha* Meyr., Trans. Ent. Soc. Lond., 1884, 344; type, *ophideres* Walk.

Antennae less than $\frac{2}{3}$. Labial palpi porrected, second joint with dense projecting scales beneath, longer towards apex, terminal joint exposed, stout. Maxillary palpi not much shorter than labial, expanded with scales towards apex, truncate. Tibial outer spurs half inner. Hindwings with lower margin of cell more or less clothed with loose hairs towards base, but without defined pecten.

A small genus of early type, containing at present two European species, one Indian ranging into Australia and Madagascar, three Australian, and one New Zealand species.

91. *H. erebopis* n. sp.: *atra* Butl., Proc. Zool. Soc. Lond., 1877, 404; Meyr., Trans. N.Z. Inst., 1885, 70.
Castle Hill, Lake Wakatipu; 2,000–5,000 ft. I think it necessary to rename this species, as Butler's name *atra* is certainly likely to lead to confusion with the European *atralis*, the type of the genus. Butler did not recognize his species as a *Heliothela*.

24. Scoparia Haw.

Scoparia Haw., Lep. Brit., 491 (1911); type, *cembrae* Haw. *Xeroscopa* Meyr., Trans. Ent. Soc. Lond., 1884, 349; type, *ejuncida* Knaggs.

Antennae $\frac{4}{5}$. Labial palpi porrected, second joint with long dense projecting scales beneath, longer towards apex, terminal joint exposed. Maxillary palpi rather long, triangularly dilated with scales. Tibial outer spurs half inner. Hindwings with 4 and 5 connate or stalked.

A large genus, of world-wide distribution, but nowhere very prominent except in New Zealand and the Hawaiian Islands, in each of which regions it is very numerously developed; in New Zealand it has eighty-eight species, being the largest genus of *Lepidoptera*, and forming nearly a tenth of the whole lepidopterous fauna, and in the Hawaiian Islands it has about sixty species. The larvae mostly feed on mosses and lichens, but sometimes on the roots of other plants, and probably many of the New Zealand species feed on the roots of grass, their habits being similar to those of *Crambus*. The greater number of the New Zealand species are considerably larger and more diversified in appearance than those of other regions; these types are most nearly approached by the few species known from the colder parts of South America, whence others will doubtless be discovered.

92. *S. thyridias* Meyr., Trans. Ent. Soc. Lond., 1905, 228.
Lake Wakatipu.
93. *S. oreas* Meyr., Trans. N.Z. Inst., 1885, 81.
Lake Wakatipu; 5,000 ft.
94. *S. philerga* Meyr., Trans. N.Z. Inst., 1885, 81.
North and South Islands; generally common.
95. *S. meliturga* Meyr., Trans. Ent. Soc. Lond., 1905, 228.
Auckland, Wellington.

96. *S. chlamydota* Meyr., Trans. N.Z. Inst., 1885, 82.
Wellington, Arthur's Pass, Dunedin, Lake Wakatipu.
97. *S. triclera* Meyr., Trans. Ent. Soc. Lond., 1905, 230.
Wellington.
98. *S. hemiplaca* Meyr., Trans. N.Z. Inst., 1889, 155.
Wellington. Larva on moss.
99. *S. dochmia* Meyr., Trans. Ent. Soc. Lond., 1905, 229.
Lake Wakatipu ; 1,300 ft.
100. *S. minusculalis* Walk., Cat., 34, 1503 ; Meyr., Trans. N.Z. Inst., 1885, 82.
Akaroa, Bealey River, Dunedin, Lake Wakatipu. Larva on moss.
101. *S. minualis* Walk., Cat., 34, 1504 ; Meyr., Trans. N.Z. Inst., 1885, 83.
Napier, Ohakune, Wellington, Christchurch, Otira River.
102. *S. chimeria* Meyr., Trans. N.Z. Inst., 1885, 84.
Taranaki, Palmerston, Masterton, Wellington, Christchurch, Dunedin, Lake Wakatipu.
103. *S. dinodes* Meyr., Trans. N.Z. Inst., 1885, 85.
Wellington, Christchurch, Dunedin.
104. *S. parmifera* Meyr., Subantarct. Isl. N.Z., 72.
Auckland Island.
105. *S. acharis* Meyr., Trans. N.Z. Inst., 1885, 85.
Wellington, Akaroa, Dunedin, Invercargill.
106. *S. cymatias* Meyr., Trans. N.Z. Inst., 1885, 86.
Nelson, Arthur's Pass, Mount Hutt, Invercargill.
107. *S. microphthalma* Meyr., Trans. N.Z. Inst., 1885, 87.
Christchurch, Lake Wakatipu.
108. *S. hemicycla* Meyr., Trans. N.Z. Inst., 1885, 87.
Mount Holdsworth, Mount Arthur, Arthur's Pass ; 3,000–4,000 ft.
109. *S. xysmatias* Meyr., Trans. N.Z. Inst., 1907, 110.
Dunedin.
110. *S. ergatis* Meyr., Trans. N.Z. Inst., 1885, 88.
Wellington, Castle Hill, Invercargill.
111. *S. autochroa* Meyr., Trans. N.Z. Inst., 1907, 110.
Invercargill.
112. *S. encapna* Meyr., Trans. N.Z. Inst., 1888, 65.
Mount Arthur ; 4,000 ft.
113. *S. critica* Meyr., Trans. N.Z. Inst., 1885, 88.
Mount Arthur, Arthur's Pass, Lake Wakatipu ; 2,500–4,000 ft.
114. *S. characta* Meyr., Trans. N.Z. Inst., 1885, 90.
Makatoku, Palmerston, Christchurch, Dunedin.
115. *S. ustimacula* Feld., Reis. Novar., pl. 135, 17 ; Meyr., Trans. N.Z. Inst., 1885, 91 : *conifera* Butl., Cist. Ent., 2, 493.
Wellington, Porter's Pass, Dunedin.
116. *S. pongalis* Feld., Reis. Novar., pl. 137, 33 ; Meyr., Trans. N.Z. Inst., 1885, 91.
Auckland, Makatoku, Dunedin.
117. *S. melanaegis* Meyr., Trans. N.Z. Inst., 1885, 92.
Arthur's Pass, Lake Wakatipu ; 1,700–4,200 ft.
118. *S. trapezophora* Meyr., Trans. N.Z. Inst., 1885, 93.
Mount Arthur, Castle Hill ; 3,000–4,000 ft.
119. *S. philetaera* Meyr., Trans. N.Z. Inst., 1885, 93.
Bealey River.

120. *S. locularis* Meyr., Trans. N.Z. Inst., 1912, 118.
Mount Arthur (3,400 ft.), Lake Wakatipu.
121. *S. torodes* Meyr., Trans. Ent. Soc. Lond., 1901, 568.
Mount Cook.
122. *S. triscelis* Meyr., Subantarct. Isl. N.Z., 71.
Lake Wakatipu, Auckland Island.
123. *S. colpota* Meyr., Trans. N.Z. Inst., 1888, 65.
Wellington.
124. *S. choristis* Meyr., Trans. N.Z. Inst., 1907, 111.
Wellington.
125. *S. periphanes* Meyr., Trans. N.Z. Inst., 1885, 94.
Whangarei, Wellington, Lake Wakatipu.
126. *S. phalerias* Meyr., Trans. Ent. Soc. Lond., 1905, 230.
Wellington.
127. *S. diphtheralis* Walk., Cat., 34, 1501 ; Meyr., Trans. N.Z. Inst., 1885, 94.
Hamilton, Palmerston, Napier, Wellington, Christchurch, Otira River.
128. *S. submarginalis* Walk., Cat., 27, 48 ; Meyr., Trans. N.Z. Inst., 1885, 95 : ? *linealis* Walk., Cat., 34, 1503 : *maoriella*, ibid., 35, 1720.
North and South Islands ; common generally.
129. *S. cataxesta* Meyr., Trans. N.Z. Inst., 1885, 96.
Otira River, Castle Hill, Lake Guyon, Lake Wakatipu.
130. *S. asaleuta* Meyr., Trans. N.Z. Inst., 1907, 111.
Lake Wakatipu.
131. *S. tetracycla* Meyr., Trans. N.Z. Inst., 1885, 97.
Nelson, Lake Coleridge.
132. *S. gyrotoma* Meyr., Trans. N.Z. Inst., 1909, 7.
Lake Tekapo, Ida Valley.
133. *S. indistinctalis* Walk., Cat., 27, 48 ; Meyr., Trans. N.Z. Inst., 1885, 97 : *rakaiensis* Knaggs, Ent. Mo. Mag., 4, 80.
Wellington, Christchurch, Lake Wakatipu.
134. *S. chalicodes* Meyr., Trans. N.Z. Inst., 1885, 98.
Napier, Wanganui, Christchurch, Mount Hutt.
135. *S. fragosa* Meyr., Trans. N.Z. Inst., 1910, 71.
Kermadec Islands.
136. *S. leptophaea* Meyr., Trans. Ent. Soc. Lond., 1902, 277.
Chatham Islands.
137. *S. psammitis* Meyr., Trans. N.Z. Inst., 1885, 99.
Mount Ruapehu, Mount Holdsworth, Mount Arthur (4,000 ft.), Arthur's Pass (4,500 ft.), Dunedin, Lake Wakatipu, Invercargill.
138. *S. leptalea* Meyr., Trans. N.Z. Inst., 1885, 98.
Hamilton, Napier, Masterton, Wellington, Christchurch.
139. *S. epicomia* Meyr., Trans. N.Z. Inst., 1885, 99.
Kermadec Islands, North and South Islands, Auckland Island ; up to 3,800 ft.
140. *S. feredayi* Knaggs, Ent. Mo. Mag., 4, 80 ; Meyr., Trans. N.Z. Inst., 1885, 100 : *moanalis* Feld., Reis. Novar., pl. 137, 34.
Wellington, Bealey River, Lake Guyon, Lake Wakatipu.
141. *S. acompa* Meyr., Trans. N.Z. Inst., 1885, 100.
Lake Wakatipu ; 1,200 ft.
142. *S. cyptastis* Meyr., Trans. N.Z. Inst., 1909, 7.
Invercargill.

143. *S. manganeutis* Meyr., Trans. N.Z. Inst., 1885, 102.
Otira Gorge ; 1,600–2,600 ft.
144. *S. crypsinoa* Meyr., Trans. N.Z. Inst., 1885, 102.
Castle Hill (3,000 ft.), Lake Wakatipu (3,000–4,000 ft.), Ida Valley.
145. *S. agana* Meyr., Trans. N.Z. Inst., 1912, 119.
Mount Ruapehu (4,500 ft.), Arthur's Pass (3,000 ft.), Lake Wakatipu.
146. *S. alopecias* Meyr., Trans. Ent. Soc. Lond., 1901, 570.
Mount Cook.
147. *S. axena* Meyr., Trans. N.Z. Inst., 1885, 103.
Mount Arthur (4,000–4,500 ft.), Arthur's Pass (4,000 ft.), Castle Hill, Dunedin.
148. *S. steropaea* Meyr., Trans. N.Z. Inst., 1885, 103.
Castle Hill ; 2,500–3,000 ft.
149. *S. exilis* Knaggs, Ent. Mo. Mag., 4, 81 ; Meyr., Trans. N.Z. Inst., 1885, 104.
Wellington, Christchurch, Dunedin, Lumsden, Lake Wakatipu.
150. *S. elaphra* Meyr., Trans. N.Z. Inst., 1885, 105.
Palmerston, Christchurch, Invercargill.
151. *S. paltomacha* Meyr., Trans. N.Z. Inst., 1885, 105.
Tararua Range, Castle Hill, Mount Hutt, Lake Wakatipu.
152. *S. deltophora* Meyr., Trans. N.Z. Inst., 1885, 106.
Mount Arthur, Arthur's Pass ; 3,000–4,500 ft.
153. *S. sabulosella* Walk., Cat., 27, 178 ; Meyr., Trans. N.Z. Inst., 1885, 106.
North and South Islands, common generally at low levels ; Enderby Island.
154. *S. panopla* Meyr., Trans. N.Z. Inst., 1885, 107.
Mount Hutt.
155. *S. clavata* Philp., Trans. N.Z. Inst., 1912, 116.
Hump Ridge ; 3,000 ft.
156. *S. trivirgata* Feld., Reis. Novar., pl. 137, 29 ; Meyr., Trans. N.Z. Inst., 1885, 107.
Mount Ruapehu (4,500 ft.), Christchurch, Mount Arthur, Lake Wakatipu.
157. *S. augastis* Meyr., Trans. N.Z. Inst., 1907, 112.
Invercargill.
158. *S. petrina* Meyr., Trans. N.Z. Inst., 1885, 111.
Castle Hill, Bealey River, Lake Guyon, Aorangi.
159. *S. halopis* Meyr., Subantarct. Isl. N.Z., 72.
Auckland Island.
160. *S. cyameuta* Meyr., Trans. N.Z. Inst., 1885, 112.
Wellington, Mount Arthur, Arthur's Pass, Mount Hutt, Dunedin, Lake Wakatipu.
161. *S. dryphactis* Meyr., Trans. N.Z. Inst., 1911, 61.
Wellington, Lake Wakatipu.
162. *S. astragalota* Meyr., Trans. N.Z. Inst., 1885, 113.
Wellington, Mount Arthur (4,000 ft.), Mount Hutt, Lake Wakatipu.
163. *S. rotuella* Feld., Reis. Novar., pl. 137, 30 ; Meyr., Trans. N.Z. Inst., 1885, 113.
Wellington, Mount Hutt.
164. *S. harpalea* Meyr., Trans. N.Z. Inst., 1885, 114.
Wellington, Otira Gorge.

165. *S. ejuncida* Knaggs, Ent. Mo. Mag., 4, 81 ; Meyr., Trans. N.Z. Inst., 1885, 114.
Bealey River, Lake Coleridge, Mount Hutt (3,000 ft.), Lake Wakatipu (3,000–4,000 ft.).
166. *S. niphospora* Meyr., Trans. N.Z. Inst., 1885, 115.
Mount Arthur, Arthur's Pass, Castle Hill, Lake Wakatipu ; 2,500–4,500 ft.
167. *S. apheles* Meyr., Trans. N.Z. Inst., 1885, 115.
Arthur's Pass ; 4,500 ft.
168. *S. aspidota* Meyr., Trans. N.Z. Inst., 1885, 115.
Wellington, Mount Hutt, Dunedin, Lake Wakatipu.
169. *S. sideraspis* Meyr., Trans. Ent. Soc. Lond., 1905, 231.
Mount Earnslaw (5,300 ft.), Humboldt Range (5,300 ft.).
170. *S. nomeutis* Meyr., Trans. N.Z. Inst., 1885, 116.
Mount Arthur, Hump Ridge, Lake Wakatipu ; 3,500–5,000 ft.
171. *S. parachalca* Meyr., Trans. Ent. Soc., Lond., 1901, 569.
Mount Cook.
172. *S. organaea* Meyr., Trans. Ent. Soc. Lond., 1901, 569.
Mount Cook.
173. *S. epicremna* Meyr., Trans. N.Z. Inst., 1885, 117.
Arthur's Pass, Castle Hill.
174. *S. luminatrix* Meyr., Trans. N.Z. Inst., 1909, 8.
Otira Gorge, Invercargill.
175. *S. legnota* Meyr., Trans. N.Z. Inst., 1885, 117.
Otira Gorge, Mount Hutt, Lake Wakatipu.
176. *S. chalara* Meyr., Trans. Ent. Soc. Lond., 1901, 570.
Mount Cook.
177. *S. octophora* Meyr., Trans. N.Z. Inst., 1885, 118.
Christchurch, Mount Hutt (3,000 ft.), Bealey River, Lake Wakatipu, Invercargill.
178. *S. asterisca* Meyr., Trans. N.Z. Inst., 1885, 118.
Wellington, Mount Hutt, Arthur's Pass (4,500 ft.), Lake Wakatipu.
179. *S. leucogramma* Meyr., Trans. N.Z. Inst., 1885, 119.
Mount Hutt, Lake Wakatipu.

25. Clepsicosma Meyr.

Clepsicosma Meyr., Trans. N.Z. Inst., 1888, 63 ; type, *iridia* Meyr.

Face slightly prominent, oblique. Antennae $\frac{3}{4}$, in ♂ fasciculate-ciliated. Labial palpi long, porrected, with long loosely projecting scales, attenuated to apex, terminal joint concealed. Maxillary palpi rather long, triangularly dilated with loose scales. Tibial outer spurs $\frac{2}{3}$ of inner.

A curious endemic genus.

180. *C. iridia* Meyr., Trans. N.Z. Inst., 1888, 64.
Auckland, Tararua Range, Kaitoke.

5. Pyralididae.

Maxillary palpi present. Forewings with 7 and 8 out of 9. Hindwings without defined pecten of hairs on lower margin of cell, 4 and 5 closely approximated or stalked, 7 out of 6 near origin, free or anastomosing with 8.

A family of moderate extent and general distribution, but the only two New Zealand species are not indigenous.

26. Diplopseustis Meyr.

Diplopseustis Meyr., Trans. Ent. Soc. Lond., 1884, 284; type, *perieralis* Walk.

Labial palpi rather long, porrected, second joint with dense rather short projecting scales, forming a short apical tuft beneath, terminal joint moderate, slender, obliquely ascending. Maxillary palpi moderate, triangularly dilated with scales. Forewings with 4 and 5 stalked. Hindwings with 4 and 5 stalked, 7 anastomosing with 8.

Perhaps contains only the following species.

181. *D. perieralis* Walk., Cat., 19, 958 (*perieresalis*): *minima* Butl., Proc. Zool. Soc. Lond., 1880, 684; Meyr., Trans. Ent. Soc. Lond., 1884, 285; Trans. N.Z. Inst., 1888, 63.

Auckland, Wanganui, Christchurch. Also common in eastern Australia, and occurs in Fiji, Formosa, Borneo, and Assam. It occurs near towns, and is probably attached to some cultivated plant.

27. Pyralis Linn.

Pyralis Linn., Syst. Nat. (12), 881 (1767); type, *farinalis* Linn.

Labial palpi ascending, second joint rough-scaled, terminal joint moderate. Maxillary palpi filiform. Forewings with 4 and 5 stalked. Hindwings with 4 and 5 stalked, 8 free.

A genus of about 20 species, chiefly Indo-Malayan, but some of the species have been very widely spread.

182. *P. farinalis* Linn., Syst. Nat. (10), 226; Meyr., Trans. N.Z. Inst., 1885, 122.

Christchurch. Generally distributed in Australia, and occurs also through most of the world, but probably Central Asiatic in origin. Larva on flour and corn-refuse, and therefore readily imported by man.

6. Thyrididae.

Maxillary palpi obsolete. Forewings with 8 and 9 usually separate. Hindwings without defined pecten of hairs on lower margin of cell, 1 absent, 8 usually free.

A family of moderate size, mainly tropical in distribution; only one species reaches New Zealand.

28. Morova Walk.

Morova Walk., Cat., 32, 523 (1865); type, *subfasciata* Walk.

Face prominent. Labial palpi short, stout, subascending, with appressed scales, terminal joint very short, obtuse. Forewings with 8 and 9 short-stalked or approximated towards base. Hindwings with 5 tolerably remote from angle, 7 from before upper angle, 8 free.

Includes only the following species.

183. *M. subfasciata* Walk., Cat., 32, 523; Meyr., Trans. N.Z. Inst., 1884, 108: *gallicolens* Butl., Voy. Ereb. Terr., Ins., 46.

Wellington, Christchurch, Dunedin. Also occurs in Fiji. Larva in gall-like swellings of the stem of *Parsonsia*.

7. Pterophoridae.

Maxillary palpi obsolete. Forewings usually fissured, forming two (rarely three or four) segments, 8 and 9 usually stalked. Hindwings without defined pecten of hairs on lower margin of cell, on lower surface with a double row of short dark spine-like scales on lower margin of cell, 5 remote from 4, 7 remote from 6, shortly approximated to 8 beyond origin, wing usually figured, forming three segments.

A considerable family of very general distribution.

29. Platyptilia Hüb.

Platyptilia Hüb., Verz., 429 (1826) ; type, *gonodactyla* Schiff.

Forehead usually with tuft of scales. Forewings bifid, segments moderate, 8 and 9 stalked. Hindwings trifid, third segment with black scales in dorsal cilia, sometimes barely traceable.

An extensive and cosmopolitan genus. The larvae are usually attached to species of *Compositae.*

184. *P. isoterma* Meyr., Trans. N.Z. Inst., 1909, 10.
Wellington.

185. *P. heliastis* Meyr., Trans. N.Z. Inst., 1885, 129.
Mount Arthur, Castle Hill, Lake Wakatipu.

186. *P. falcatalis* Walk., Cat., 30, 931 ; Meyr., Trans. N.Z. Inst., 1885, 128 : *repletalis* Walk., Cat., 30, 931.
North and South Islands, common ; up to 3,600 ft.

187. *P. aeolodes* Meyr., Trans. Ent. Soc. Lond., 1902, 278 ; Trans. N.Z. Inst., 1909, 10.
Wellington, Invercargill, Chatham Islands, Auckland Island.

188. *P. deprivatalis* Walk., Cat., 30, 946 : *haasti* Feld., Reis. Novar., pl. 140, 58 ; Meyr., Trans. N.Z. Inst., 1885, 128.
Hamilton, Christchurch, Otira River, Lake Wakatipu, Invercargill.

189. *P. campsiptera* Meyr., Trans. N.Z. Inst., 1907, 112.
Lake Wakatipu.

190. *P. epotis* Meyr., Trans. Ent. Soc. Lond., 1905, 231 ; Trans. N.Z. Inst., 1911, 73.
Mount Arthur, Humboldt Range (3,600 ft.).

30. Alucita Linn.

Alucita Linn., Syst. Nat., 542 (1758) ; type, *pentadactyla* Linn.

Forehead without tuft. Forewings bifid, segments narrow, 2 sometimes absent, 3 absent, 8–10 absent, 11 sometimes absent. Hindwings trifid, third segment without black scales in dorsal cilia ; 3 absent.

Fairly extensive, but mainly located round the shores of the Mediterranean ; some of the species range very widely. The New Zealand species seem to be of Indo-Malayan affinity, but are all endemic.

191. *A. monospilalis* Walk., Cat., 30, 950 ; Meyr., Trans. N.Z. Inst., 1885, 124 : *patruelis* Feld., Reis. Novar., pl. 140, 56.
Whangarei, Auckland, Wellington, Nelson, Otira River, Christchurch, Dunedin.

192. *A. lycosema* Meyr., Trans. N.Z. Inst., 1885, 124.
Auckland, Wellington, Christchurch, Dunedin.

193\. *A. furcatalis* Walk., Cat., 30, 950; Feld., Reis. Novar., pl. 140, 52; Meyr., Trans. N.Z. Inst., 1885, 123.
Auckland, Cambridge, Palmerston, Makatoku, Wellington, Otira River.

194\. *A. innotatalis* Walk., Cat., 30, 945; Meyr., Trans. N.Z. Inst., 1885, 124; Trans. Ent. Soc. Lond., 1885, 424.
Napier, Palmerston, Masterton, Nelson, Otira River, Christchurch, Invercargill.

31. Stenoptilia Hüb.

Stenoptilia Hüb., Verz., 430 (1826); type, *pterodactyla* Linn.

Forehead with horny prominence or tuft of scales. Forewings bifid, segments moderate or rather narrow, 8 and 9 stalked. Hindwings trifid, third segment without black scales in dorsal cilia.

A genus of moderate extent, generally distributed.

195\. *S. celidota* Meyr., Trans. N.Z. Inst., 1885, 125.
Christchurch, Lake Wakatipu. Also widely distributed in Australia.

196\. *S. lithoxesta* Meyr., Trans. N.Z. Inst., 1885, 127; Gen. Ins., 100, f. 18.
Arthur's Pass.

197\. *S. charadrias* Meyr., Trans. N.Z. Inst., 1885, 126.
Arthur's Pass.

198\. *S. vigens* Feld., Reis. Novar., pl. 140, 49; Meyr., Trans. N.Z. Inst., 1912, 119.
Lake Wakatipu.

199\. *S. orites* Meyr., Trans. N.Z. Inst., 1885, 126.
Clinton.

200\. *S. zophodactyla* Dup., Hist. Nat. Lép. Fr., 11, 314: *canalis* Walk., Cat., 30, 944.
Wellington. Occurs also in eastern Australia, India, Europe, Africa, and South America.

In the following indexes the numbers refer to those attached to the genera and species in consecutive order. Names italicized are synonyms.

Index of Genera.

INDEX OF GENERA—*continued.*

INDEX OF SPECIES.

INDEX OF SPECIES—*continued.*

Index of Species—*continued.*

Art. VI.—*Description of a New Species of* Perla *(Stone-fly) in New Zealand.*

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

[*Read before the Wellington Philosophical Society, 1st May, 1912.*]

Leptoperla grandis n. sp.

The expansion of the wings is 2 in. The antennae are shorter than the forewings. The head and thorax are blackish-brown, the abdomen paler brown. The forewings are pale greyish-brown, darker towards the base, and very sparsely covered with clear dots; the posterior veinlets are very distinct, and marked with clearer lines. The hindwings are transparent, with a chain of oblong grey marks on the costa between the veinlets. The eggs are brownish-grey, banded with paler. The caudal setae are about one-quarter the length of the abdomen, yellowish-brown.

A single specimen of this very fine species, which is as large as the well-known *Stenoperla prasina*, was discovered by Mrs. Hudson last January amongst foliage on the banks of the Mangawhero River, near Ohakune, Main Trunk line. Every effort was made to secure further specimens, but without result. It is evidently a rare insect, and, as I am unwilling to allow it to remain undescribed for an indefinite period, the foregoing description has been prepared. It must, however, be regarded as provisional only, and as soon as other specimens are available they will be submitted to a specialist in the group, in order that the description may be amplified if necessary, and the reference of the species to the genus *Leptoperla* verified.

Art. VII.—*Notes on Flightless Females in certain Species of Moths, with an Attempted Explanation.*

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

[*Read before the Wellington Philosophical Society, 31st July, 1912.*]

The existence of semi-apterous females in certain species of moths has long been known to entomologists, and has been fully described in many entomological works, but, as far as I have been able to ascertain, no attempt has yet been made to explain why the semi-apterous condition has been assumed by the female sex, or in what respects such a condition in that sex can benefit the species.

Owing to the limited number of foreign works on entomology, and the restricted nature of the exotic collections at present available for study in the Dominion, I have been obliged to confine my attention to species inhabiting New Zealand and the British Islands. The circumstances in connection with the occurrence of flightless females in both these regions prove, however, to be strikingly similar, and this fact merits careful consideration when seeking to obtain an explanation of this interesting phenomenon. It is perhaps needless to point out that the loss of the power of flight in one sex, whilst fully retained in the other, is a very remarkable and interesting circumstance, and the present requirements of natural history demand not only that a detailed account of the surrounding facts be given, but that a provisional theory at least be set up to account for it. I should perhaps here point out that these semi-apterous females are quite on a different footing to those insects where the power of flight has been lost in both sexes. The general question of apterous insects has very often been dealt with, and many adequate explanations have been given to account for the loss of flight under the most varied conditions. The present paper, however, is solely concerned with those insects in which the wings of the female are so abbreviated as to render that sex incapable of flight, the male retaining his flying-powers quite unimpaired.

Before proceeding further it will be desirable to consider the following list of *Lepidoptera* in which the females are semi-apterous. In addition to general remarks, this list gives, as far as is known, the food plant of the larva of each species, as well as its distribution, and the time of the year when the perfect insect appears.

In the *Psychidae*, which are represented in New Zealand by two species —i.e., *Oeceticus omnivorous* and *Orophora unicolor*—the females are not only apterous, but have rudimentary legs, and are incapable of walking, being, in fact, mere egg-bags. I have not included these insects in the present paper, as the species here dealt with have the females normally developed except in respect of the wings.

A. *New Zealand Species.*

Name.	Time of Appearance.	Food Plant.	Distribution of Food Plant.	General Remarks on Habits.
Metacrias strategica ..	Middle of November to end of January	Various grasses ..	General ..	Frequents the flat country near Invercargill, and has also been taken on the Richardson Range, South Canterbury. The males fly in warm sunny weather only. (Philpott.)
Metacrias erichrysa ..	January	*Senecio bellidioides* (Meyrick)	,, ..	A strictly mountain insect, at present only recorded from the tableland of Mount Arthur, at elevations of over 4,000 ft. The males fly with great rapidity in the hottest sunshine.
Metacrias huttonii ..	December and January	Various grasses ..	,, ..	Another strictly alpine species, frequenting the mountains around Lake Wakatipu, at elevations of about 4,000 ft. The males fly very rapidly in hot sunshine.
Hybernia indocilis ..	July to January ..	*Leptospermum?* ..	,, ..	According to the late Mr. R. W. Fereday, the male is found plentifully at rest on bare ground amongst *Leptospermum*, and the female on the stems.
Atomotricha ommatias	August and September	Unknown	Unknown ..	Found on fences during cold nights in August and September. The female, if touched, hops 2 in. or 3 in. (Philpott and Sunley.)
Brachysara sordida ..	June and July ..	,, ...	,, ..	Found on fences during cold nights in the depth of winter. (Sunley.)
Mallobathra scoriota ..	Early in September (Invercargill)	,, ...	,, ..	The males of this species were found by Mr. Philpott flying in numbers over ferns in an open space in the forest. A semi-apterous female evidently referable to this species was found at rest on a fern-leaf.
Taleporia aphrosticha ..	December	,, ...	,, ..	Two males and one semi-apterous female were taken by Mr. Philpott on The Hump, Southland, at an elevation of 3,500 ft. above sea-level. It is evidently a mountain insect, and therefore subject to winter conditions.

B. *British Species.*

Name.	Time of Appearance.	Food Plant.	Distribution of Food Plant.	General Remarks on Habits.
Orgyia antiqua (Vapourer Moth)	August and September	Most trees and bushes	General ..	Flies rapidly in hot sunshine. Is very common in the streets of London. (Stainton.)
Orgyia gonostigma (Scarce Vapourer Moth)	June. Second brood, July or August. Larva hibernates	Generally sallow, willow, and oak; also beech, elm, hawthorn, sloe, and nut	,, ..	The moths emerge in June, and from their eggs caterpillars result in July. These, feeding up quickly, attain the perfect state in late July or early August. Caterpillars from this second generation usually go into hibernation when quite small, and feed up in the following April and May; in confinement they may, however, get through their metamorphosis and reach the moth state in September or October. Sometimes it happens that a part of the summer brood of caterpillars will feed up straight away and produce moths in August; others, feeding and growing more slowly, assume the winged state in November, whilst a third portion will remain small and go into hibernation. (South).
Cheimatobia brumata (Winter Moth)	November to February	Apple and other fruit trees	..	The parent moth deposits her eggs in the months of November and December, frequently on hawthorn or apple; in the early spring as soon as the hedges begin to have a greenish tinge, but before the leaf-buds are fully expanded, these eggs hatch, and the small looping larvae begin feeding on the young unexpanded leaves, eating a number of holes in them. They are sometimes extremely injurious from their numbers to apple orchards and even to hawthorn hedges. A few years ago I had about 50 yards of a hawthorn hedge eaten perfectly bare by the larvae of this insect, and the larvae feeding on the young unexpanded shoots cannot be expelled by shaking or beating. When they attack apple orchards in numbers the entire crop may be lost. About the end of May these small green looping larvae are full-fed, and then descend below the surface of the earth, where they undergo their change to the pupa state. About the middle of November the pupa comes to the surface, and, the skin cracking, the moth escapes, and, crawling up the hedge or tree-stem, proceeds to expand and dry its wings. It is, however, only the male which has developed wings; the female has the wings no larger than when it first emerges from the pupa, and is therefore incapable of flight. On a mild November evening the males may be seen flying along the leafless hedges by hundreds, and if we examine the hedges with a lantern we shall see the subapterous females sitting on the twigs. (Stainton.)
Cheimatobia boreata ..	October to December..	Birch	General ..	A rare species.
Hybernia rupicapraria (Early Moth)	January and February	Hawthorn, sloe, plum, and bilberry	,, ..	Although generally common, and often abundant, over England, Wales, the south of Scotland, and Ireland, this species hardly ever comes under notice unless hedgerows and hawthorn-bushes are examined in January and February by the aid of a lantern after darkness has set in. Then the males and almost-wingless females will be found in numbers, sitting at the ends of the twigs. (South.)

Hybernia leucophaearia (Spring Usher)	February	Oak	,,	The moth rests on tree-trunks, fences, &c., and the males may be thus found during the day in February, earlier or later in some seasons; the female is less often obtained on trees and fences, but may be beaten, together with the male, from the dead leaves which remain upon oak and other bushes. (South.)
Hybernia aurantiaria (Scarce Umber)	October to December	Oak, birch, blackthorn	,,	The moth is out in the latter part of the year from October, and is best obtained at night, when sitting on the twigs of trees or bushes, but a specimen or two may be found on tree-trunks, palings, &c., in the daytime. (South.)
Hybernia marginaria (Dotted Border)	March and April	Oak, birch, hawthorn, sloe, alder, sallow	,,	The moth is out in March and April, and after their short evening flight the males may be seen in numbers on hedgerows and the twigs of trees. It is not infrequent at sallow-catkins and sometimes is not scarce on palings and tree-trunks. The female may occasionally be detected in the crevices of bark on tree-trunks, but is more easily obtained on the twigs at night. (South.)
Hybernia defoliaria (Mottled Umber)	October to December, January to February, March	Birch, oak, and other forest-trees, fruit-trees, rose, honeysuckle, &c.	,,	Generally abundant during winter months.
Anisopteryx aescularia (March Moth)	March	Hawthorn, sloe, privet, lilac, currant, plum, cherry, rose, oak, hornbeam, &c.	,,	The moth is out in spring, and may be found on palings, tree-trunks, &c., in the daytime, and more freely flying about or sitting on hedges at night, when the spider-like wingless female is more frequently obtained. The male is attracted by light, and sometimes is not uncommon on gas-lamps.
Phigalia pedaria (Pale Brindled Beauty)	Usually January–March; sometimes November and December; also mid June	Birch, oak, elm, lime, poplar, sallow, hawthorn, sloe, plum, and other fruit trees	,,	The moth may be seen in the daytime on tree-trunks, palings, &c., but the female secretes herself in any convenient cranny, and is not easily detected. The male flies at night, and comes freely to light. (South.)
Apocheima hispidaria (Small Brindled Beauty)	February and March	Oak, hawthorn, birch, and elm	,,	This moth is found resting on oak-trunks or on the grass-stems, &c., under or around the trees. The male is attracted by light. (South.)
Nyssia lapponaria (Rannoch Brindled Beauty)	April and May, in Perthshire, Scotland	Heather, bog-myrtle; will also eat birch, sallow, and hawthorn	,,	The moth is very local, frequenting damp places near streams. (South.)
Nyssia zonaria (Belted Beauty)	March and April	Sallow, dandelion, dock, plantain, clover, yarrow, grass, &c.	,,	The moth rests by day on or among herbage. The male has been known to fly in the sunshine, but its more usual time of flight is the early evening. (South.)

NOTE.—Twelve British species of *Tineina* with semi-apterous females are not included in the above table. The larvae of all these feed on plants of universal distribution. One species appears in March, four in April, one in May, one in October and November, one in November and December, and four at midsummer. Detailed habits of these species are not available to me, but the species stated to appear in midsummer belong to the genera *Fumea* and *Taleporia*. They are obscure insects, and their precise habits may not be fully known at present.

With the few exceptions shortly to be specified, it will be seen that a striking agreement exists between the New Zealand and the British species in the following respects:—

(1.) *General Distribution of the Food Plant of the Larva in the Region where the Insect is found.*—There is no exception to this rule, which holds good in every case where the female is semi-apterous and the food plant is known. It is, in fact, obvious that the semi-apterous state would be absolutely fatal to an insect feeding on a scarce or local plant, as the females would require to travel over extensive areas in order to deposit their eggs. Any advantage which a species might obtain by possessing a semi-apterous female would, therefore, be wholly neutralized unless its food plant were very common and generally distributed.

(2.) *Appearance of the Imago in Winter, or in Very Early Spring.*—It is in this circumstance, which is common to all the species having semi-apterous females, with the exception of the three species of *Metacrias* in New Zealand and the two species of *Orgyia* in the British Isles, that, in my opinion, an explanation of the semi-apterous condition of the female is to be sought. As a matter of fact, *M. erichrysa* and *M. huttonii* can hardly be regarded as exceptions, seeing that they are both strictly alpine insects, and therefore practically exist under winter conditions. One of the species of *Orgyia* also occasionally appears in winter, and may therefore have recently changed its habits. The only important exceptions are, therefore, *M. strategica* (New Zealand) and *O. antiqua* (Britain), and of the latter insect there appear to be a succession of broods throughout the entire summer. As corroborative evidence from insects belonging to an order other than the *Lepidoptera*, two of our common crane-flies (*Tipula obscuripennis* and *T. heterogama*) occur to me. They have semi-apterous females, and appear often in considerable numbers late in April and during May, a period which must, of course, be regarded as winter in New Zealand. I think, therefore, there can be no doubt that the semi-apterous condition of the female is in some way connected with the appearance of the species during cold periods.

The Effects of Cold on Insects.

In considering the cause of semi-apterous females amongst moths appearing in winter, the effect of cold on insects generally must be briefly considered. A slight lowering of the temperature below the normal produces torpidity, which is first manifested by inability to fly. Further cold results in inability to walk, then in suspended animation, and, if prolonged, in death. It is a matter of common observation that species appearing late in the autumn or in the winter are frequently so overpowered by the cold as to render them incapable of flight, and it is equally obvious that a female so incapacitated, when away from the food plant of the larva, would fail to leave offspring, owing to her eggs being deposited in a position where the young larvae would be unable to obtain food. In this way the loss of the power of flight would be a distinct advantage to the female, as she would be prevented from straying from the food plant, and, although semi-torpid through cold, would in most cases have sufficient vitality to deposit her eggs in a fitting spot before death. On the other hand, the power of flight would still be necessary for the male in order to enable him to seek out the female, and to prevent the evil effects of prolonged interbreeding. The fact that a certain number of males would no doubt perish from the cold without pairing would be of little importance so far as the perpetuation of the species is concerned, especially if the males outnumbered the females, which is known to be the case in many insects. It may, of course, be urged that a far simpler explanation of the semi-apterous condition is to be found in a lowered vitality, induced by cold, preventing the full development of the organs of flight; but the winged condition of the male, in my opinion, negatives this explanation, and the existence of many winter insects with fully developed wings in both sexes is also against it. Briefly stated, then, I believe that the semi-apterous females have been evolved in many insects appearing in the winter or very early spring because such a condition prevents them from leaving the food plant and being afterwards unable to return to it to deposit their eggs when overcome by the effects of cold. Such insects would naturally feed on widely distributed plants, as otherwise the semi-apterous condition of the female would be a fatal disadvantage; and this fact is in complete agreement with actual observation. In view of the restricted data on which this theory is based, it is put forward as a provisional hypothesis only, and may, of course, be subject to modification or rejection in the light of more extended investigations.

As a subsidiary advantage, the ability possessed by semi-apterous females to secrete themselves in crevices in the bark or in the ground may be mentioned; but I do not consider such an advantage would be commensurate with the loss of flight, and it cannot therefore, in my opinion, be regarded as the primary cause of the modification.

In conclusion, I should point out that the extreme abundance of many of the species possessing semi-apterous females indicates that the innovation has proved a most successful one in the struggle for existence, and this is further demonstrated by the fact that almost all the species appear in winter, when the insectivorous birds are often sorely pressed by hunger, and in consequence keenly on the alert for insect food.

Art. VIII.—*Notes on the Entomology of the Ohakune and Waiouru Districts.*

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

[*Read before the Wellington Philosophical Society, 1st May, 1912.*]

The following notes on insects observed and captured in the neighbourhood of Ohakune and Waiouru are the results of a visit made by myself, wife, and daughter in January last. During the twelve days spent in the locality the weather was, on the whole, favourable for collecting, but a deficiency of brilliant sunshine considerably restricted the appearance of certain species. At Ohakune almost all the collecting was done in the forest, which is very accessible, and traversed by good tracks in several directions. On one of the most favourable days of our visit I managed to make a hurried trip to the lower slopes of Mount Ruapehu, but, owing to the distance which had to be traversed, only about three hours were available for collecting on an area ranging from 4,500 ft. to 5,000 ft. above the sea-level. I have seldom visited a mountain so barren of insect-life, and, although my stay was necessarily very brief, the weather was perfect, and it therefore seems evident that most of the species characteristic of mountains in the South Island are not found on Ruapehu.

The following list of the species observed or captured near Ohakune cannot, of course, be regarded as in any way complete, and will, no doubt, be much extended when the district has been more completely worked by entomologists.

Lepidoptera.

Vanessa gonerilla.

One seen on Mount Ruapehu, at an elevation of about 5,000 ft. Several seen in the lowlands, and a few young larvae observed feeding on a tree-nettle (*Urtica ferox*) in the forest.

Chrysophanus salustius.

Apparently much rarer than in most places. The few examined were of the typical form.

Euxoa admirationis.

A few at light.

Melanchra mutans.

One at light.

Hypenodes anticlina.

This species, which is usually rare, occurred quite commonly in the depths of the forest. The general results in Noctuae were extremely poor, although sugaring was tried on several nights.

Tatosoma timora.

This insect was remarkably common in the forest, the males in the proportion of about ten to one female.

Tatosoma n. sp. ?

A single male of an apparently new species was captured by my daughter. If actually new, this will make the seventh species of *Tatosoma* known in New Zealand.

Chloroclystis nereis.

Three specimens of this mountain-insect were taken on Ruapehu, at about 5,000 ft.

Hydriomena deltoidata.

Only a few of this usually abundant insect were observed. They were larger and more vividly marked than average specimens taken further south.

Hydriomena subochraria.

A few in clearings.

Hydriomena rixata.

A few in forest.

Hydriomena purpurifera.

Several taken. I believe this is the first time the species has been taken in the North Island.

Asaphodes megaspilata.

Common as usual.

Xanthorhoe limonodes.

Two specimens.

Xanthorhoe semifissata.

Common in the forest. Only males seen.

Xanthorhoe beata.

Rare. Some like the South Island forms.

Xanthorhoe chorica.

A fine series of this rare and very beautiful species was secured. Specimens were principally beaten from a shrub closely resembling *Leptospermum*, on which its larva may possibly feed. This insect has hitherto been recorded from the South Island only.

Xanthorhoe cymozeucta.

Fairly common in forest. A new species not previously taken.

Xanthorhoe cinerearia.

Specimens of both the large lowland and smaller hill form (*invexata*) were observed.

Epirranthis alectoraria.

Rare.

Selidosema fenerata.

Commonly resting on the trunks of rimu-trees (*Dacrydium cupressinum*) on which its larva probably feeds. In cultivated districts, where the insect is usually common, the food plant is *Cupressus macrocarpa*.

Selidosema aristarcha.

Two very fine specimens of this rare insect were beaten out of tree-ferns.

Selidosema leucelaea.

Taken amongst totara (*Podocarpus totara*), on which its larva feeds.

Selidosema productata.

Rare.

Selidosema panagrata.

Some fine varieties found resting on tree-trunks.

Selidosema monacha.

One specimen of this extremely rare insect was found drowned in a mountain-tarn on Ruapehu, at about 4,800 ft.

Chalastra pelurgata.

Fairly common. Some good varieties taken.

Sestra humeraria.

Common as usual.

Gonophylla gallaria.

Rare.

Gonophylla fortinata.

Several observed amongst its food plant (*Aspidium aculeatum*).

Gonophylla ophiopa.

Some very fine varieties were secured, as well as typical forms.

Drepanodes muriferata.

Fairly common.

Declana floccosa.

Only young larvae observed.

Declana atronivea.

One crushed specimen found on a road in Ohakune.

Diptychophora pyrsophanes.

Very common.

Diptychophora chrysochyta.

Common ; larger than usual.

Diptychophora leucoxantha.

Rare.

Diptychophora metallifera.

A few ; probably nearly over.

Diptychophora selenaea.

Common, and very finely marked.

Diptychophora auriscriptella.
D. elaina.

Rare.

Crambus flexuosellus.

Rare.

Crambus ramosellus.

The commonest species of *Crambus* at Ohakune.

Crambus apicellus.

A few on the edges of a mossy lagoon in the forest.

Scoparia minualis.

The commonest *Scoparia* at Ohakune.

Scoparia dinodes.

Rare.

Scoparia chimeria.
S. acharis.
S. diphtheralis.
S. characta.
S. sabulosella.

A few specimens of each of these species were observed.

Scoparia cyameuta.

A few at light.

Scoparia paltomacha.
S. trivirgata.
S. crypsinoa.

These three species were common on Mount Ruapehu, at about 5,000 ft. above sea-level.

Scoparia choristes.
S. harpalea.
S. epicomia.
S. asterisca.
S. rotuella.

Single specimens of each of these species were taken in the forest.

Musotima nitidalis.

Evidently rare.

Mecyna flavidalis.

Rarer than usual.

Pterophorus monospilalis.

Several seen. The only " plume " noticed in the locality.

Tortrix excessana.

A few large varieties taken.

Epalxiphora axenana.

Rare.

Tortrix incessana.
Cnephasia jactatana.
C. imbriferana.

These species were common as usual.

Tortrix conditana.

One only.

Izatha copiosella ?

Four specimens of this fine species, which is the largest of the genus yet known, was discovered in the forest at Ohakune.

Izatha huttonii.
I. metadelta.

Two specimens of each of these species seen.

Izatha picarella.

One very small specimen taken.

Phloeopola dinocosma.

Fairly common.

Trachypepla anastrella.
T. lathriopa.

Both these species were very common.

Gymnobathra flavidella.

This autumnal species was evidently just appearing.

Borkhausenia armigerella.

A few only.

Borkhausenia griseata.

Common, and very large.

Dolichernis chloroleuca.

One only.

Stathmopoda skelloni.
Thylacosceles acridomima.

Both these species were common in the depths of the forest.

Lysiphragma epixyla.

Two taken.

Batrachedra agaura.

A few specimens of this species were found.

Eschatotypa derogatella.

A few only; evidently too late for it.

Endophthora mesotypa.

One very fine specimen found resting on a mossy tree-trunk, where its colouring was strikingly protective.

Sagephora steropastis.

Common.

Erechthias chasmatias.

One only.

Tinea certella.

Rare.

Sabatincta incongruella *(Palaeomicra chalcophanes)*.

The phenomenal abundance of this interesting species, the most ancient lepidopterous insect known, fully corroborates Mr. Meyrick's suggestive remark as to the connection between these insects and pine forests.

Mnesarchaea loxoscia.

The same remarks apply also to this species.

Hepialus virescens.

From burrows observed in the trunks of *Melicope simplex* and other trees, this must be an abundant insect in its season.

Porina signata.

Common at light.

Neuroptera.

This order was very well represented by several large and interesting species.

Leptoperla grandis.

One specimen of this large new species was discovered by Mrs. Hudson near the Mangawhero River, and is described in a separate paper (*ante*, p. 51).

Heteroperla cyrene.

Rare.

Sympetrum bipunctatum.

A very fine series of this brilliant red species, which I had not seen since 1887, was obtained round a large pond in the forest, where, in fact, all the species of dragon-flies known to me occurred in some numbers.

Sympetrum ?

This delicate yellow species was also common.

Uropetala carovei.

This large and conspicuous insect was fairly common.

Somatochlora smithii.

Fairly common.

Aeschna brevistyla.

Of this very rapid-flying local species we secured a good series.

Lestes colensonis.
Xanthagrion zealandica.

Both these small dragon-flies were abundant, as usual.

Ichthybotus hudsoni.
Coloburiscus humeralis.

Several seen.

Stenosmylus incisus.

Several taken in forest.

Oeconesus maori.

Several found.

Olinga feredayi.

One seen.

Pseudonema obsoleta.

One seen.

Hydropsyche fimbriata.
H. colonica.
Hydrobiosis umbripennis.

All these and several other closely allied species of *Trichoptera* were seen in numbers.

Diptera.

In addition to several rare species of flies not yet determined, the following species of crane-flies ("daddy-long-legs") were observed.

Macromastix montana.

Very common on Mount Ruapehu at about 5,000 ft.

Limnophila sinistra.
L. argus.

Both these species were very common in forest at Ohakune.

Tipula viridis.

Several in forest.

Tipula novarae.

One seen on Mount Ruapehu at 5,000 ft.

Tanyderus annuliferus.

Two seen.

Dilophus nigrostigma.

Common on Mount Ruapehu at 4,500 ft.

Coleoptera.

Metriorhynchus erraticus.

This beautiful beetle was very common on dead logs in the hot sunshine.

Stethaspis suturalis.

Several observed.

Beetles generally were not much in evidence, although the locality would probably prove a good one if adequately worked by a coleopterist.

Orthoptera.

A large yellow-green grasshopper with blackish markings and rudimentary wings was very common on Mount Ruapehu at about 5,000 ft. It is apparently closely allied to several species found on mountains in the South Island.

Miscellaneous Observations.

A peculiar cracking sound was heard on several different days proceeding from the middle of a dead tree standing in the forest, and was, I think, due to a large number of weevils (probably belonging to a species of *Psepholax*) drilling their way out of the tree. When the trunk was violently kicked the sound stopped, but it always resumed two or three minutes afterwards.

A black spider, with paler markings and a long pointed abdomen, was very abundant on the shores of the large pond already mentioned. It was gregarious, spinning geometrical webs in irregular series amongst the rushes. The spiders, when resting in the webs, exactly resembled dead flies enshrouded in spider's web, and it seems probable that such a striking resemblance would be beneficial to the spider both for aggressive and defensive purposes. As I am not acquainted with spiders, I cannot give this note scientific precision, but deem it desirable to place such an interesting habit on record.

Before returning to Wellington we stayed three days at Waiouru (altitude 2,600 ft. above sea-level), and thoroughly worked the tussock plain on the south-east side of Ruapehu. This locality has a somewhat forbidding aspect, but the following list of the species found indicates that its insect fauna is by no means devoid of interest. The weather experienced at Waiouru was most favourable, and the complete absence of *Argyrophenga antipodum* here clearly proves, I think, that this butterfly does not occur on the tussock lands of the North Island.

Vanessa gonerilla.

Several seen. No nettles observed.

Chrysophanus boldenarum.

Very common, and rather darker than usual on the underside.

Chrysophanus salustius.

Common.

Nyctemera annulata.

Rare.

Euxoa admirationis.

One at sugar.

Leucania unica.

Fairly common at sugar.

Leucania semivittata.

Three taken at sugar.

Aletia moderata.

Several at sugar.

Aletia griseipennis.

One at sugar.

Persectania disjungens.

Several very fine specimens taken at sugar.

Melanchra rubescens.

One at sugar.

Melanchra agorastis.

One at sugar

Melanchra omicron.

One at sugar.

Hydriomena deltoidata.

Rare.

Xanthorhoe chlamydota.

Of this rare species one specimen was dislodged from flax-bushes near a stream, and another seen.

Xanthorhoe clarata.

Several observed. Rather smaller than usual.

Xanthorhoe stinaria.

Three observed. Apparently the first record from the North Island.

Notoreas vulcanica.

A good series of this fine insect was secured. It was rather scarce, and flew very rapidly in the hot sunshine.

Notoreas perornata.

A fine orange-yellow form occurred occasionally.

Dasyuris partheniata.

Very common, and in the finest condition.

Crambus ramosellus.

A few only.

Crambus vitellus.

Abundant.

Crambus simplex.

Common.

Crambus flexuosellus.

A few only.

Crambus siriellus.

One only.

Crambus apicellus.

Rare.

Crambus heliotes.

Common in the hot sunshine in damp places near the stream.

Scoparia sabulosella.

Common as usual.

Scoparia dinodes.

One at light.

Scoparia diphtheralis.
S. submarginalis.

A few of each were observed.

Diasemia grammalis.

One taken, and several others seen.

Platyptilia aeolodes.

Two specimens on the Tokaanu Road.

Tortrix leucaniana.

Several seen.

Megacraspedus calamogonus.

Two specimens flying in late afternoon sunshine.

COLEOPTERA.

Cicindela tuberculata.

The very large handsome variety which was discovered in this locality in 1887 by my brother, Mr. W. B. Hudson, was common and in fine condition.*

Zorion castum.

This beautiful little beetle was common on the blossoms of the *Dracophyllum*.

Stethaspis suturalis.

Abundant at dusk.

NEUROPTERA.

Aeschna brevistyla.

Three taken.

Somatochlora smithii.

Common.

Xanthagrion zealandicum.

Common as usual.

Pseudonema obsoleta.
Hydropsyche fimbriata.

Both these species occurred over a small stream.

DIPTERA.

Cloniophora cuprea.
C. wakefieldi.
C. sp. ?

Several of these interesting crane-flies were obtained.

Anabarhynchus maori.
Itamus varius.

Both these rapacious flies were abundant.

HEMIPTERA.

Melampsalta cincta.

This little cicada was common, the males singing vigorously in the tussocks.

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* I am informed by Major Broun that this is a distinct species of *Cicindela*.

Art. IX.—*On* Tipula heterogama, *a New Species of Crane-fly in New Zealand.*

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

[*Read before the Wellington Philosophical Society, 31st July, 1912.*]

The male of this handsome crane-fly is often seen resting on fences about Wellington and the suburbs, but, owing to her semi-apterous condition, the female is seldom noticed.

The expansion of the wings of the male is 1½ in., and the length of the body slightly over ½ in. General colour reddish-brown. Head ochreous-brown, with the eyes black. Prothorax dull ochreous, with two dark-brown triangular marks and two oval spots; rest of the thorax dark reddish-brown. *Abdomen dark reddish-brown, with the central segments black and the terminal appendages large and conspicuous; the entire abdomen is highly polished.* Legs dark-brown and rather stout.

The length of the body in the female is about ¾ in., and *the length of the rudimentary wings less than ⅛ in.* (In *Tipula obscuripennis* they are distinctly longer.) The general colour is blackish-brown, and shining. *The abdomen is elongate-pointed, with a conspicuous reddish-brown ovipositor.* The legs are short and rather stout.

The late Captain Hutton, who did so much valuable work amongst the New Zealand *Diptera*, regarded this species as a variety of *T. obscuripennis.* I am now quite convinced, however, that it is a good species, and have italicized in the above description some of its most essential distinctions. I hope, however, that in the near future a more detailed description will be drawn up by an expert in the order.

During the early part of this winter I made many observations on living examples of both *Tipula heterogama* and *Tipula obscuripennis* whilst the insects were under natural conditions in my garden, and this has enabled me to repeatedly apply the test of syngamy, and thus fix beyond a doubt the relative males and females and the absolute distinctness of each of the species. *Tipula heterogama* appears in the perfect state about the end of April, and continues abundant until the end of May. It is indifferent to low temperatures, and I have counted as many as six males resting on the south side of my house at night and in the early morning with the thermometer standing at 44° Fahr. *T. obscuripennis* is also a late autumn and early winter species, but its time of greater abundance appears to be about a fortnight earlier than that of *T. heterogama.* The two species are, however, about together, and this circumstance, coupled with the fact that they both have semi-apterous females, no doubt caused the late Captain Hutton to regard them merely as varieties of one species.

ART. X.—*Notes on a Moth-killing Spider.*

By W. W. SMITH, F.E.S.

[*Read before the Manawatu Philosophical Society, 25th July, 1912.*]

WHEN residing at Featherston, in the Wairarapa, in November, 1907, I devoted much time to collecting a good series of specimens of all the species of hepialid moths occurring in the district. The winter and spring months of the year, though very mild, were exceptionally wet, and therefore were very favourable to the habits of the rhizophagous larvae of these large moths. The larvae of *Porina umbraculata* Guenée fed numerously on the roots of cocksfoot-grass (*Dactylus glomerata*), which fodder plant grows vigorously on the outskirts of the remnants of native forest remaining in the district. The presence of such large numbers of these larvae during these months augured well for a successful collecting season when the beautiful moths appeared on the wing. The first moth appeared at light on the 5th November; by the 11th they were numerous, and a week later we could have captured two or three dozen any night. The dwelling-house is situated in the bush, and our method of capturing these large and handsome moths without injuring them was by placing a brilliantly lighted lamp on the table close to the window in the sitting-room. They invariably came to the light much earlier and were more numerous on dark and drizzling nights than on others that were drier and clearer. The insects were alike in being in perfect condition and coloration, and without carefully removing the viscera and filling their bodies with wadding well powdered with arsenic and chalk it would have been difficult to preserve the specimens from "greasing" when placed in the cabinet. Several large specimens of *Porina signata* Walker were also taken on the window. From the 10th November until the 9th December, on which date I left the district, the large moths continued to come to the light, though in somewhat diminished numbers. Throughout the spring months of that year (1907) many species belonging to numerous other genera were also more or less abundant, and were in very perfect condition. Owing probably to the excessively humid winter and spring months, some of the specimens exhibited a more or less melanic tone of coloration than in normal seasons.

The dwellinghouse (a wooden structure) referred to is of considerable age, and the window-fittings on both sides were therefore somewhat contracted. In the interstices thus formed several individuals of a large and finely marked native spider, *Epeira corrugatum* Urquhart (Trans. N.Z. Inst., vol. 16, pp. 72, 73), lived concealed, subsisting chiefly on nocturnal insects becoming entangled in their strong webs. The webs, though irregular in form and structure, were generally constructed across the corner of the panes, with several long and strong threads fastened to the window-frame, near the latch, to give strength and buoyancy to the webs. On several nights, whilst capturing the large moths, I observed several become entangled in the webs. The alert and sensitive spider awaiting concealed in the window-niche, on feeling the struggles of the entangled moth, generally moved slowly and cautiously along the outer strands towards the moth, which it seized, and instantly applied its powerful falx, or poison-fang, to the right side of the moth's thorax. Although the bodies of the large healthy moths would each weigh those of seven or eight spiders, and notwithstanding their being endowed with powerful wings, they were easily overpowered, and immediately collapsed into a state of anaesthesia on being wounded by the spider's fang. For a few seconds a few faint vibrations or tremulous motions of the wings were the only signs of life in the anaesthetized moths. With a view to testing and ascertaining how long any visible signs of life remained in the insects after receiving the spider's venom, I collected several and placed them under an inverted glass in a cool and shady place. With the males faint signs of life could be detected in the antennae, in some instances, on the second day. The females lived longer. By the aid of a strong lens very slight twitchings of the antennae and the extremity of the ovipostor could be detected on the third day.

In submitting these notes to the Society I am fully aware that the same results would follow in a greater or lesser degree with all the insects on which spiders subsist, especially those of the genus *Epeira*. The hepialid moth referred to in these notes is, so far as I have observed or have otherwise known, unquestionably the largest species of insect destroyed by a native spider. The peculiar potency of the spider's venom preserved the large bodies of the moths, and thus enabled the animals to subsist on them for several days before they became unfit for food. Many more moths were killed than were consumed. But spiders are equally liable to be attacked and destroyed by an almost precisely similar method to that by which they despatch their prey or render them comatose for several days before being devoured. The two large and beautiful species of native wasps (*Salius fugax* Fabricius and *S. carbonarius* Smith) hunt large spiders, sting them and render them torpid, to be dragged to their nests and then torn to pieces to be put into the clay cells to feed the young wasp-larvae when they emerge from the eggs. A more remarkable case of parasitism, or reciprocal parasitism, is that of the small fly (species unknown at present) that destroys the spider after being devoured by it. The spider while consuming the viscera of the fly also swallows its eggs uninjured. The latter in due time develop into larvae, which grow rapidly by subsisting on the viscera of the spider, and duly destroy it.

Art. XI.—*On Two Blepharocerids from New Zealand.*

By C. G. Lamb, M.A., B.Sc., Clare College, Cambridge.

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

[*Read before the Wellington Philosophical Society, 1st May, 1912.*]

Among the insects presented to the Zoological Museum at Cambridge by Mr. G. V. Hudson there are many interesting species, but one of the most striking points is the presence of two species of the family *Blepharoceridae*. The members of this family form a very isolated group, which occur in special localities in various parts of the globe. They apparently form a decadent family which has specialized in habit so as to maintain its existence, and the various members of it are usually found by mountain-streams which are highly aerated, in the waters of which the extraordinary larvae and pupae live. Accounts of the habits and morphology will be found in a paper "On the Net-veined Midges of North America," by V. L. Kellogg, Proceedings, California Academy of Sciences, 3rd series, Zoology, vol. 3, and in a monograph of the family by the same author published in Wytsman's "Genera Insectorum," 1907.

The genera hitherto known are distributed as follows:—

Apistomyia. Corsica and Cyprus.
Hammatorrhina. Ceylon.
Paltostoma. St. Vincent, West Indies, Columbia, South America.
Kelloggina. Rio de Janeiro.
Curupira. Brazil.
Hapalothrix. Italy.
Blepharocera. Europe, East America, California.
Bibiocephala. America, Rocky Mountains and west.
Philorus. Europe and West United States.

In addition, I have seen a species from the Cape, which is to be described by Mr. F. W. Edwards; it appears to belong to the genus *Kelloggina;* and I have also seen an unnamed species from India.

The two new species here treated are of especial interest, as they carry the range of the family into the Australian region. The insects belong to two distinct genera. They have very minute hairy palpi, which are inserted at the base of the proboscis, and require careful looking for to see at all clearly. The proboscis is enclosed in a sheath which ends in two remarkable long processes, which in the males are as long as the parts forming the sheath. This character seems to be one which is not possessed by any of the hitherto-published species. The hind legs are excessively long, both absolutely and relative to the other pairs. The presence of long hind legs is very usual in the family, but none of the published figures or descriptions show the great disparity which exists in the present species.

The larger of the two species is represented by males only, and is shown three times the full size in fig. 1. The photograph is a little incomplete, as the specimen had lost the last joint of one hind tarsus and the last two joints of the other. It was selected for illustration as it was set out flat, so that the relative proportions can be easily measured. The figure shows very well the great length of the hind legs. In its general character it comes nearest to the genus *Curupira* (F. Müller) O. S. This genus was described and figured in great detail by F. Müller, "Archivos do Museo Nacional do Rio de Janeiro," vol. 4, 1879, pl. 7. The differences between the present insect and the figures and description of Müller are so considerable that it is felt to be impossible to place it in that genus. Baron Osten Sacken (Berl. Ent. Zeit., vol. 40, 1895, p. 160) gave a warning against the multiplication of genera in such an evidently decadent family as the *Blepharoceridae*, pointing out that it may result in many genera becoming monotypical; but it is felt that having regard to the isolated position of the present species, and

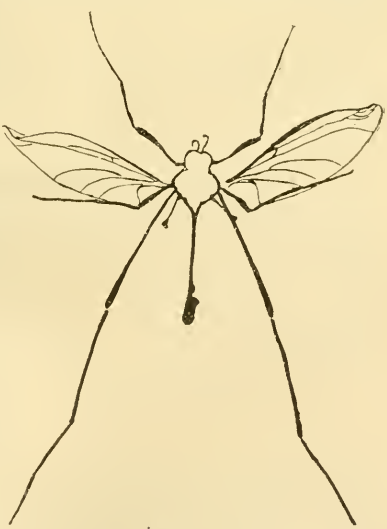

Fig. 1.—*Neocurupira hudsoni;* × 3.

the considerable differences existing, it is justifiable in this case to make a new genus.

NEOCURUPIRA gen. nov.

In Kellogg's monograph, "Genera Insectorum, Blepharoceridae," 1907, a table of the genera known up to that date is given. The present species belongs to the section with no incomplete vein near the hind margin, and with holoptic eyes. This leads to the genus *Curupira*, as mentioned above. From that genus the present insect differs as follows: The long-ended tips to the tongue-sheath, the small palpi (*Curupira* has long palpi, *vide* Arch. Mus. Nac. R. Jan., pl. 7, fig. 20), and the very long hind legs.

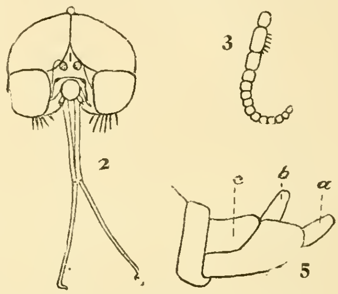

FIG. 2.—♂. Head, front view.
FIG. 3.—Antenna.
FIG. 5.—Hypopygium.

The genus can be defined as follows:—

Eyes holoptic on the vertex, very hairy, divided into two regions, an "upper eye" and a "lower eye." These two regions are absolutely contiguous, and have no intervening space; the upper eyes have large brown facets, the lower eyes have small black ones. The upper eyes touch from the well-marked ocellar "turret" to somewhat above the antennae; the lower eyes are widely and fairly evenly separated by the wide face. The turret bears 1 ocellus near the top and 2 on the sides towards the back. Palpi minute and hairy, almost hidden in a sort of depression each side of the base of the tongue. The tongue is longer than the vertical depth of the head, the sheaths are prolonged into 2 long flagella, which are jointed just at the tip of the tongue, where they divaricate (fig. 2). Antennae normal (fig. 3).

Thorax of normal form for the family. Wings as shown in fig. 4. The first vein is very close to the costa, and extends from about A to B in the

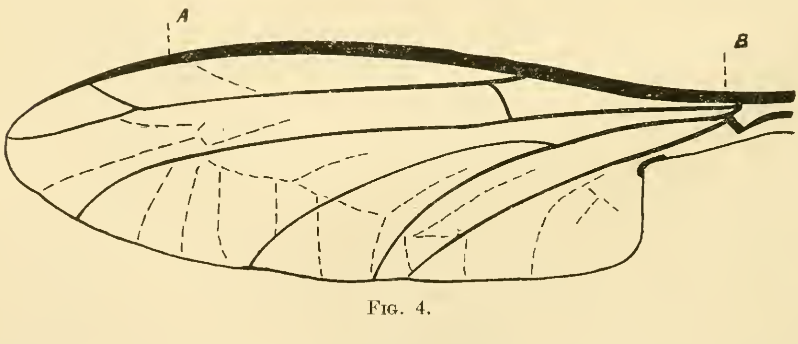

FIG. 4.

figure. It is not shown in the drawing, which was made with a camera lucida, as it was almost in the same plane as the costa. There is a forked vein between the first and the fourth; no incomplete vein on hind margin; a cross-vein from the fourth to the one before, but none between the fourth and fifth.

The hind legs very long, both absolutely and compared with the others; femora elongate club-shaped; tibial spurs on the hind pair; claws simple, no visible empodia.

Abdomen, in the dried specimens, compressed laterally, with the usual large and complex hypopygium (fig. 5).

Type.—The following species.

Country.—New Zealand.

Neocurupira hudsoni sp. nov.

Head as in figures. The vertex is small, so that only the black ocellar turret is visible. Upper eyes brown, lower black, both clothed with profuse dense brown pubescence. The lower margins of the lower eyes with long hairs. Antennae brown-black. Face grey; tongue, &c., black.

Thorax deep dull black, tiny orange humeral protuberances with orange patch behind; hind angles of thoracic dorsum and the pleurae above the wing-bases orange; lower pleurae dusted with grey. Scutellum margined with greyer black; metanotum more shining black. Wings as figured and described for the genus, glassy with black veins; the extreme base orange; a fine ciliation along the hind margin, which is longer at the extreme base and at the anal angle; the little chitinous patch at the angle of the axillary lobe is well marked; net veins evident, but showing no special characters.

Halteres with long pale stalks and flattened triangular brown heads.

Legs brownish-black, except for the front coxae, the base of the front femora, and the thin basal two-thirds of the hind femora, which are paler. Front femora bent and thickened towards the tip. Hind femora very long, about three times the length of the middle ones, spindle-shaped, with a slender basal part, which gradually thickens out into a slender club-shaped distal part. Two well-marked spines on the hind tibiae. All the claws simple, but thickened at the base.

Abdomen slender, compressed laterally in the dried specimens. Black, paler at the base, and indistinctly and narrowly so on the margins of the segments. Male hypopygium with the usual complex structure, and as shown in fig. 5 in side view: (*a*) is one of a pair of later terminal lobes, (*b*) one of a pair of dorsal lobes, (*c*) is a hood-like extension of the dorsal part of a segment, it is depressed in the centre but not bifid. The internal structures could not be studied, owing to the small amount of material, but as far as they can be seen are much like those figured in Kellogg's monograph, pl. 2, fig. 15.

Size.—About 8 mm.; wing, about 8 mm.

Locality.—Otira, New Zealand. The species is numbered 231 in Mr. G. V. Hudson's collection.

Type in Cambridge Museum.

Paratypes in the British Museum and at Cambridge.

The other species is represented by both sexes, and the male is shown three times full size in fig. 6. It is distinguished by the non-holoptic eyes (see fig. 7), which are just bisected by a furrow into lower and upper, while the facets are of nearly equal size. There is an unforked vein between the first and fourth, the general venation being very like that of *Paltostoma* (see Kellogg, "Genera Insectorum," pl. , fig. 21). The palpi are minute as in that genus, and the proboscis is long. The insect differs from Schiner's generic description (Verh. der Zool. Bot. Gesellsh. in Wien, xvi, 1866, p. 931) in many important respects. The hind femora and metatarsi are long, as in *Paltostoma*, but the relative proportions of the tarsal joints are quite different; the metatarsus is the longest, and the second to last joints get progressively smaller and smaller. There are no spines on the last joint. Neither in Schiner's description nor in Williston's figure of *P. schineri* (Trans. Ent. Soc. London, 1896, pl. 8, fig. 27*b*) is there any mention or sign of the extraordinary ocellar turret which will be seen from fig. 7 to be so large in the present species. Furthermore, there is no mention in *Paltostoma* of a cross-line dividing the eyes into lower and upper halves, nor is any such line shown in Williston's figure.

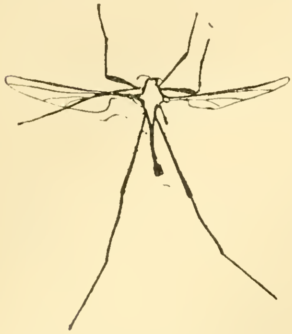

FIG. 6.—*Peritheates turrifes*; × 3.

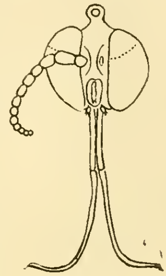

FIG. 7.

PERITHEATES gen. nov.

♂. *Head.*—Eyes separated by a broad space from the vertex to the mouth, this space being nearly equally wide for the whole distance. The eyes are bisected by a somewhat shallow groove into smaller upper and larger lower halves; the whole eye very pubescent, and the upper eye-facets but little larger than the lower. The vertex has a very prominent and elegant ocellar turret; the front ocellus is on the front side of the turret, and the others one on each side. The tongue is long, with a sheath furnished with two long processes like the last species. The palpi are minute and almost hidden at the base of the tongue. In vertical view the face is seen to project in the form of a broad keel standing out beyond the plane of the eyes and the normal-shaped antennae are inserted towards the sides of this keel.

Thorax.—Very like that of the last genus. Wings as in fig. 8. An unforked vein between first and fourth and a cross-vein between this middle vein and the fourth. Net-veining well marked, but normal.

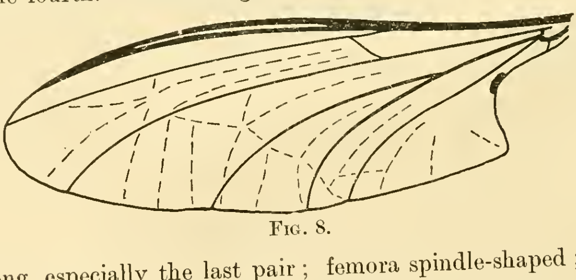

FIG. 8.

Legs long, especially the last pair; femora spindle-shaped; hind tibiae with 2 spines; claws normal; no visible pads.

Abdomen.—Slender and laterally compressed as the last genus, with the usual complex hypopygium.

♀. The long processes to the tongue-sheath are much shorter. The legs are shorter in proportion, especially the hind legs. The abdomen is cylindrically pointed.

Note.—In one of the ♀ specimens the last vein in the wing does not meet the margin.

Type.—The following species.

Country.—New Zealand.

Peritheates turrifer sp. nov.

Head.—Vertex, turret, and all the eyes black, the latter with a profuse light-brown pubescence. Face greyish; tongue brown, with brown-black sheath. Antennae black.

Thorax.—Dorsum deep dull black slightly pollinated with grey; humeral knobs orange on the tip; hind angles of dorsum just above the wing-bases lined with orange; pleurae profusely pollinated with grey. Scutellum in outline like a very blunt-pointed long-based triangle. Wings as in the generic description, glassy with black veins, orange at the base; the chitinous patch at the anal angle well marked; hind margin finely ciliated, especially from the extreme base round the anal angle.

Halteres with long pale stalk and long oval head of darker colour.

Legs black, except for the front trochanters, base of front femora, middle trochanters and base of femora, hind trochanters, and basal four-fifths of femora, which are paler. Front femora slightly bent and swollen from middle to tip; middle femora straight, but similarly swollen; hind femora about three times as long as the middle ones, very thin for the basal two-thirds, then swelling out into a slender spindle shape. Hind tibiae with two spurs. Front and hind metatarsi very long, about as long as the rest of the joints; middle shorter, about as long as $2\frac{1}{2}$ joints.

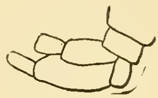

FIG. 9.

Abdomen.—Slender, compressed laterally, brown-black with well-marked orange margins to the segments. Male hypopygium in side view as fig. 9, with end and upper pair of processes.

The ♀ specimens were immature. All the legs are slender and proportionately shorter than in the ♂.

Size.—$4\frac{1}{2}$ mm.; wing, 6 mm.

Locality.—Otira, New Zealand. This species is numbered 230 in Mr. G. V. Hudson's collection.

Types in the Cambridge collection.

Paratypes in the British Museum.

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

Both insects described by Mr. Lamb in the foregoing paper were captured flying over the foaming waters of Warnock's Creek, Otira River, on the 5th and the 13th December, 1908. They frequented only the most disturbed portions of this violent mountain-torrent, where the noise of the falling waters was deafening. Both species seemed to be engaged in nuptial dances amongst the flying spray, the long hind legs of the males being held out behind, looking like the caudal appendages of an *Ephemera*. I secured both sexes of *Peritheates turrifer*, but could find only males of *Neocurupira hudsoni;* they rested on the wet boulders close to the water's edge. These insects seem to be very local, as I have not observed either of them on any other occasion. Dr. Chilton described a larva of a Blepharocerid in vol. 38, p. 277, of the "Transactions of the New Zealand Institute." I observed similar larvae in the streams at Otira during my visit. They are very probably referable to the insects described in the foregoing paper.

Art. XII.—*Descriptions of New Species of* Lepidoptera.

By Alfred Philpott.

Communicated by Dr. W. B. Benham, F.R.S.

[*Read before the Otago Institute, 1st October, 1912.*]

Hydriomenidae.

Tatosoma alta sp. nov.

♂♀. 25–30 mm. Head pale green. Antennae reddish-brown. Thorax green, mixed with ochreous. Abdomen ochreous-grey, becoming more ochreous on terminal segments; segmental divisions marked with black. Forewings triangular, costa moderately arched, termen obliquely rounded, faintly sinuate below middle; white, with numerous irregular pale-green transverse lines; subbasal line black, almost straight; first line black, interrupted in middle, bent posteriorly on dorsum where it is joined by a projection from subbasal; *median band broad, furcate on costa and dorsum, anterior edge from before ½ to ½, posterior edge from ¾ to ⅘, black, thickly irrorated with reddish;* a double subterminal line of the same colour, much interrupted, most pronounced beneath costa and above middle; a terminal series of paired black dots: cilia white, with dark median line and dark bars opposite paired dots. Hindwings pale fuscous-grey, darker posteriorly; *lobe in ♂ ⅖*: cilia grey.

In one ♂ the median band is hardly traceable, and there is a suffused yellow mark along lower median from vein 2 to origin of vein 3. This is also represented in other specimens by a few yellow scales.

Nearest to *T. agrionata* and *T. tipulata*. From the latter it is at once distinguished by the much larger lobe of the male, and from the former by the well-defined median band and the darker hindwings.

The only example of the female known at present was taken at Otira in December, 1908, by Mr. G. V. Hudson. It was captured in forest at about 1,260 ft. above sea-level. From the 24th to the 26th December, 1911, Mr. C. C. Fenwick took a good series of the male on Bold Peak, Humboldt Range, at an elevation of 4,000 ft. to 4,500 ft. They were all taken in the evening, being attracted by the camp-fire, and search during the day on the beech-trunks did not result in any captures. On the 27th December I found a worn male on The Hump in the stunted bush at about 3,000 ft. From these particulars it would seem probable that the species inhabits subalpine forests from about 1,000 ft. upwards. The rarity of the ♀ is somewhat unusual in this genus, other species showing about equal numbers in the sexes.

Xanthorhoe undulata sp. nov.

♂. 35 mm. Head ochreous. Antennae ochreous, shortly bipectinated. Thorax grey-brownish. Abdomen ochreous, with scattered black scales and a double black dot on the dorsal surface of each segment. Anterior legs black, annulated with ochreous. Forewings triangular, costa moderately arched posteriorly, apex obtuse, termen crenate, slightly rounded, oblique; brownish-ochreous; lines white; basal line thin, curved, anteriorly bordered with black scales, especially near dorsum; first line thin, irregularly indented, curved inwardly to approach basal line on dorsum; median band slightly darker; vein 1 with black blotch on anterior edge and smaller dot at posterior; *vein 2 with large irregular black dot at origin; veins* 2, 3, *and* 4 *well marked in black from posterior edge to near centre of band;* slight dark dashes on other veins at posterior edge; second line thin, with blunt double projection at middle; subterminal line waved, regular; a prominent black crenate terminal line; interneural terminal spaces thickly irrorated with white scales: cilia ochreous, with two brown lines. Hindwings with termen crenate, pale brownish-ochreous; a dark-brown central line, obsolete on costal half; indications of two or three other lines near termen; a prominent black crenate terminal line: cilia as in forewings.

Nearest to *X. cedrinodes,* but easily distinguished by the peculiar black marks on veins.

Tisbury, Invercargill; a single male, in August.

SELIDOSEMIDAE.

Selidosema argentaria sp. nov.

♂ 31–36 mm.; ♀ 33–34 mm. Head and antennae grey. Thorax fuscous-grey. Abdomen white, thickly strewn with fuscous. Forewings triangular, costa moderately arched, termen slightly bent at middle; *white, densely strewn with light fuscous;* lines dark fuscous, all except subterminal more or less interrupted and obscure; subterminal dentate, almost straight, followed by a clear white line which is again followed by indications of another fuscous line; a terminal chain of small spots: cilia white, with some fuscous scales. Hindwings in male suboblong, dorsum obliquely rounded, termen rounded with blunt projection at middle; white, irrorated with pale fuscous towards termen: cilia white, with scattered fuscous scales.

Closely allied to *S. fenerata* Feld. From that species the male may at once be distinguished by the silver-grey colour of the forewings, there being no trace of ochreous. The hindwings are also somewhat different in shape, being less oblong, and the dorsum being rounded instead of angular. The female of *S. argentaria* can be distinguished from that sex in *S. fenerata* by the shorter and broader forewings; in the latter species these are unusually long. The colour and markings of the females of the two species approximate much more closely than do those of the males.

Invercargill, Wallacetown, Tuturau. Probably generally distributed throughout Southland. January to April; most abundant in the autumn at flowers of *Senecio jacobaea.*

TORTRICIDAE.

Harmologa tributaria sp. nov.

♂. 25 mm. Antennae fuscous, annulated with whitish. Palpi reddish-brown, *inner and upper surfaces white.* Head and thorax dark reddish-brown mixed with grey. Abdomen fuscous-grey. Forewings suboblong, costa moderately arched, fold slight, termen rather oblique, rounded beneath; dark fuscous, densely strewn with reddish scales which tend to form a streak beneath costa from base to $\frac{1}{2}$; a broad irregular pale-yellow streak from base to apex, basal $\frac{2}{3}$ margined above and beneath with blackish, *at* $\frac{1}{2}$ *a thin tributary streak runs to tornus, thus enclosing a long triangular patch of* *ground-colour;* some grey scales forming obscure interneural lines beneath apical half of costa: cilia grey, with an obscure darker line. Hindwings fuscous: cilia yellowish-white, with a fuscous basal line.

Not far removed from *H. siraea,* but the central pale streak is quite different and the termen is more oblique.

Discovered by Messrs. G. Howes and A. Hamilton at Obelisk, Old Man Range, Central Otago. Taken on the 2nd February.

Oecophoridae.

Izatha mira sp. nov.

♂. 21 mm. Head and thorax black sprinkled with whitish. Palpi, second joint black sprinkled with white, terminal joint white with black median band. Antennae fuscous, obscurely annulated with darker. Abdomen dark fuscous, margins of segments marked with ochreous-white. Forewings moderate, costa strongly arched, apex obtuse, termen straight, hardly oblique; *black, densely sprinkled with pale bluish-white;* markings black, rather obscure; a narrow basal patch extending a short distance on dorsum; an irregular fascia near base, outwardly strongly oblique to fold; a thick irregular fascia from costa at $\frac{1}{3}$ almost to dorsum at $\frac{1}{2}$; a similar obscure fascia at $\frac{2}{3}$, touching dorsum; a series of obscure spots from costa at $\frac{3}{4}$ round termen to tornus: cilia fuscous, with occasional white scales. Hindwings dark fuscous, fading to grey anteriorly: cilia fuscous, with darker basal line.

Though superficially appearing to be abundantly distinct, the markings show this species to be near to *I. picarella.* The beautiful bluish tint of the forewings makes it one of the most handsome members of the genus.

I obtained one example on The Hump in December. Taken in forest at 3,000 ft.

Art. XIII.—*Concerning the Kermadec Islands Avifauna.*

By Tom Iredale.

Communicated by W. R. B. Oliver.

[*Read before the Auckland Institute, 11th December, 1912.*]

In these Transactions the birds of the Kermadec Islands have been previously catalogued, and it is in this place that almost all the notes regarding this avifauna have appeared.

Almost three years ago I drew up a list of the birds met with on the Kermadec Islands during the year 1908, but fortunately it was not published at that time, owing to my discovery that the nomenclature needed revision. I therein followed the nomination used in the "Supplement to the Birds of New Zealand," by Sir Walter Buller, just previously published. That nomenclature was at fault, inasmuch as the rules adopted by the International Congresses of Zoology were not adhered to, and consequently it was imperative that revision should be attempted.

In the *Emu,* April, 1910, will be found a paper wherein the habits of the birds as observed by myself are recorded, and it is not necessary to rewrite these here, as most of the information there given has already appeared in these Transactions.

I now simply give the name of the bird as determined under the above rules, and note the occurrence of the bird as verified by myself with the help of the other members of the party—Messrs. W. R. B. Oliver, S. R. Oliver, W. L. Wallace, and C. E. Warden—and especially of the island settlers, Messrs. Roy and King Bell.

The latest complete list of the Kermadec avifauna previous to our visit was that of Mr. T. F. Cheeseman, published in these Transactions, vol. 23, p. 216 *et seq.*, 1891. In that paper no fewer than forty species were totalled, but I was not so fortunate as to collate such a number.

I had instituted comparisons of this avifauna with those of Lord Howe and Norfolk Islands, but deferred making use of my data until such time as further study reinforced my conclusions.

I find that my friend Mr. W. R. B. Oliver had undertaken a *résumé* of these avifaunas, and from a study of literature arrived at conclusions quite compatible with those of my own, but somewhat different from those he had propounded from his botanical studies alone. I propose here to touch upon these results, as with access to specimens and advice not available to my friend I am able to indicate some improvements and alterations, though in the main I confirm his conclusions.

Firstly, I would reject all the doubtful records which he not only includes but amplifies. Thus, in his paper on "The Geographic Relationships of the Birds of Lord Howe, Norfolk, and the Kermadec Islands" (Trans. N.Z. Inst., vol. 44, p. 215, 1912) Oliver adds six names of birds not hitherto recorded from the group—three from skins received by Mr. Cheeseman from Mr. Roy Bell, the fourth a record by himself (which, however, had been already noted six years previously by Ogilvie Grant, *Ibis*, 1905, p. 554), and two others on Mr. Roy Bell's authority.

Oliver has fairly well gauged the affinities of the Lord Howe avifauna, and I would add the following information.

Nesolimnas sylvestris Sclater has been shown by Mathews ("Birds of Australia," vol. 1, p. 191, 1911) to be no relation of the Neozelanic *Nesolimnas* nor *Gallirallus* (= *Ocydromus*), but congeneric with the New Caledonian *Tricholimnas lafresnayanus* Verr. & Des Murs., a semi-flightless descendant of the north Australian *Eulabeornis*.

In the same place Mathews (p. 247 *et seq.*) has gone into the history und examined the supposed specimens of *Notornis alba*, and has conclusively proven that the reference of the unique specimen of *Fulica alba* White to he genus *Notornis* was incorrect, and that the bird was apparently a fixed lbinistic species of *Porphyrio* closely allied to *P. melanotus* Temminck, ıd that there can be no good reason for considering it to have any more lationship with New Zealand than with Australia or New Caledonia. prefer the latter source.

With regard to *Cyanoramphus subflavescens* Salv., it has more relation-p with *C. cooki* Gray of Norfolk Island and *C. saisseti* Verreaux, the New ledonian form, than with the Neozelanic forms. I would consider the ole of the red-fronted parrakeets as representing one species, but that above three are closer to each other than to the Neozelanic forms, which ıld include the Kermadec race. I might note here that I have examined the birds mentioned in this paper in connection with the forms com-ed, and that herein my conclusions are given to the best of my ability.

Where other workers are mentioned these must be regarded as confirmatory evidence of my own views.

As regards the "two" species of *Gerygone*, there is only one (Mathews, Novit. Zool., vol. 18, p. 448, 1912) which is more closely allied to New Caledonian forms than to Neozelanic species, whilst the *Zosterops* has very little affinity to the New Zealand *Z. lateralis*, which, moreover, can only be considered a recent immigrant to New Zealand, and consequently should not enter into comparisons regarding ancient land connections. *Ninox albaria* I have not yet seen, and its affinities are not yet well known.

The *Rhipidura* belongs to the Austro - New Zealand species *R. flabellifera*. Examination of long series of Australian *Rhipidura* point to the fact that the New Zealand form is a comparatively recent settler from Australia, as north Australian races differ more from south Australian than the latter do from the Neozelanic race. It would seem that this would also be a dubious factor to use in basal comparisons. The *Pachycephala*, which Oliver writes is "probably related to Australian forms," is only subspecifically distinct from the common Australian *P. gutturalis*, and was only separated as recently as 1898.

Oliver concluded: "Numerically the Australian, New Zealand, and New Caledonian elements in the endemic birds of Lord Howe Island are about equal, or overwhelmingly in favour of a New Caledonia - New Zealand migration as against an Australian immigration. The two flightless rails turn the balance in favour of New Zealand. . . . The existence of two brevipinnate rails belonging to genera found elsewhere only in New Zealand is sufficient proof of a former land connection with that country." As the rails are little related to Neozelanic forms, as shown above, I hope that the natural conclusion will be accepted, and that the sentence "Lord Howe Island would therefore properly belong to the New Zealand biological region" will be altered to "Lord Howe Island *cannot* be accepted as part of the New Zealand biological region." I have written critically, so that it will be clearly understood that there is, practically speaking, no endemic Neozelanic element in the avifauna of Lord Howe Island. The supposed Neozelanic basal element is purely New Caledonian, and the true relationships of the Lord Howe bird-life will be fully developed in a paper, now in manuscript, by Mr. G. M. Mathews and myself.

In the Norfolk Island avifauna there is undoubtedly present a Neozelanic basis, and this constitutes a most intricate factor in the disposition of this faunula. However, the New Caledonian influence is so predominant that there can be little hesitation in preferring that fauna as being the closest and the most natural to which it might be attached. The only endemic Neozelanic genus worth consideration is *Nestor*, and against this must be placed *Turdus*, *Diaphoropterus*, and *Aplonis*, genera which occur in New Caledonia but not in New Zealand or Australia. *Hemiphaga* is very closely related to *Carpophaga*, and these pigeons are birds of quite a considerable power of flight. The *Zosterops* are quite a peculiar little group notable for their very large size. It might be noted that the two species of *Turdus* on Lord Howe and Norfolk Islands are not what are generall understood as representative forms — *i.e.*, subspecies — but have had different origin, as have also the species of *Gerygone* and *Zosterops* on th two islands. Further evidence will be put forward in the paper note above, but the conclusions arrived at by Oliver must be revised, and th attachment of Lord Howe and Norfolk Islands to the New Zealand biologic region must be negatived unless also New Caledonia be included in the New Zealand biological region.

It has been constantly overlooked by most New Zealand writers that the fauna and flora of New Caledonia are closely related to those of New Zealand, and this factor has been entirely neglected when the disposition of these island faunulas has been under discussion. Hedley (Proc. Linn. Soc. N.S.W., 1899, p. 402) clearly indicated this, and noted it was simply lack of material that obscured its recognition by New Zealand scientists. Oliver's conclusion that "the natural arrangement is to keep the Kermadec Islands separate from Lord Howe and Norfolk Islands" I fully endorse, and the incorporation of the former in the New Zealand biological region I advocate also, but only on consideration that the Kermadec Group be always carefully noted as constituting a distinct province, which I would call the "Kermadec province."

This province is well characterized by its strong Polynesian facies with its Neozelanic basis. This has been fully shown by other writers in every other branch that has been studied. Oliver's explanation of this combination (p. 218) seems to me to be the most suitable.

For Lord Howe and Norfolk Islands I would accept Hull's name of "Phillipian" but would consider it as only of the rank of a province, and note its attachment to the Australian region as an outlier of the New Caledonian province. In this manner all the facts from every side will be fully accounted for, and the anomalies present in every other disposition that has yet been put forward dispensed with in a thoroughly scientific manner.*

The nomenclature used in the following list differs considerably from that of previous writers, and therefore I am introducing the original reference in each case; in addition, giving a quotation to Cheeseman's list, and also the name used in Buller's Supplement.

As regards the Procellariformes and Lariformes, I have taken full advantage of the revision of these groups now appearing in Mathews's "Birds of Australia," and also given explanatory notes for the changes thus made.

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* Since the preceding notes were drawn up I have come across a quotation from a paper by W. L. Tower, entitled "An Investigation of Evolution in Chrysomelid Beetles of the Genus *Leptinotarsa*," wherein the following extraordinary statement occurs: "The geographical distribution of animals, or animal-geography, is usually considered from one of two viewpoints, the static or the dynamic. Considered from the static standpoint, the facts of distribution are taken and arranged according to some empirically chosen standard, and zones, subzones, or other unnatural areas of distribution are established. The study of animal-distribution from this standpoint is a dead and profitless pursuit." Inasmuch as it is accepted that the geological record is manifestly imperfect, it is most necessary to consider means independent of geological data whereby actual facts can be arranged. All "static" workers are aware of the great advantage of "dynamic" methods, but are also painfully aware of the impossibility, through lack of evidence, of correctly applying such. And "dynamic" methods improperly used will lead to grievous errors, whereas "static" calculations easily lend themselves to correction when the necessary "dynamic" data are forthcoming. I have here noted this as both Oliver's paper and my notes preceding this are based on static data; yet I do not consider them valueless, though, as Oliver has noted, they would be vastly improved were "dynamic" facts possible. At the present stage it would be quite "a dead and profitless pursuit" to endeavour to apply "dynamic" methods to such problems as are represented in the faunas of these islands, though by means of "static" data we can make calculations such as Oliver has presented, and, moreover, such tabular statements are fully worthy of record.

I. Birds actually observed in 1908.

Porzana plumbea (Gray) subsp. ?

Crex plumbea Gray in Griffith's ed. Cuvier's "Animal Kingdom," vol. 8, p. 410, 1829: New Zealand. *Ortygometra tabuensis* Cheeseman, Trans. N.Z. Inst., vol. 23, p. 220, 1891. *Porzana plumbea* Buller, Suppl. Birds N.Z., vol. 1, p. 63, 1905.

This bird was commonly heard, though rarely seen, in the swamp close to where we camped in Denham Bay. A dead specimen, unfit for preservation was picked up on the north coast. Though it nested on the island, its nest was not found, but a young one just hatched was obtained on the 5th November. As no specimens were collected, I am unable to decide the subspecific relationship of the Kermadec-breeding form, the range of the species extending over the Pacific islands, Australia, and New Zealand.

Pelagodroma marina (Latham) subsp. ?

Procellaria marina Latham, Index Ornith., vol. 2, p. 826, 1790: South Atlantic Ocean. *Pelagodroma marina* Cheeseman, *loc. cit.*, p. 226; Buller, *loc. cit.*, p. 98.

This species has been recorded as breeding on Meyer Island. I was unable to verify this, but as two dead specimens were picked up on Sunday Island in the spring it is quite likely that a small breeding colony does exist there. Mathews (Birds Austr., vol. 2, p. 24, 1912) has named the Noezelanic form *P. m. maoriana*, and has suggested that Solander's description of his *P. passerina* may be applicable to the present breeding race.

Puffinus assimilis assimilis Gould.

Puffinus assimilis Gould, Synops. Birds Austr., pt. 4, app., p. 7. 1838: Norfolk Island; Cheeseman, *loc. cit.*, p. 226; Buller, *loc cit.*, p. 100.

As far as I ascertained, this bird only bred on Meyer Island during the winter months. Arriving in May, its eggs were not laid until the end of June, and chiefly in July. The type locality of the species is Norfolk Island, where the bird also breeds in July and August, and it has recently been again recorded from Lord Howe Island, probably since Oliver's paper was written, as he does not include this species. Gray had, however, noted it at Lord Howe Island fifty years ago (*Ibis*, 1862, p. 244).

Mathews (Birds Austr., vol. 2, pp. 50–70, 1912) has recently reviewed the allied forms of this species, and has shown that Forster's *Procellaria gavia* was given to a form of this species, and must be used for the New-Zealand-breeding bird, which differs, as already indicated by Captain Hutton and Buller (*loc. cit.*). The bird commonly known to New Zealand students as *P. gavia*, following Hutton (Cat. Birds N.Z., p. 45, 1871), who, however, admitted its doubt, has been renamed by Mathews *Puffinus reinholdi* (*loc. cit.*, p. 74). I have examined specimens of this species from the type locality of Forster's *P. gavia*, and there can be no doubt of the accuracy of Mathews's determination. Mathews has also drawn attention to the discrepancies between Reischek's and Sandager's accounts of the breeding of these species, and suggested that possibly there may be a breeding form of *Puffinus lherminieri* resident in New Zealand which has been confused with *P. assimilis* Gould and *P. reinholdi* Mathews.

Puffinus pacificus pacificus (Gmelin).

Procellaria pacifica Gmelin, Syst. Nat., p. 560, 1789: Kermadec Islands breeding. *Puffinus carneipes* Cheeseman, *loc. cit.*, p. 226. *P. chlororhynchus, ibid.*; Buller, *loc. cit.*, p. 105. *P. c. iredali* Mathews, Bull. Brit. Orn. Club, vol. 27, p. 40, 1910.

Probably the most abundant bird breeding on the island. Though Hutton, Buller, Salvin, and Goodman all admitted that the Kermadec-breeding bird was quite distinct, it did not receive a name until Mathews, comparing it with the type of *P. chlororhynchus* Lesson from Shark Bay, Western Australia, named it as above. However, when he came to monograph the petrels in his "Birds of Australia" he conclusively proved that Gmelin's *P. pacifica*, which had been previously ignored, should be accepted as the species name, and, moreover, that it was best applied to this large Kermadec race (*loc. cit.*, p. 80). This course I fully approve of.

In the paper quoted in the introduction to this account Oliver includes as breeding on Lord Howe, Norfolk, and the Kermadec Islands *Puffinus sphenurus*. *Puffinus sphenurus* Gould is an absolute synonym of *P. chlororhynchus* Lesson, which name must be restricted to the west-Australian-breeding bird.

Mathews has named the east-Australian-breeding form *Puffinus pacificus royanus* (Birds Austr., vol. 2, p. 85, 1912), and Lord Howe Island birds agree fairly—one Norfolk Island specimen not quite as close; but with these typical Kermadec birds cannot be confused. So that as far as comparisons go the Lord Howe and Norfolk Island breeding forms must not be confused with the Kermadec form, whether they be called *P. pacificus* or *P. chlororhynchus* subspp. The name *P. sphenurus* must not be used.

Pterodroma neglecta (Schlegel).

Procellaria neglecta Schlegel, Mus. de Pays Bas, vol. 6, Procell., p. 10, 1863: Kermadec Islands. *Oestrelata mollis* Cheeseman, *loc. cit.*, p. 225. *Oestrelata* sp., *ibid.* *O. neglecta, ibid.* *O. mollis* Buller, *loc. cit.*, p. 112. *O. neglecta, ibid.*, p. 115. *O. phillipi, ibid.*, p. 119.

The synonymy shows the confusion that has existed regarding the forms of surface-breeding petrels living at the Kermadec Islands. In the *Emu*, vol. 10, p. 13, 1910, I briefly sketched the problem, and my conclusions that only one species without any well-marked varieties could be recognized by me. Further study has not more enlightened me, but has decided me to withhold the exhaustive account of my researches I had drawn up until I feel better able to give some explanation of the anomalies presented.

The disuse of the familiar *Aestrelata* is due to the investigations of Mathews (Birds Austr., vol. 2, p. 129, 1912). Mathews has also shown that there is (or was) a bird breeding on Norfolk Island very closely allied to the present species, but that *O. montana* Hull (= *O. phillipi* (Gray) = *O. solandri* Gould = *P. melanopus* Gmelin) may not at present breed on Norfolk Island, and has confirmed my conclusion that the bird is quite different from *P. neglecta* Schlegel, and has given a full history of the species under the name *P. melanopus* Gmelin.

Pterodroma cookii nigripennis (Rothschild).

Oestrelata nigripennis Rothschild, Bull. Brit. Orn. Club, No. x, p. lvii, 1893: Kermadec Islands. *O. cookii* Cheeseman, *loc. cit.*, p. 224. *O. nigripennis* Buller, *loc. cit.*, p. 113.

This beautiful little bird is more numerous on the outlying islands and on Macauley Island and Curtis Island than on Sunday Island. It breeds during the summer months, whilst *Puffinus a. assimilis* only breeds in the winter on Meyer Island, so that Cheeseman's remark, "Breeds . . . more sparingly on Sunday Island in company with *Puffinus assimilis*," needs correction.

Pterodroma macroptera gouldi (Hutton).

Aestrelata gouldi Hutton, *Ibis*, 1869, p. 351: New Zealand. *Oestrelata gouldi* Buller, *loc. cit.*, p. 111. *O. fuliginosa*, *id.*, *ib.*, p. 118. *O. macroptera* Ogilvie Grant, *Ibis*, 1905, p. 554; Oliver, Trans. N.Z. Inst., vol. 44, p. 215, 1912.

A specimen washed up on the beach on the 7th August, 1908, proved sufficient for identification. Another bird, too much damaged for preservation, had been noted on the 25th July. However, it had already been added to the Kermadec avifaunal list by Ogilvie Grant, whose specimen, which I have examined, also proves to be a washed-up bird. It belongs to the New Zealand race, so that I do not doubt Oliver's bird is also referable to that form. The typical subspecies inhabits the Cape seas, whilst Mathews (Birds Austr., vol. 2, p. 139, 1912) has described a west-Australian-breeding race as *P. m. albani*.

Pterodroma externa cervicalis (Salvin).

Oestrelata cervicalis Salvin, *Ibis*, 1891, p. 192: Kermadec Island. *Oestrelata* sp. Cheeseman, *loc. cit.*, p. 224. *O. cervicalis* Buller, *loc. cit.*, p. 114.

A beautiful bird, which appeared to be decreasing in numbers through the ravages of cats, only a few small scattered colonies now being known. Its closest relative breeds on Juan Fernandez Island, where also a very close ally of *P. neglecta* is recorded as breeding.

Diomedea exulans rothschildi Mathews.

Diomedea exulans rothschildi Mathews, Birds Austr., vol. 2, p. 246, 1912: Australian seas. *D. exulans* Cheeseman, *loc. cit.*, p. 224; Buller, *loc. cit.*, p. 128.

A specimen which had been washed up on the beach at Denham Bay previous to our arrival is the basis of this record. At the place quoted Mathews has given a good history of this bird and of the allied species commonly known under the name of *Diomedea regia* Buller, but which must bear the older name of *D. epomophora* Lesson.

Onychoprion fuscatus serratus (Wagler).

Sterna serrata Wagler, Naturl. Syst. Amphib., p. 89, note, 1830: New Caledonia. *S. fuliginosa* Cheeseman, *loc. cit.*, p. 221; Buller, *loc.* cit., p. 159.

Bred abundantly on Denham Bay beach, and sparingly on the rocks off the north-west corner and on Meyer Island. The rejection of the well-known specific name of *fuliginosa* Gmelin is unavoidable, as Linné had previously named a young bird from the Island of Domingo, West Indies, *Sterna fuscata*. This was founded on the *Sterna fusca* of Brisson (a post-Linnean (1758) non-binomial writer), and Brisson's description and figure are admirable and unmistakable to one who has seen the young, as I have. The South Pacific birds are easily separable from typical birds, and the name to be used is the one I have given.

Procelsterna cerulea cinerea Gould.

Anous cinereus Gould, Proc. Zool. Soc. (Lond.), 1845, p. 104: north-east coasts, Australia; Cheeseman, *loc. cit.*, p. 222. *Procelsterna cinerea* Buller, *loc. cit.*, p. 161.

Bred sparingly on the cliffs at each end of Denham Bay: more commonly on Meyer Island; also at Macauley and Curtis Islands.

Megalopterus minutus minutus (Boie).

Anous minutus Boie, *Isis*, 1844: north-east Australia. *A. melanogenys* Cheeseman, *loc. cit.*, p. 221. *Micranous leucocapillus* Buller, *loc. cit.*, p. 163.

An increasing colony bred on Meyer Island and one of the other outlying islets, though not on Sunday Island. A flight was seen at Macauley Island, but as there are no trees I do not think it was breeding there. This species has been commonly known as *Micranous leucocapillus* Gould, but Mathews (Novit. Zool., vol. 18, p. 4, 1911) showed that the correct generic name was *Megalopterus* Boie, which had priority; whilst more recently (Birds Austr., vol. 2, 1912) the same writer has accepted Boie's specific name, which has also priority over Gould's specific name.

Gygis alba royana Mathews.

Gygis alba royana Mathews, Birds Austr., vol. 2, p. 433, 1912: Kermadec Islands. *G. candida* Cheeseman, *loc. cit.*, p. 222. *G. alba* Buller, *loc. cit.*, p. 163.

Only bred sparingly round the sea-coast of Sunday Island. A most delightful account of the habits of this bird has recently appeared from the pen of Mr. Roy Bell (*Emu*, vol. 12, pp. 26–30, 1912), whose photos, considering the difficulties under which he worked, have scarcely been excelled by any bird-observer. A splendid review of the species of *Gygis* will be found in the place above quoted, where Mathews has separated the Kermadec-breeding bird under the name given. I have carefully considered all the points, and fully endorse Mathews's conclusions.

Pluvialis dominicus fulvus (Gmelin).

Charadrius fulvus Gmelin, Syst. Nat., p. 687, 1789: Tahiti; Cheeseman, *loc. cit.*, p. 220. *C. dominicus* Buller, *loc. cit.*, p. 174.

This was the wader met with most frequently on Sunday Island, thirteen being noted during September and October. A flock of thirteen waders seen off Macauley Island on the 12th November seemed to consist mostly of this bird.

Eupoda vereda (Gould).

Charadrius veredus Gould, Proc. Zool. Soc. (Lond.), 1848, p. 38: north Australia.

On the 22nd April Mr. W. R. B. Oliver shot a specimen of this bird on Denham Bay beach. Mathews (Novit. Zool., vol. 18, p. 5, 1911) has shown that *Eupoda* Brandt, 1845, has seven years' priority over the more familiar *Ochthodromus* Reichenback, 1852.

Numenius phaeopus variegatus (Scopoli).

Tantalus variegatus Scopoli, Del Flor. Faun. Insule, fasc. ii, p. 92, 1786: Luzon, Philippine Islands. *Numenius variegatus* Buller, *loc. cit.*, p. 181.

One specimen (out of a pair) was shot on the north coast by Oliver on the 24th September; a few days later three similar birds were seen.

Pisobia maculata acuminata (Horsfield).

Totanus acuminatus Horsfield, Trans. Linn. Soc. (Lond.), vol. 13, p. 192, 1821: Java. *Heteropygia acuminata* Buller, *loc. cit.*, p. 187.

On the 25th October Oliver shot a specimen on Denham Bay beach. Mathews (Novit. Zool., vol. 18, p. 7, 1911) has shown that Sharpe's identification of the Watling drawing upon which was based Latham's *T. aurita* was purely an error, and hence the usage of Latham's name incorrect. This is the bird Oliver (*loc. cit.*, p. 221) catalogues under the name *Erolia aurita*. The generic name *Erolia* was introduced for the curlew sandpiper, and the present species cannot be considered congeneric with that bird.

Anas superciliosa Gmelin subsp. ?

Anas superciliosa Gmelin, Syst. Nat., p. 537, 1789: Dusky Sound, south New Zealand; Cheeseman. *loc. cit.*, p. 221; Buller, Suppl., vol. 2, p. 5, 1906.

This bird was constantly seen on the crater-lakes, and, although noted all the year round, was not observed to breed. I do not know whether the birds were referable to the New Zealand or Australian form.

Sula dactylatra personata Gould.

Sula personata Gould, Proc. Zool. Soc. (Lond.), 1846, p. 21: north Australia. *S. cyanops* Cheeseman, *loc. cit.*, p. 223; Buller, *loc. cit.*, p. 49.

Did not breed on Sunday Island; a couple bred on Meyer Island; plentifully on one of the less islets, hence known to the settlers as Gannet Island. A fair number breed on Macauley Island and Curtis Island. Mathews (Novit. Zool., vol. 18, p. 9, 1911) has shown that the species name to be used is *dactylatra* Lesson, that name having six years' priority over the more familiar *cyanops*, both being given to Ascension Island, Atlantic Ocean, breeding birds.

Phaethon rubricauda novaehollandiae Brandt.

Phaethon novaehollandiae Brandt, Mem. Acad. Sci. St. Petersb., ser. 6, vol. 5, pt. 2, p. 272, 1840: Lord Howe Island. *P. rubricauda* Cheeseman, *loc. cit.*, p. 223; Buller, *loc. cit.*, p. 53.

Breeding sparsely all round Sunday Island, and more plentifully on Meyer Island. Rothschild separated (Avifauna Laysan, pl. 3, p. 296, 1900) the Kermadec, Lord Howe, and Norfolk Island breeding birds under the name *P. rubricauda erubescens*. Mathews (Novit. Zool., vol. 18, p. 243, 1912) has shown that Brandt had previously introduced the name here accepted for a young bird described by Latham from a drawing made at Lord Howe Island. The subspecies is well differentiated by its larger size and brighter coloration.

Circus sp.

Circus gouldi Cheeseman, *loc. cit.*, p. 218 ; Buller, *loc. cit.*, p. 54.

There cannot be much doubt that the harrier which frequented Sunday Island during the winter months was referable to the species *Circus approximans* Peale, but to which race cannot be decided without study of specimens. The species has a wide range over Australia, New Caledonia, Fiji, and New Zealand.

Mathews (Novit. Zool., vol. 18, p. 10, 1911) has noted that *Circus approximans* Peale, 1848, given to the Fijian race, has priority and must be used as a species name whilst *C. gouldi* Bonaparte, 1850, can be utilized, but restricted for the east Australian form. It will be most interesting to learn from which source come the birds which travel to and from the Kermadecs.

Cyanoramphus novaezelandiae cyanurus Salvadori.

Cyanorhamphus cyanurus Salvadori, Ann. Mag. Nat. Hist., ser. 6, vol. 7, p. 68, 1891 : Raoul Island, Kermadec Group. *Platycercus novaezealandiae* Cheeseman, *loc. cit.*, p. 218. *Cyanorhamphus cyanurus* Buller, *loc. cit.*, p. 87.

A parrakeet bred on Meyer Island ; it very rarely occurred in the autumn on Sunday Island. On Macauley Island also not uncommonly was seen a similar parrakeet. Salvadori named a bird procured by Macgillivray at Raoul Island *C. cyanurus*. The wing-measurement is there given as 6·6 in. This is copied into the Cat. Birds Brit. Mus., vol. 20, p. 587, but reference to the type specimen shows this to be a misprint for 5·6 in. In the Cat. Birds Brit. Mus. the habitat of *cyanurus* is given : " Raoul Island, of the Kermadec Group, and perhaps also Sunday Island (where it has been exterminated by wild cats), Meyer, and Macauley Islands (Cheeseman). Whether the birds from Sunday, Meyer, and Macauley Islands, also from the Kermadec Group, belong to the same species as those from Raoul Island remains to be ascertained."

Of course, Raoul Island is Sunday Island, and the bird so labelled by Macgillivray was probably procured on Meyer Island.

Buller's accounts in the Supplement are too confused to be intelligible. On p. 84, under *C. novaezealandiae*, he wrote : " Specimens brought from Macauley Island, in the Kermadec Group, do not differ from the New Zealand bird. . . . I have examined a caged parrakeet, brought by Mr. Ernest Bell from Curtis Island, situated a few miles from Sunday Island, in the Kermadec Group, where also this parrakeet was abundant till the introduction of the domestic cat, which soon killed it off. I can detect no difference from the New Zealand bird. . . . Macauley Island, where a distinct species closely allied to *C. novaezealandiae* is said to exist, lies about a degree distant from Sunday Island." Then on the following page is written : " Mr. Bethune [*sic*], of the 'Hinemoa,' declares that the Macauley Island parrakeet is quite distinct from the one inhabiting Sunday Island. He says he could readily pick a specimen out of a hundred of the others. . . . Mr. Cheeseman records that he found this parrakeet very plentiful on Macauley Island. . . . He states that all his specimens were larger than New Zealand ones, but that he could not detect any other difference. It is highly probable, therefore, that this was *C. cyanurus*, which differs only in having the tail of a bluish hue." Then on p. 86 occurs : " That from Macauley Island (Kermadec Group), of which several were brought by the 'Hinemoa,' is undoubtedly the same as our *Cy. novaezealandiae,* which enjoys a wide geographical range." Then on p. 87 he added, under "*Cy. cyanurus*": "Mr. Ernest Bell, of Wellington, had a tame one (obtained at Curtis Island, Kermadec Group)." I do not intend to discuss the preceding contradictory statements, but state the facts, which are simple: The Meyer Island bird, which is the true *Cy. cyanurus* of Salvadori, is a subspecies of *C. novaezealandiae* which is distinguished by its larger size and the blue tinge on the central tail-feathers. It seems certain that the Macauley Island bird agrees, and the reference of the Curtis Island specimen to *Cy. cyanurus* points to all the Kermadec Group birds being different from the mainland New Zealand *Cy. novaezealandiae.* Whether the Macauley Island birds are separable from the Meyer Island form can only be determined by the examination of series from each locality. In the meanwhile the only course possible is to refer all the Kermadec birds to *C. n. cyanurus* Salvadori.

Sauropatis sanctus vagans (Lesson).

Alcedo vagans Lesson, Voy. de la "Coquille," Zool., vol. 1, p. 694, 1830: Bay of Islands, N.Z. *Halcyon vagans* Cheeseman, *loc. cit.*, p. 218; Buller, *loc. cit.*, p. 97.

Fairly common all over Sunday Island. This subspecies ranges over New Zealand, Norfolk Island, Lord Howe Island, and Sunday Island, Kermadecs. Whether the island forms are separable from the mainland New Zealand birds can only be decided by examination of series. Tristram (*Ibis*, 1885, p. 49) described the Norfolk Island bird as *Halcyon norfolkiensis*, but that form has been more recently merged. I shall be surprised if the birds later prove distinct, as I have concluded that they are quite recent immigrants to these island groups. In support of this view I would quote the known history of this bird on Lord Howe Island. In Hill's account of the "Birds of Lord Howe Island," p. 54, 1869, there is catalogued "*Halcyon* sp., blue kingfisher; no specimen; only one seen": whilst in the Records Austr. Mus., vol. 2, p. 89, 1889, we read, "We were told, a comparatively recent addition to the avifauna of the island"; and now, "This bird is found in large numbers," though "it is therefore generally shot when it approaches too close to the fowlyard" (Hull, Proc. Linn. Soc. N.S.W., vol. 34, p. 677, 1910). Thus in the short space of forty years it has become a common bird, in spite of persecution.

Urodynamis taitensis (Sparrman).

Cuculus taitensis Sparrman, Museum Carlson, fasc. ii, No. 32, 1787: Tahiti. *Eudynamis taitensis* Cheeseman, *loc. cit.*, p. 218. *Urodynamis taitensis* Buller, *loc. cit.*, p. 98.

This bird was more commonly heard than seen, but was noted in every month of the time I was on the island. It was more numerous in October than in any other month.

Prosthemadera novaeseelandiae (Gmelin) subsp. ?

Merops novaeseelandiae Gmelin, Syst. Nat., p. 464, 1788: Queen Charlotte's Sound, South Island, N.Z. *Prosthemadera novaezealandiae* Cheeseman, *loc. cit.*, p. 218; Buller, *loc. cit.*, p. 144.

This bird was abundant, but as no series was collected I do not know whether it was subspecifically separable from mainland forms. As it had lost its voice, it seems certain that it would be.

II. BIRDS RECORDED BUT NOT OBSERVED BY MYSELF OR MEMBERS OF THE PARTY IN 1908.

Megapodius sp. ?

Megapodus sp. ? Cheeseman, *loc. cit.*, p. 219. *M. pritchardi* Buller. *loc. cit.*, p. 31.

I note that Oliver, in the paper cited, has omitted this bird from consideration, but without any explanation of his action. Lister's conclusions (Proc. Zool. Soc. (Lond.), 1911, p. 749 *et seq.*) are confirmatory of my own, as there acknowledged, and, as this paper has been utilized in the Dominion to approve of the non-acceptance of *Megapodius pritchardi* as a New Zealand bird, no further arguments need be adduced.

Carpophaga novaezealandiae Gmelin.

Carpophaga novaezealandiae Cheeseman, *loc. cit.*, p. 219.

Oliver doubtfully includes this, but I can see no valid reason for such inclusion. The only basis is a second-hand tale, and I unhesitatingly reject all such, however distasteful to my views such action may be.

Hypotaenidia philippensis Linné subsp. ?

Rallus philippensis Cheeseman, *loc. cit.*, p. 220.

Cheeseman notes it as "by no means common" at the Denham Bay Lagoon. Although we camped at this spot for ten months, it was neither heard nor seen. It is possible that stragglers may occur, and it would be delightfully interesting to know which subspecies straggled to this out-of-the-way place.

Porphyrio melanotus Temminck subsp. ?

Porphyrio melanotus Cheeseman, *loc. cit.*, p. 220.

Cheeseman recorded that he saw one in Denham Bay. It must have been a straggler, as we did not see it. The same remarks apply here as to the preceding.

Puffinus tenuirostris Temminck.

Hutton (Proc. Zool. Soc. (Lond.), 1893, p. 749) received a specimen from Sunday Island. It is very probable that it was a bird washed up during the winter months, and that it belonged to the Australian-breeding race *P. tenuirostris brevicaudus* Gould.

Prion desolatus Gmelin subsp. ?

Oliver (*loc. cit.*, p. 215) has made this addition to the Kermadec avifauna. Mathews (Birds Austr., vol. 2, pp. 194–231, 1912) has given a splendid review of the prionitic petrels, and by means of figures has removed the confusion previously existing in this group. The genus *Heteroprion* is there introduced for the birds like *P. desolatus*, and the Auckland-Islands-breeding bird is named *H. desolatus alter.* Comparison should be instituted with correctly identified material, and the form occurring at the Kermadecs determined.

Daption capensis Linné.
Diomedea melanophrys Boie.
Phoebetria fuliginosa Gmelin.

Under the above names Cheeseman (*loc. cit.*, p. 224) records having observed petrels at sea in Kermadec waters. They were not noted by any member of our party.

Mathews (Birds Austr., vol. 2, 1912) has shown that the correct name for the bird noted above as *Diomedea melanophrys* Boie is *Thalassarche melanophris impavida* Mathews; whilst until specimens are procured we can only guess at the identity of the last-named. The same author has carefully reviewed the literature, and by means of ample material has shown that two distinct species have been confused under the name *P. fuliginosa* Gmelin: that the correct name for one is *P. palpebrata* Forster, of which *P. fuliginosa* Gmelin is an absolute synonym; whilst the other must bear the name *P. fusca* Hilsenberg. The New-Zealand-breeding races have been named by Mathews *Phoebetria palpebrata huttoni* and *Phoebetria fusca campbelli*. Which of these two occurs in Kermadec waters is problematical, the probability being the latter.

Sterna caspia Pallas.

Two years ago I made the following comment in manuscript: "Cheeseman (p. 221) included this bird on the authority of Mr. Bell as having been noted. No use can be made of such records, as we are unable to judge whether the bird seen (!) was referable to the New Zealand or Australian subspecies, whilst it is only guesswork to have called it *S. caspia* at all!"

Oliver has now recorded *Sterna bergii* (p. 215), and has omitted *S. caspia* altogether, though including doubtful records. It would therefore appear that he has concluded that the record of *S. caspia* applies to his new record. The nomenclature of the two species has been elaborated by Mathews (Birds Austr., vol. 2, 1912), and the bird commonly known as *S. caspia* must be called *Hydroprogne tschegrava* Lepechin, the Australian subspecies being known as *H. tschegrava strenuus* Gould. *S. bergii* is referred to the genus *Thalasseus*, and the races discussed, the north Australian race being called *Thalasseus bergii pelecanoides* King, the south-east Australian *Thalasseus bergii poliocercus* Gould, and the Fijian form *Thalasseus bergii rectirostris* Peale. As the species does not occur in New Zealand, the straggler procured must belong to one of these.

Whilst on the subject of terns, I might note that Oliver (p. 220) has included as a visitor to Norfolk Island the New Zealand *Sterna albistriata*. If this is based on the record in the Cat. Birds Brit. Mus. it would be better expunged, as the specimen which I have carefully examined is in very immature plumage, and it has no history! I myself would not admit it, and Mathews, in his "List of the Birds of the Phillipian Region" (Novit. Zool., vol. 18, pp. 447–52, 1912), has rejected it without comment, as Saunders himself did not believe in it.

Anous stolidus Linné.

At the end of his account of *Anous cinereus* Gould (p. 222) Cheeseman noted it was probable that *A. stolidus* might also breed on the group. By a misreading of what was written, Buller included the species in the Supplement (p. 162) as breeding on the Kermadecs on Cheeseman's authority, and it has been included in the most recent list of New Zealand birds. But this bird does *not* yet breed at the Kermadecs, and has been omitted by Oliver without explanation.

Limosa novaezealandiae Gray.

Cheeseman (p. 220) included this bird on Mr. Bell's authority. Such a common New Zealand migrant should occur, but we did not meet with it during the time we were on the island. This points to it being but a scarce straggler to the group, and that the group does not lie in the line of its migration. The correct name to be used for this bird is *Limosa lapponica baueri* Naumann.

Tringa canutus Linné.

Oliver (p. 215) has added this visitor. For a fortnight in September, 1908, I endeavoured, unsuccessfully, to shoot a bird which I thought might prove to be this species. It associated with a small flock of *Charadrius dominicus fulvus* Gmelin which frequented Denham Bay beach. The correct name of the species is *Canutus canutus* (Linné) (Mathews, Novit. Zool., vol. 18, p. 5, 1911).

Ardea sacra Gmelin.
Sula serrator Gray.

Admitted by Cheeseman (p. 220) on Mr. Bell's authority. These must be omitted until skins are actually received from the group.

Sula leucogaster.
Phalacrocorax sulcirostris.

These have been added by Oliver (p. 215) on Mr. Roy Bell's authority. As both of my friends know, I do not admit hearsay records, however much faith I have in the observer; consequently these two records are inadmissible in my list of the Kermadec avifauna.

Tachypetes aquilus Linné.

Mr. Cheeseman introduced this (p. 223) on Mr. Bell's authority. No one can possibly separate the two species of frigate-birds on the wing, and they are not easily differentiated when in the hand. Both species have occurred in New Zealand.

Chrysococcyx lucidus Gmelin.

Cheeseman's record (p. 219), upon the same authority as the preceding, needs verification by means of skins. No one can separate the Australian form from the New Zealand forms without careful examination of specimens. The correct name would be *Lamprococcyx lucidus* Gmelin for the New Zealand bird.

Zosterops caerulescens Latham.
Anthus novaezealandiae Gmelin.

These two species were met with by Cheeseman himself (p. 218). They were apparently only stragglers from New Zealand which have failed to establish themselves, as I did not meet with either. The latter, recorded as plentiful on Macauley Island in 1887 by the same author, was not seen by me on that island.

The preceding notes fairly represent the knowledge of the Kermadec avifauna as obtained by the members of our party in 1908.

A word may be here put forward regarding the nomenclature of the species of *Puffinus* used by Oliver (pp. 219–20) in his comparisons. North has already corrected that utilized by Hull, upon which Oliver based his article, which corrections, however, have been incorporated by Oliver. At the present time it seems inexpedient to include *P. griseus* in the Norfolk Island list, the bird so identified being probably *P. carneipes* subsp. ? A further note will, however, be shortly contributed clearing up this article, as material for critical comparison will soon be available.

Art. XIV.—*Further Notes on the Birds of the Kermadec Islands.*

By W. R. B. Oliver.

[*Read before the Auckland Institute, 11th December, 1912.*]

The report by Tom Iredale appearing in this volume (p. 78) on the birds observed in the Kermadec Islands in 1908 calls for some additional notes, especially with regard to those species concerning which further information has been obtained or skins procured by Messrs. Roy and King Bell since the return of our expedition.

In concluding that Lord Howe and Norfolk Islands have received the basal elements in their avifaunas by way of New Caledonia, Iredale is in complete accordance with the views I have already given in these Transactions (vol. 44, p. 214, 1912), but he differs in considering the avifaunas more closely related to that of New Caledonia than to that of New Zealand.

Porzana plumbea.

A number of nests were found by Messrs. Roy and King Bell in the swamp in Denham Bay, Sunday Island. From R. Bell's diary I summarize the particulars as follows: From the 10th November to the 3rd December, 1909, five nests of three eggs each, one nest of four eggs; from the 15th November, 1910, to the 3rd January, 1911, four nests of two eggs each, four nests of three eggs each, one nest of four eggs. In addition to these, a nest with one egg was found on the 2nd November, 1909, but was shortly afterwards destroyed, apparently by rats. In the Auckland Museum there are several skins of this species obtained on Sunday Island.

Anas superciliosa.

Nests of the grey duck were found by K. Bell in the crater of Sunday Island in 1910. One, found on the 1st October, contained six eggs; another, found on the 22nd October, contained seven eggs.

Porphyrio melanotus.

The skin of a specimen shot by K. Bell on the Denham Bay beach on the 27th April, 1909, is in the Auckland Museum. R. Bell notes: "Contents of stomach, quills and bits of feather. From this we may conclude that it has been eating the dead wideawakes."

Sterna bergii.

The skin on which the first record (*l.c.*, p. 215) of this bird in the Kermadecs was based is that of a young male shot by K. Bell on the 1st April, 1910. The bird was first noticed on Denham Bay beach on the previous day.

Limosa novaezealandiae.

One skin collected by R. Bell on the 4th November, 1909, and eleven others collected on various dates from the 16th October to the 28th November, 1910, are in the Auckland Museum. Bell records that these birds were seen singly or in small flocks, sometimes associating with *Charadrius dominicus*, in the crater and in Denham Bay.

Prion desolatus.

The skin on which the record (*l.c.*) is based was taken from a specimen found by R. Bell cast up by the sea on Denham Bay beach on the 29th July, 1910.

Tringa canutus.

The specimen recorded (*l.c.*) was taken on Denham Bay beach on the 17th October, 1910.

Heteropygia acuminata.

A skin obtained from a specimen shot by R. Bell on the 29th October, 1910, is in the Auckland Museum.

ART. XV.—*Some New Species of Plants.*

By T. F. CHEESEMAN, F.L.S., F.Z.S., Curator of the Auckland Museum.

[*Read before the Auckland Institute, 11th December, 1912.*]

1. **Aciphylla Spedeni** Cheesem. sp. nov.

A. Dobsoni Hook. f. affinis, sed differt caule multo majore, foliis numerosibus et flabellatim 6–9-lobatis.

Planta robusta, e basi ramosa, 10–30 cm. diam., ramis dense compactis. Folia numerosissima, 40–60, dense conferta aut imbricata, 10–15 cm. longa, rigida, coriacea, glaberrima, nitida quasi vernicosa, flabellatim 6–9 lobata; petiolis vaginantibus, apice coriaceis, basi membranaceis, 2–3·5 cm. latis, lobis (aut segmentis) linearibus, 6–8 cm. longis, 2·5–5 mm. latis, apice acuminatis et pungentibus. Pedunculi robusti, erecti, foliis vix longiores. Umbellae compositae, in capitulum densum crassum congestae 6–8 cm. diam. Bracteae inferae 3–5 cm. longae, basi membranaceae, latae, apice breviter 7–8 partitae. Flores albi, numerosi. Fructus ignotus.

Hab.—South Island: Rocky places on Cecil Peak, near Lake Wakatipu, altitude 5,000–6,000 ft.; also in several other localities on the Eyre Mountains, of which Cecil Peak is the northern termination; *Mr. James Speden!*

Apparently forming large simple or branched masses 4–12 in. diameter or more; rootstock thick and woody, branched at the top. Leaves very numerous, 40–60 or more, crowded, spreading, the lower curved downwards, the upper more erect, 4–6 in. long, flabellately divided into 6–9 leaflets springing from the top of the petiole; petiole rather more than half the length of the whole leaf, very thick and coriaceous at the top and about $\frac{1}{3}$–$\frac{1}{2}$ in. broad, flat above, convex beneath, gradually widening and becoming thinner and more membranous towards the base, where it is $\frac{3}{4}$–$1\frac{1}{2}$ in. broad. Leaflets usually 7, but sometimes the central one is 2- or 3-fid almost to the base, thus making the number 8 or 9, very rarely 5 or 6, very thick, rigid and coriaceous, $2\frac{1}{2}$–3 in. long, $\frac{1}{6}$–$\frac{1}{10}$ in. broad, narrow-linear, narrowed towards the apex into a short rigid and pungent point; midrib and margin thick and cartilaginous; veins parallel with the midrib, but connected by numerous transverse veinlets. Male inflorescence alone seen; flowering-stem or peduncle stout, nearly $\frac{1}{2}$ in. diameter, 3–4 in. high, bearing at the top numerous compound umbels congested into a capitate mass 3 in. diameter. Lower bracts $1\frac{1}{2}$ in. long, composed of a broad and thin membranous sheath $\frac{1}{2}$–$\frac{3}{4}$ in. diameter, tipped by 7–8 short linear leaflets. Primary umbels 10–12, peduncles $\frac{1}{2}$–1 in. long; secondary umbels very numerous, bractlets wanting. Flowers white; calyx-teeth short, triangular; petals obovate-spathulate, with a rather long claw. Fruit not seen.

A very distinct and curious species, which I have much pleasure in dedicating to its discoverer, who has furnished me with much valuable information respecting the botany of Central Otago and Southland. It is no doubt related to *A. Dobsoni*, but differs widely in the much greater size of all its parts, in the remarkable digitately or flabellately divided leaves, which are not nearly so coriaceous as those of *A. Dobsoni*, and in the much larger and more massive inflorescence. Its discovery shows that there is still much to be done on the higher mountains of the southern portion of the South Island.

2. **Raoulia Cheesemanii** Beauverd in Bull. Soc. Bot. Geneva, vol. 4 (1912), p. 55, sp. nov.

"Herba pusilla, fruticulosa, ramosissima, procumbens. Ramuli breves (4–10 mm.), erecti, cinereo-incani, dense foliati, monocephali. Folia regulariter denseque disticha imbricata, 2 mm. longa, subelliptico-lineari, recurva apice mucronulata, limbo crassiusculo sericeo-cinereo, valde plicato, sub lente anastomoso-nervoso; petiolo obsolete cauli adpresso, 3–5 nervio. Capitula minima, 5 mm. longa, terminalia, sessilia, cylindracea, post anthesin radiata. Involucri squamae 3–4·5 mm. longae, squarrosae obtusae vel emarginatae albido-lutescentes, apice atro-fuscae; extus sericeae vel glabratae; intus glaberrimae. Flosculi hermaphroditi femineique subaequilongi (3–3·5 mm. longi), quam pappi setae breviores. Antherae 1·5 mm. longae. Styli flosculi hermaphroditi femineique aequilongi. Achaenia fl. ☿ puberula, fl. ♀ glabra, aequilonga, 1 mm."

Hab. South Island: Marlborough, Awatere River; *J. H. Macmahon!*

The above species has been described by M. Beauverd, the well-known keeper of the Boissier herbarium, in a valuable paper on the genus

Raoulia printed in the "Bulletin of the Botanical Society of Geneva" (vol. 4, 1912, pp. 41–55), and which contains much new matter of importance respecting the classification of the species. The type of *R. Cheesemanii* was collected by Mr. J. H. Macmahon in the Awatere Valley, and was forwarded by myself to M. Beauverd under the name of *R. Monroi*. But M. Beauverd considers that it is specifically distinct in the regularly distichous arrangement of the cauline leaves, which in the true *R. Monroi* are not distichous but are arranged in several ranks. He also remarks that the leaves are smaller and not so spathulate as in *R. Monroi*, that the venation is different, and the flower-heads narrower and more cylindrical. The distribution of the two forms will require to be worked out anew in the light of M. Beauverd's views; but judging from the specimens in my herbarium it seems that *R. Cheesemanii* is the more plentiful of the two, ranging from Marlborough to the south of Otago, and from sea-level to 2,500 ft. altitude. Of the plant which M. Beauverd considers to be typical *R. Monroi* I have no specimens from levels below 2,000 ft. It should be remarked that the drawing of *R. Monroi* in the "Illustrations of the New Zealand Flora" (t. 102), now in the press, is for the most part based on specimens of *R. Cheesemanii*.

3. **Veronica Townsoni** Cheesem. sp. nov.

Ad *V. macrocarpam* proxime accedit, sed differt foliis angustioribus et maxime coriaceis, calycis lobis acutis; corollae tubo multo breviore; capsula quam calycem vix 2-plo excedente.

Frutex 1–2 metralis, ramis rigidis. Folia subsessilia aut brevipetiolata, 5–7 cm. longa, 6–7 mm. lata, lineari-lanceolata, acuta, rigida, coriacea, supra plana, subtus cum costis eminentibus. Racemi 6–10 cm. longi, attenuati, acuminati, laxiflores. Flores 5 mm. diam.; calycis segmenti oblongo-lanceolati vel oblongo-ovati, acuti vel subacuti. Corollae tubus brevis, calyce vix longior. Capsula 4–7 mm. longa, ovata, quam calycem vix 2-plo excedente.

Hab. South Island: Rocky hills between the Little Wanganui and Mokihinui Rivers, north of Westport; and on limestone rocks by Fox's River, near Brighton; *W. Townson!*

A branching shrub, 3–6 ft. high or more, branchlets stout, rigid, glabrous, ringed with the scars of the fallen leaves. Leaves sessile or very shortly petiolate, spreading, 2–3 in. long, $\frac{1}{4}$–$\frac{1}{3}$ in. broad, linear-lanceolate, acute, very thick and coriaceous, rigid when dry, glabrous, flat and smooth above, midrib elevated beneath, veins obscure. Racemes usually longer than the leaves, 3–6 in. long, lax-flowered, often attenuated towards the tip, glabrate or nearly so. Flowers about $\frac{1}{4}$ in. diameter. Calyx 4-partite, segments oblong-ovate to oblong-lanceolate, acute or subacute, margins ciliolate. Corolla-tube short and broad, hardly exceeding the calyx; limb 4-lobed; lobes oblong, obtuse. Capsule $\frac{1}{5}$–$\frac{1}{4}$ in. long, ovate, acute, compressed, about twice as long as the calyx.

This is one of the many discoveries made by my friend Mr. W. Townson while exploring the vegetation of the south-western portion of the Nelson Provincial District. At the time of the publication of the Manual I was only acquainted with fruiting specimens, and consequently referred it, as var. *crassifolia*, to the closely allied *V. macrocarpa*. But since then Mr. Townson has furnished me with good flowering specimens, which prove that it is a perfectly distinct species, distinguished from all the forms of *V. macrocarpa* by the smaller and narrower much more coriaceous and rigid leaves, by the acute calyx-segments, by the very short and broad corolla-tube, which is hardly longer than the calyx, whereas in *V. macrocarpa* it is quite twice the length, and by the capsule not being more than twice the length of the calyx-segments. As the name *crassifolia* is preoccupied by a European species, I have attached the name of its zealous discoverer to the plant.

It is worth mention that on the under-surface of the leaves, just within the margin, there is a row of small pits, or "domatia," somewhat similar to those which exist on the under-side of the various species of *Coprosma*, where, however, they are found in the axils formed by the junction of the main veins with the midrib. These pits appear to be inhabited by small *Acari*, as in *Coprosma*.

4. **Caladenia exigua** Cheesem. sp. nov.

C. minor Hook. f. affinis, sed differt caule minore et graciliore, sepalis et petalis acuminatis, labelli lobo intermedio margine 1-glanduloso.

Erectus, gracillimus, 8–15 cm. altus. Caulis strictus, tenuis, glanduloso-pilosus, basi unifoliatus. Folium parvum, anguste lineare, 2–6 cm. longum, 1 mm. latum, parce pilosum. Flores 1 aut raro 2, sepalo intermedio erecto, anguste lanceolato, acuminato; lateralibus petalisque similibus, patentibus vel deflexis; labello lato, 3-lobo, disco glandulis 2-seriatis stipitatis ornato; lobo intermedio margine 1-glanduloso.

Hab.—North Island: *Leptospermum* scrub near Kaitaia, Mongonui County; *R. H. Matthews* and *H. B. Matthews!*

Stems shorter and more slender and wiry than in *C. minor*, 2–5 in. high, sparingly glandular-pilose. Leaf solitary from the base of the stem, small, very narrow linear, $\frac{3}{4}$–$2\frac{1}{2}$ in. long, broad, very sparingly pilose or almost glabrate. Flowers seldom more than one; sepals and petals subequal, all narrow-lanceolate and acuminate, upper sepal erect, the rest spreading or deflexed. Lip broad, 3-lobed; disc with two continuous rows of bright-yellow stipitate glands as in *C. minor;* intermediate lobe with only one marginal stipitate gland on each side; lateral lobes with transverse purplish bands.

Since I published this in the Manual as var. *exigua* of *C. minor* I have been supplied by Mr. H. B. Matthews with an extensive series of both fresh and dried specimens of the various *Caladeniae* found near Kaitaia. Mr. Matthews has always contended for the specific distinctness of *C. exigua*, and his specimens prove that the differences are constant, and are also accompanied by a difference in the flowering season, *C. exigua* flowering at Kaitaia from the 10th September to the 25th September, while *C. minor* blooms during October and the early part of November. I accept *C. exigua*, therefore, as differing from *C. minor* in its much smaller size and more slender habit; in the smaller flowers; in the sepals and petals being narrow-lanceolate and acuminate, instead of linear and obtuse as in *C. minor;* and in the middle lobe of the lip having only one stipitate gland on each side, whereas *C. minor* has several.

Art. XVI.—*Descriptions of New Genera and Species of* Coleoptera.

By Major T. Broun, F.E.S.

[*Read before the Auckland Institute, 22nd November, 1910.*]

(*Continued from Vol. XLIV.*)

Group Otiorhynchidae.

3259. **Nicaeana nesophila** sp. nov. *Nicaeana* Pascoe, Man. N.Z. Coleopt., p. 427.

Elongate, moderately convex, opaque; thickly covered with rotundate depressed squamae, chiefly whitish along the sides and the suture of the elytra, and also forming specks on the dorsum, where they are of a pale infuscate hue, across the top of the posterior declivity darker scales form an irregular band; legs and antennae fusco-rufous.

Rostrum rather shorter than thorax, about as broad at its base as the head, slightly narrowed towards the finely setose extremity. Eyes slightly prominent, free from thorax, lateral, not spherical, being somewhat longitudinally oval. Thorax almost as long as broad, a little rounded before the middle and gently narrowed backwards, base and apex truncate, its punctation completely concealed; on its sides there are a few short erect grey setae. Scutellum obsolete. Elytra rather wide and rounded at the middle, much narrowed towards the base, which hardly exceeds that of the thorax in breadth, the apical declivity nearly vertical and a good deal narrowed; they are regularly and rather finely striate-punctate; the setae are not numerous, some are white, others fuscous.

Underside piceous, densely clothed with depressed grey setae; basal ventral segment flat, rather longer than the 2nd.

Scape stout, reaching just beyond the back of the eye, bearing many greyish setae; 2nd joint of the funiculus as long as the 1st, joints 3–7 obconical, longer than broad; club elongate, oval, triarticulate. Legs rather elongate, with grey scales and setae.

The antennae are obviously longer than those of *N. cinerea* or *N. cervina*, and equal those of *N. infuscata* (2860), which most resembles this species, which, however, has less-flattened eyes, and the body appears much more medially contracted, owing to the greater width of the middle portion of the elytra.

Length (rostrum inclusive), $4\frac{1}{2}$ mm.; breadth, $1\frac{1}{2}$ mm.

D'Urville Island. My specimen, like many others, is from Mr. A. O'Connor's collection.

3260. **Epitimetes grisealis** sp. nov. *Epitimetes* Pascoe, Man. N.Z. Coleopt., p. 435.

Convex, oblong, narrowed anteriorly, opaque; fuscous, tarsi pale castaneo-rufous, funiculus shining ferruginous; encrusted with greyish sappy matter, through which numerous short setae protrude; these are more or less infuscate and erect.

Rostrum slightly dilated at apex, little more than half the length of thorax and about as broad as the short head, with a ridge along the middle ending in a broad interocular depression. Thorax a good deal, yet not abruptly, narrowed in front, rather broader than long; the surface a little uneven, with a broad frontal impression near each side, the median impression distinct at the base, less so in front, the punctation entirely hidden. Elytra oblong, narrowed and vertical behind, twice the length of thorax, broader than it is, medially incurved at the base, thus causing a sublunate gap between it and the thorax, the shoulders obtusely prominent; they seem to be coarsely seriate-punctate; the 3rd interstices are unevenly but only moderately elevated, somewhat prominent at the base, and terminate as nodiform elevations on the summit of the apical declivity; the 5th are less raised, and the posterior nodosity on each is smaller than that on the 3rd, and does not extend quite as far back; the suture is obtusely elevated behind.

Legs coarsely setose, tibiae a little flexuous, mucronate, with fine fulvescent setae near the extremity, the posterior with some denticles along the inner or front face. Tarsi finely setose above, their penultimate joint moderately dilated and bilobed, the terminal nearly as long as the others, taken together.

Scape inserted near the apex, barely attaining the thorax, very gradually incrassate, dull, bearing pale squamae and outstanding setae. Funiculus more finely setose, the basal joint longer than the elongate 2nd, 3rd of about length and breadth, joints 4–7 moniliform. Club oblong-oval, densely and minutely pubescent, indistinctly triarticulate.

There are no ocular lobes or scutellum. The eyes are free from the thorax, widely separated above and subacuminate below. Scrobes open above, subapical, extending half-way to the eyes. Posterior corbels with duplicate cilia and distinct but not broad truncations externally.

The typical species (763) is distinguishable by a glance at the spiniform process near the base, on the inner face, of the hind tibiae; the other (2099) by the mesial thoracic depression being deeper near the front.

The sappy, scale-like encrustation is hardly removable with the point of a needle, the actual sculpture, therefore, is invisible.

Length (rostrum inclusive), $7\frac{1}{2}$ mm.; breadth, $3\frac{1}{2}$ mm.

Christchurch. My specimen was kindly sent by Dr. F. W. Hilgendorf, D.Sc., who found it in the cultivated ground at Lincoln Agricultural College.

3261. **Nonnotus nigricans** sp. nov. *Nonnotus* Sharp, Man. N.Z. Coleopt., p. 1177.

Convex, elongate, slightly nitid, nigrescent; antennae, tarsi, and knees more or less ferruginous, legs rufo-piceous; sparingly clothed with small nearly white squamae and slender suberect setae.

Rostrum nearly as long as thorax, slightly arched, not quite as broad as the head, but not at all abruptly narrower, irregularly punctate, and with a fine median carina. Eyes large, transverse, nearly flat, not quite as distant from the thorax as they are from each other. Antennae moderately stout and elongate; scape gradually thickened, and attaining the thoracic margin; basal joint of funiculus rather longer than 2nd, 3rd and 4th obconical, 5–7 bead-like; club oblong-oval, triarticulate. Thorax slightly broader than long, moderately rounded laterally, a little narrower in front than at the base, not uneven above, with a short smooth central line, elsewhere rather closely but not coarsely punctured. Scutellum small. Elytra a little incurved at the base, broader than thorax there, almost thrice its length, not vertical behind ; with short basal striae near the suture, seriate-punctate elsewhere.

Legs finely setose ; tibiae flexuous, the anterior curved at the extremity, the others expanded there, posterior corbels narrowly truncate and with double cilia externally.

Underside blackish, covered with elongate grey scales and setae. Basal ventral segment flat and, in the middle, longer than 2nd, which is hardly as long as the 3rd and 4th combined ; 5th obconical, irregularly and closely punctate, rufescent and strongly rounded at the extremity, the supplementary segment quite exposed, with broad margins. Metasternum broadly depressed behind.

In Sharp's *N. griseolus* the elytra have fine, simple striae. *N. albicans* (781), which also belongs to this genus, has striate-punctate elytra, and chestnut-red legs and antennae. These are the nearest species.

Length (rostrum inclusive), 6 mm. ; breadth, quite 2 mm.

Waipori. A pair forwarded by Mr. A. O'Connor from Mr. H. Hamilton's collection.

3262. **Tigones rugosa** sp. nov. *Tigones* Broun, Man. N.Z. Coleopt., p. 855 = *Protophormus* Sharp, p. 1178.

Opaque, dark fusco-piceous, densely covered with depressed dull coppery squamae and rather lighter slender setae ; on the apical declivity the scales are paler and brighter, some being slightly viridescent ; the tarsi, scape, and club are dark obscure fusco-rufous, the funiculus more shining and rufescent.

Rostrum a third shorter than thorax, moderately pterygiate, nearly plane along the middle. Head broadly impressed between the eyes, with a shining narrow angular bare spot behind. Eyes distant from the thorax by less than their own length. Thorax very slightly longer than broad, a little narrowed behind the middle ; its surface slightly unlevel and irregularly rugose, its punctation hidden by the squamae. Scutellum oblong, grey. Elytra more than double the length of thorax and evidently broader than it is at the base, their apical portion vertical ; they are seriate-punctate along the middle, more coarsely and irregularly at the sides, but without distinct sculpture on the declivity ; the 3rd interstices are elevated at the base, and again behind the middle, and terminate as large nearly horizontal prominences on top of the declivity ; the 5th also are somewhat raised from before the middle backwards, but do not extend as far back as the 3rd, and are less prominent ; the apices are simple.

Tibiae flexuous, with grey setae. Funiculus fully the length of the scape, 2nd joint as long as the 1st. Club normal.

Length (rostrum inclusive), 7 mm. ; breadth, $2\frac{1}{2}$ mm.

Mount Arthur. Mr. H. W. Simmonds.

Var. Fem.—Vestiture paler and brighter, but not viridescent behind. Rostrum a little longer, with a slight central carina. Thorax not rugose, a little shorter. Scutellum rather broader. Elytra with more definite punctures, each with a minute grey scale, apices not prolonged.

Dr. Sharp's *Protophormus robustus* (2091) is nearly related, but the apices of the elytra are prolonged, and the 7th interstices apparently are somewhat nodiform behind. I have not seen it as yet.

3263. **Tigones albopicta** sp. nov.

Subdepressed, nigrescent, densely clothed with opaque nigro-fuscous scales and decumbent greyish setae; on the 3rd interstices, near the beginning of the hind slope, there is a spot formed of nearly white scales; legs and scape slightly, the funiculus more distinctly, rufescent.

Rostrum pterygiate, a third shorter than thorax, the shallow longitudinal grooves separated by an obtuse keel. Head simple. Thorax slightly rounded laterally at the middle, its length and breadth about equal, with a slight ridge along the centre, its sculpture completely concealed. Scutellum triangular. Elytra nearly thrice the length of the thorax, and broader than it is at the base, narrowed but not abruptly declivous behind, with simple apices; their sculpture consists of rather narrow serial punctures; the suture and 5th interstices are only very slightly elevated behind, and the 3rd at the base.

Scape stout and finely setose; 2nd joint of funiculus as long as the 1st, joints 4–7 moniliform.

There can be no difficulty in recognizing this species, owing to the smoky vestiture and pair of white spots on the after part of the elytra.

Length (rostrum inclusive), 6 mm.; breadth, 2 mm.

Orepuki. My specimen is from Mr. H. Hamilton's collection, and was given to me by Mr. A. O'Connor.

3264. **Platyomida hamiltoni** sp. nov. *Platyomida* White, Man. N.Z. Coleopt., p. 1186 = *Empaeotes* Pascoe, p. 441, and *Eurynotia* Broun, p. 440.

Asperate, opaque, rufo-piceous, tarsi and antennae fusco-rufous; densely covered with pale-coppery and grey scales, the latter congregated at the sides of the thorax and on the top of the posterior declivity, and also with some squamiform setae, which are chiefly confined to the sides of the thorax and more elevated parts of the hind-body.

Rostrum nearly a third shorter than thorax, and, owing to the dense squamosity, not distinctly carinate. Eyes large, very slightly convex, wice as distant from each other as they are from the thorax, with a linear impression between them. Thorax slightly dilated laterally near the middle, of equal length and breadth; its surface very uneven, with a broad longitudinal impression in front and behind, its punctation hidden, but with several dark specks which, in some lights, seem like minute tubercles. Scutellum small. Elytra slightly sinuate at the base and but little broader than the thorax there, wider behind the oblique shoulders, apical declivity nearly vertical and much narrowed; biseriate-punctate near each side of the suture, more irregularly punctured near the sides; 3rd interstices, on the disc, slightly trinodose, the basal elevation not projecting, and with a larger additional prominence on the top of the posterior declivity; 5th nearly similarly nodose, but without any basal elevation, not extending as far back, and less prominent; the declivity itself rather rough, bearing several small tubercular elevations; their sides also are uneven.

Basal two ventral segments covered with yellowish squamae, the others with greyish setae.

Legs squamose, and bearing also many more or less curled greyish setae; tibiae flexuous, the posterior corbels with a narrow external truncature and double cilia. Scape gradually incrassate and attaining the back of the eye; 2nd joint of the funiculus rather longer than 1st, 3–7 longer than broad; club elongate-oval, triarticulate, densely and minutely pubescent.

No other described species accords with this. In *P. amota* (1415) the inequalities are almost confined to the after part of the elytra; there, however, they are very much more conspicuous.

Length (rostrum inclusive), 7½ mm.; breadth, 3 mm.

Mount Greenland, Westland. My specimen was received from Mr. O'Connor, but was discovered as an altitude of 2,500 ft. by Mr. H. Hamilton, whose name has been attached to it.

3265. **Platyomida morosa** sp. nov.

Narrow, asperate, opaque, piceous, antennae and tarsi pitchy red, squamosity dull coppery brown.

Somewhat similar to *P. hamiltoni*, evidently narrower; the dark-grey setae scarcely relieve the prevailing sombre aspect. The central thoracic impression is almost continuous. Scutellum obsolete. The 3rd elytral interstices are trinodose behind the posterior femora; on the 5th there are 3 nodosites, the central is placed in line with the hind thigh, the anterior is distant from the base and as far from the central as the posterior is; there is another at each side, about equidistant from the base and middle, besides other smaller inequalities.

Length (rostrum inclusive), 6½ mm.; breadth, 2⅓ mm.

Mount Greenland. A single individual, from the same source as the preceding species.

3266. **Lyperobates guinnessi** sp. nov. *Lyperobates* Broun, Man. N.Z. Coleopt., p. 1461.

Robust, opaque, piceous; densely covered with small cupreous squamae, those on the rostrum slightly tawny; antennae and tarsi rufo-piceous.

Rostrum subpterygiate, nearly as long as thorax, with 2 broad longitudinal grooves separated by a median carina; the scrobes deep, quite open above, prolonged to the apex, and extending obliquely almost to the lower part of the eyes. Head short, nearly as broad as the front of thorax, on the same plane as the rostrum, rather broader than it is, and with an elongate interocular fovea. Scape opaque, slightly flexuous and rather slender; 2nd joint of funiculus elongate and rather longer than the 1st; club elongate-oval, triarticulate. Thorax of equal length and breadth, its sides somewhat narrowed near the front, almost straight behind; disc a little uneven, with 3 moderate frontal ridges and an obtuse median elevation behind the middle; near each anterior angle there is a broad impression; no punctures are visible, but some minute black granules can be seen; a few pale elongate scales or coarse setae are distributed over the surface, in front especially. Scutellum covered with very slender flavescent setae. Elytra with pale setae at the base, just as wide as thorax there, each elytron slightly curved towards the suture; the shoulders gradually dilated towards the large lateral prominence just behind each middle thigh, and at that part twice the width of the thorax; there is a small nodosity near each hind thigh; from thence the sides are a little incurved and again expanded, so that the outer horizontal prominences on top of the apical declivity extend very nearly as far outwards as the post-humeral dilatations; the dorsum is not quite flat, being broadly concave behind; it is subtruncate on the summit of the vertical declivity, and there tipped with short grey setae; the serial punctures are rather indefinite, but the rows of pale squamae are distinct, and there are some small black granules on the basal half; on the 3rd interstices there is a basal nodiform elevation and a smaller one in line with the posterior femora; there are 2 others near each side before the middle; the declivity is a good deal narrowed, its sides are darker than the suture, with some well-marked punctures; along the fuscous vertical sides of the hind-body the punctation is seriate and moderately coarse.

This is the largest member of the genus as yet known. The most similar species is *L. virilis* (2867), which may be easily separated by the trinodose elytral interstices, the thicker and quite straight scape, and more prominent sides of the thorax, just before the middle.

Length (rostrum inclusive), 11 mm.; breadth, $5\frac{1}{2}$ mm.

Erua. One example only, found amongst decaying leaves in January, 1910, by Mr. W. J. Guinness and myself. It bears that gentleman's name.

3267. **Lyperobates elegantulus** sp. nov.

Piceous, closely and uniformly clothed with small depressed fulvescent squamae; tarsi and antennae rufo-piceous.

Rostrum with an obtuse median carina and a broad groove along each side of it, slightly shorter than thorax; interocular fovea elongate. Thorax subcylindrical, a little longer than broad, slightly dilated and broadly rounded, but not at all prominent, before the middle, very gently curvedly narrowed anteriorly, nearly straight behind; its surface a little uneven, with 4 shallow frontal and 2 basal impressions, its central portion irregularly and longitudinally but only obtusely elevated, and with some small black granules there. Scutellum with very slender fulvous setae. Elytra slightly broader than thorax at the base, shoulders oblique; just behind each of these there is an outstanding, elongate, lateral tubercle; in line with these the breadth is double that of the widest part of the thorax; the sides are widely incurved towards the horizontal lateral protuberances, which project backwards beyond the subtruncate summit of the nearly vertical posterior declivity, and extend outwardly very nearly as far as the humeral tubercles; the dorsum is almost flat, and bears on each elytron 4 small well-defined grey-tipped tubercles, which are placed before the middle; the 3rd interstices are nodiform at the base; the serial punctures on the disc are moderately fine and distant, those on the fuscous somewhat inflexed sides are rather coarser.

Scape slightly flexuous, very gradually incrassate; 2nd joint of funiculus rather longer than the basal; club elongate-oval, its intermediate joint slightly narrowed towards the base and consequently distinctly marked off from the 1st.

Underside nigrescent, with slender bright coppery squamae. Metasternum with a deep median puncture. Basal ventral segment slightly impressed along the middle, subtruncate between the coxae, not quite twice the length of the 2nd.

The subcylindric thorax, nearly quite level elytral disc, the elongate humeral tubercles, and posteriorly prolonged subapical protuberances are distinctive characteristics. The nearest species are *L. virilis* and *L. guinnessi.*

Length (rostrum inclusive), 10 mm.; breadth (maximum), $4\frac{1}{2}$ mm.

Erua. Unique. Picked out of leaf-mould forwarded to me by Mr. W. J. Guinness in April, 1910.

3268. **Lyperobates rostralis** sp. nov.

Robust, opaque, piceous, thickly covered with slender depressed pale yellowish-brown scales, and numerous coarser and more flavescent ones; antennae and tarsi fusco-rufous.

Rostrum with a pair of broad basal grooves which do not extend forwards as far as the middle, and a fine median carina in front; the head and rostrum conjointly just the same length as thorax; the interocular fovea small and quite punctiform. Thorax with 4 large impressions, two frontal and two basal, and with irregular intervening elevations; there are a few small black granules along the middle, but no punctures are discernible; it is of equal length and breadth, distinctly more dilated before the middle than it is elsewhere; the yellowish setae or scales are somewhat congregated in front. Scutellum small and short. Elytra not wider than thorax at the base, the shoulders gradually widened to beyond the middle thighs and at that part not quite double the breadth of thorax, but slightly wider than the lateral dilatations on top of the apical declivity; between these lateral prominences there is a small nodosity; the disc is not quite level, as from each shoulder an obtuse, more or less interrupted, ridge extends obliquely backwards to beyond the hind thigh, but does not reach the suture; the 3rd interstices are elevated at the base; they are indistinctly seriate-punctate, and bear some minute black granules near the suture; the flavescent squamiform setae are serial near the suture; the sides and posterior declivity are vertical and seriate-punctate.

Scape nearly straight, and gradually thickened; 2nd joint of funiculus slightly longer than 1st, joints 3–7 each longer than broad; club elongate-oval.

Underside piceous, covered with an admixture of greyish-yellow depressed coarse and fine setae; it is very finely and indefinitely sculptured; the basal segment behind and the 2nd in front are medially impressed lengthways, the 5th is subtruncate at the apex.

No other species closely resembles this. It is larger than all, except *L. guinnessi*, from which it is differentiated by the much less prominent post-humeral angles and more uneven dorsum. The abbreviated rostral grooves and small punctiform interocular fovea will aid in its identification.

Length (rostrum inclusive), 11½ mm.; breadth, 5 mm.

Waimarino. Two found by myself in the forest, on the ground, midway between that place and Erua in January, 1910.

3269. **Lyperobates punctatus** sp. nov.

Subopaque, pale castaneous, antennae piceo-rufous; squamosity dense, somewhat tawny, grey, with a slightly reddish tint, on the legs.

Rostrum with a slight frontal carina, the broad grooves are confluent behind, so that the middle of the head is depressed; it is rather shorter than the thorax; the clypeal portion is rufescent and finely punctured; instead of the usual interocular fovea there is an oval, smooth, blackish spot. Thorax slightly broader than long, widest and obtusely prominent just in front of the middle, distinctly narrowed anteriorly, nearly straight behind; its surface uneven, with 4 frontal and 2 oblique basal impressions, the intervals irregularly and obtusely elevated, and bearing some small dark granules near the middle. Scutellum short. Elytra nowhere twice the breadth of the widest part of the thorax, very little broader than it is at the base; the shoulders oblique and rounded behind, the median lateral prominences also obtusely rounded, the posterior moderately expanded, not prolonged backwards; between each of these and the suture, on top of the apical declivity, there is a smaller horizontal nodosity; each elytron has 4 dorsal series of coarse punctures, the lower marginal series along the somewhat inflexed sides are rather coarser than those nearer the upper surface; the disc itself is just a little uneven, the 3rd and 5th interstices being interruptedly and only obtusely elevated; the hind declivity is nearly vertical, unevenly convex along the suture, somewhat maculated and coarsely punctate; there are some minute dark granules along the middle of the disc.

Legs with elongate setae. Scape slightly flexuous and gradually incrassate.

The general contour is somewhat similar to that of *L. waterworthi* (3122), but the sculpture is totally different. The rather coarse and definite serial punctation is its chief distinguishing feature.

Length (rostrum inclusive), 10½ mm.; breadth, 5 mm.

Mount Ngauruhoe. One picked out of leaf-mould sent to me by Mr. W. J. Guinness in March, 1910.

Phaeocharis gen. nov.

Rostrum stout, nearly as broad as the head, quite half the length of thorax, not pterygiate, parallel, depressed in front, obtusely ridged above. Scrobes deep, open above, beginning near the apex and extending obliquely downwards, but not reaching the eyes. Scape thick, very gradually incrassate. Funiculus 7-articulate, basal two joints elongate, 3rd obconical, 4-7 moniliform. Club oblong-oval, triarticulate. Head short, nearly the width of the thoracic apex. Eyes moderately prominent, with coarse facets, subrotundate, rather less than their own length distant from the thorax, widely separated above. Thorax without ocular lobes, of about equal length and breadth, base and apex subtruncate. Scutellum absent or indistinct. Elytra somewhat cordate, broader than thorax at the base, shoulders oblique, narrowed and nearly vertical behind. Legs stout and elongate; tibiae flexuous, mucronate, the posterior a little dilated, corbels with single cilia, without any external truncature. Tarsi rather short, their 3rd joint bilobed and bearing elongate setae underneath, the 1st slender at the base and glabrous below.

Prosternum widely incurved in front, the coxae prominent and contiguous, equidistant from base and apex; intermediate coxae moderately, the posterior widely separated. Metasternum short. Epipleurae linear. Abdomen nearly plane, basal segment broad and almost truncate between the coxae, 2nd about half the length of the 1st, not longer than 3rd and 4th combined. Mentum large, subquadrate. Palpi invisible.

In *Hygrochus* the prosternum is not incurved, the scape only reaches the back of the eye, the scrobes are very different, the elytra are not broader than the thorax at the base, &c. *Lyperobates* has a distinct external truncature of the posterior corbels, the eyes are longitudinal, the scrobes differ, and the scape does not extend beyond the back of the eye. In *Phaeocharis* the scape attains the front of the thorax, the rostrum differs entirely from that of these genera—in fact, it more nearly resembles that of *Notiopatae;* its systematic location. therefore, is clearly indicated.

Its species exist amongst decaying vegetable matter on the ground.

3270. **Phaeocharis cuprealis** sp. nov.

Piceous, legs and scape obscure fusco-rufous, funiculus and tarsi usually ferruginous; the body densely covered with variegated squamae, along the suture and across the basal portion of the elytra they are of a reddish-coppery hue, whilst some similar ones are scattered over the dark areas near the sides, and on the middle of the thorax; the vestiture near the sides of the latter, as well as on the head and rostrum, is for the most part yellowish; the setae are pallid or slightly infuscate.

Rostrum with slender grey setae on the nearly bald apical portion, with an obtuse ridge along the middle, and a broad oblique impression in front of each eye. Thorax of equal length and breadth, somewhat prominent laterally before the middle, obliquely narrowed anteriorly, nearly straight behind; its surface uneven, with a large angular median impression, before the middle, which is prolonged towards the base as a broad channel; near each anterior angle there is another large impression; the intervals are more or less elevated; in front and at the sides there are some elongate, coarse, pale setae; no punctation can be seen. Scutellum obsolete. Elytra quite twice the length but not double the width of thorax, narrower at the base, with a slight lateral prominence just behind the oblique shoulders, they are a good deal narrowed behind the posterior femora; dorsum slightly uneven, with an obtuse elevation at each side of the slight yet rather broad basal depression; in line with each of these, on top of the declivity, there is another, and outside this a pair; the suture is obtusely elevated along the posterior declivity; there are no dorsal striae or punctures.

The legs bear coarse greyish setae. Scape thickly, funiculus sparingly, setose; 3rd joint of the latter barely half the length of the elongate 2nd, 7th rather broader than 6th; club finely pubescent, its intermediate joint rather shorter than the basal.

Underside piceous, with pale elongate setae; basal ventral segment flat in front, its hind suture oblique towards the sides, its sculpture, like that of the 5th, close but ill defined.

Length (rostrum inclusive), $5\frac{1}{2}$–6 mm.; breadth, $2\frac{1}{2}$ mm.

Erua; January, 1910. Two found amongst leaves on the ground at an elevation of nearly 2,500 ft.

3271. **Phaeocharis punctatus** sp. nov.

Opaque, piceous, squamosity dense, fuscous or dull cupreous, nowhere concentrated, obscure tawny on the rostrum and sides of thorax; funiculus and tarsi somewhat ferruginous.

In most respects like *P. cuprealis*, the body narrower, thorax rather more elongate, its impressions less definite; but the elytra are striate-punctate, and the front or inner face of the posterior tibiae bears some small denticles.

Length (rostrum inclusive), 5 mm.; breadth, $1\frac{1}{2}$ mm.

Raurimu. I found two in January, 1910.

3272. **Notiopatae terricola** sp. nov. *Notiopatae* Broun, Man. N.Z. Coleopt., p. 1186.

Variegate, slightly nitid, thorax fuscous; the rostrum, elytra, and legs fusco-rufous; funiculus and tarsi lighter; elytral disc thinly clothed with fulvescent decumbent setae, which, behind, are somewhat more prominent and curled; near the sides they are much coarser, curled, and either greyish or infuscate; on the thorax the setae are irregularly distributed, and form a large patch along the middle, and another, but smaller, at each side; all these are flavescent and curled, as are those on the head; on the tibiae they are greyish, curled, and coarse.

Rostrum a third shorter than thorax, stout, subparallel, nearly glabrous in front. Thorax obtusely prominent laterally before the middle, and at that part a third broader than long, base and apex truncate; disc a little uneven but without well-marked sculpture. Elytra subovate, very little wider than thorax at the base, their length, but not the breadth, twice that of the thorax, posterior declivity nearly vertical; with moderately coarse, distinctly separated, serial punctures; the declivity substriate.

Tibiae flexuous, the anterior evidently inwardly mucronate. Scape thick, opaque, bearing slender, bent, pale setae; funiculus sparsely and finely setose, 2nd joint as long as the 1st, both elongate, joints 3–7 differ but little, none transverse; club ovate, finely pubescent, indistinctly triarticulate.

Underside somewhat rufescent, with numerous depressed yellowish-grey setae, without distinct sculpture.

The rostrum is not pterygiate, but the short, deep, and broad scrobes, which are quite open above, cause the upper portion, near the front, to appear narrower than the lower. The eyes are rather flat. Anterior coxae almost contiguous.

The other species—2102, 2535, and 755—may be at once distinguished by their outstanding straight setae.

Length (rostrum inclusive), $3\frac{1}{2}$ mm.; breadth, $1\frac{1}{2}$ mm.

Retaruke, near Erua. Another species, of which I obtained two specimens, amongst the leaf-mould collected by Captain H. S. Whitehorn.

Getopsephus gen. nov.

Body subovate, moderately convex, clothed with small depressed squamae.

Rostrum a fourth shorter than the thorax and about half its breadth, slightly dilated near the apex. Scrobes quite open above for most of their length, beginning near the extremity but not quite reaching the lower part of the eyes. Scape gradually incrassate, attaining the middle of the eye. Funiculus 7-articulate, 2nd joint rather longer than the basal, 3rd slightly longer than 4th, both slender at the base, joints 4–7 moniliform. Club elongate-oval, triarticulate, its joints of about equal length. Eyes very slightly prominent, subrotundate, widely distant above, the space between each and the front of the thorax not greater than its own length. Thorax a little broader than long, base and apex truncate, ocular lobes obsolete. Scutellum depressed. Elytra rather broader than thorax at the base, oblong-oval, their apices, however, are subacuminate but not prolonged.

Tibiae slightly flexuous, the anterior moderately mucronate; posterior corbels apparently simple, but, on the outside, with double cilia separated by a narrow truncature. Tarsi glabrous along the middle, their soles elsewhere densely brush-like; 3rd joint moderately expanded and deeply bilobed.

Prosternum widely incurved in front. Metasternum, in the middle, rather shorter than the basal ventral segment, which, at the sides, is but little longer than the 2nd, the following two are moderately short, the 5th elongate and obconical. Epipleurae linear, but thickened at the extremity. Anterior coxae contiguous, the intermediate moderately, the posterior widely, separated. Mentum large, nearly filling the buccal cavity, curvedly narrowed backwards. Palpi minute.

This cannot be made to accord structurally with any of our genera. The European *Otiorhynchus* is at once separable by its strongly pterygiate rostrum and elongate scape. The posteriorly attenuate hind-body is more like that of the subantarctic *Catodryobius vestitus.*

3273. **Getopsephus acuminatus** sp. nov.

Black, moderately nitid; sparingly clothed with inconspicuous scales, which are nearly as dark as the derm itself, and also with slender straw-coloured setae that are most numerous behind.

Rostrum irregularly punctate, with a rather broad, nearly smooth, median ridge, and a broad groove along each side of it; the triangular apical portion is distinctly marked off. Head finely but not closely punctured, with an interocular fovea. Thorax a fifth broader than long, a little wider before the middle than at the base; with an angular median impression near the front, where it is finely punctured; behind that part and at the sides the surface becomes somewhat asperate with coarse, irregular, but not definitely tubercular sculpture. Elytra nearly thrice the length of the thorax, much narrowed and declivous behind, their sides very slightly rounded and somewhat inflexed; they are regularly striate-punctate, quite coarsely towards the sides, but rather indistinctly behind; the discoidal interstices are nearly plane, there being only a slight elevation of the 3rd at the base.

Underside nigrescent, with some pale bluish-green and light-coppery scales and depressed flavescent setae. Basal ventral segment broadly impressed.

♂. Length (rostrum inclusive), 11 mm.; breadth, 4½ mm.

Bold Peak, Wakatipu. My specimen was found at an elevation of 5,500 ft. by Mr. H. Hamilton.

Obs.—Since the foregoing description was compiled, a female specimen, in the possession of Mr. A. O'Connor, was submitted for inspection. It exhibits the following differences: The surface is covered with small, depressed, rotundate squamae, which are mostly infuscate grey, but intermingled with these, on the thorax especially, there are others of metallic lustre, some being viridescent and others of a pale-coppery hue. The rostrum is rather longer, and its central keel is cariniform. The thorax is only very slightly uneven. It measures 6 by 2¼ lines.

3274. **Brachyolus labeculatus** sp. nov. *Brachyolus* White, Man. N.Z. Coleopt., pp. 432, 1194.

Opaque, fuscous, legs obscure fusco-rufous, tarsi and funiculus lighter; thorax densely covered with pale greyish-brown squamae; on the elytra they are much darker at the sides than near the suture, and on the disc are intermingled with some pale greyish-blue ones; the setae, though not very coarse, are conspicuous, being quite white.

Rostrum about half the length of the thorax, nearly plane along the middle, but at the base on an abruptly lower level than the broader head. Eyes oblique, oval, not prominent. Thorax slightly broader than long, widest and obtusely prominent before the middle, with an indefinite linear median impression which becomes more distinct at the base; no punctures are visible. Elytra quite double the length of thorax, a little broader than it is at the base, the humeri oblique, behind these the sides are nearly straight, but are rather abruptly narrowed near the extremity; they are rather finely striate-punctate; 3rd interstices slightly and obtusely elevated, but not projecting, at the base, only minutely at the middle, and, like the 5th, terminating on top of the declivity as nodiform but not very prominent elevations, the 5th being smaller, the suture is obtusely raised towards the extremity.

Tibiae slightly flexuous, the anterior mucronate. Scape thick, gradually incrassate, setose; 2nd joint of funiculus as long and almost as stout as the 1st, 5–7 equal and quite moniliform; club elongate-ovate, triarticulate, minutely and densely pubescent.

Scrobes visible in front, directed downwards, but not attaining the eyes. Posterior corbels simple. Ocular lobes only slightly developed.

The bluish specks seen amongst the darker scales on the hind-body will serve as a good differentiating character.

Length (rostrum inclusive), 4 mm.; breadth, $1\frac{2}{3}$ mm.

Wairiri, Kaikoura. Unique. Another of Mr. W. L. Wallace's discoveries.

3275. **Brachyolus varius** sp. nov.

Subopaque, densely covered with depressed variegated scales, and short erect white and fuscous setae; the squamae for the most part are of a pale coppery brown, there are, however, several blackish spots on the thorax and hind-body; on the former there is usually a central greyish spot, on the latter the grey scales and setae are somewhat concentrated near the top of the apical declivity, they also form a few specks on the dorsum; legs also a little variegate, the scape dull, funiculus fusco-rufous, terminal joint of the tarsi paler.

Rostrum thick, nearly half the length of thorax, a little dilated in front, depressed at the base, not perceptibly ridged. Thorax slightly broader than long, a little wider before the middle than it is elsewhere; with an indistinct median groove, but without other well-marked inequalities; its punctation entirely hidden. Scutellum small, grey. Elytra hardly a fourth longer than broad, their sides almost straight, vertical and much narrowed behind, their shoulders evidently wider than the base of thorax; striate-punctate, 3rd interstices slightly elevated, 5th less so, blackish and subnodiform on the summit of the posterior declivity, but not projecting at the base.

Underside densely covered with depressed pale squamae and numerous slender setae, so that the punctation is not discernible. Prosternum deeply incurved in front. Basal ventral segment slightly longer than the metasternum, subtruncate between the coxae, its hind suture oblique from the sides to the middle, the 5th with a pair of punctiform impressions.

Scrobes open above, subapical, and almost foveiform. Ocular lobes moderately developed. Scape stout, gradually incrassate, and attaining the back of the eye, which is nearly contiguous to the thorax. Funiculus with dark setae, its 2nd joint about as long as the 1st, 3rd scarcely longer than 4th, joints 4–7 moniliform.

B. labeculatus has a larger and broader thorax, the shoulders are obliquely narrowed, and the serial punctures are less distinct. *O. posticalis* has very different sculpture and a longer rostrum. These are the only similar species.

Length (rostrum inclusive), 4½ mm.; breadth, 2 mm.

Titahi Bay, near Wellington. Another of Mr. O'Connor's captures. The specimen described above has been thoroughly cleaned with benzine, but in its natural state is paler and less variegated.

Agatholobus gen. nov.

Rostrum as long as thorax, half its width, not pterygiate. Scrobes broad and open above in front, beginning at the apex, directed obliquely downwards, but not reaching the eyes. Head short, not much broader than the rostrum, globose underneath. Eyes subdepressed, transversal, obliquely oval, just free from the thorax, widely separated from each other. Scape inserted near the apex, very gradually thickened, attaining the middle of the eye. Funiculus 7-articulate, basal joint slightly longer than 2nd, joints 3–7 obconical, gradually shortened, the last, nevertheless, is not transverse. Club elongate-oval, triarticulate. Thorax subquadrate, base and apex truncate, with strongly developed ocular lobes. Scutellum small or obsolete. Elytra oblong, with oblique shoulders, so that the base hardly exceeds that of the thorax in width, much narrowed and quite vertical behind.

Femora simple, moderately clavate. Tibiae slightly flexuous, mucronate. Tarsi finely setose, basal joint slightly longer than 2nd, penultimate moderately expanded and bilobed, finely and densely setose underneath.

Prosternum incurved in front, with a small diamond-shaped process behind the contiguous coxae. Mesosternum with a moderate process extending half-way between the intermediate coxae. Metasternum short. Basal ventral segment longer than 2nd, broadly rounded between the widely separated coxae, 3rd slightly longer than 4th. Mentum large, occupying the buccal cavity. Palpi invisible. Posterior corbels with double cilia, the truncate interval very narrow.

The single exponent differs from all the other genera of the group known to me in facies and structure. The rostrum is unlike that of the European *Otiorhynchus*, which, moreover, is without ocular lobes. It is most nearly allied to *Inophloeus*, but differs therefrom in general appearance, and in the form of the rostrum, posterior corbels, &c.; the ocular lobes, however, are equally prominent.

3276. Agatholobus waterhousei sp. nov.

Opaque, nigrescent; thorax and elytra almost entirely and densely covered with small, depressed, dark-fuscous squamae which have a peculiar silky gloss; on the posterior declivity and a large space at each side, behind the posterior femora, the scales vary from yellowish-grey to fusco-testaceous; rostrum wholly covered with cream-coloured squamae; the legs, except the fuscous basal half of the femora, are clothed with yellowish-grey scales and setae; antennae and terminal joint of tarsi piceo-rufous.

Rostrum subparallel, not dilated apically, with shallow longitudinal grooves separated by a slender median carina, which terminates in a linear interocular impression. Thorax slightly swollen laterally near the front, behind that part nearly straight, being just a little narrowed towards the base; disc slightly uneven, with a median groove from base to apex which is deeper and more expanded before and behind than at the middle; a few inconspicuous, elongate, obscure tawny scales are sprinkled over the surface, but no punctation is visible. Elytra more than double the length of the thorax, coarsely seriate-punctate; 3rd interstices almost sharply elevated at the base, less so near the middle, plane behind, each with a prominent elevation on top of the apical declivity; this is sharply bordered with tawny scales and, lower down, unites at the suture with its fellow of the other elytron, so that the pair, when examined from behind, seem to form two sides of a triangle; 5th interstices less distinctly elevated, each terminating as an angular nodosity, but not extending as far back as that of the 3rd.

Scape opaque, with some fuscous setae. Club densely pubescent and dull, about as long as the last four joints of the funiculus combined, its terminal articulation evidently longer than either of the others.

Underside with minute scales and distinct elongate setae. The anterior pairs of coxae tawny; the metasternum and middle of basal ventral segment fuscous, the sides of the latter and all the 2nd tawny.

Length (rostrum inclusive), 10 mm.; breadth, $4\frac{1}{3}$ mm.

Erua, 2,500 ft. elevation; January, 1910. Unique.

This, the most strikingly variegated New Zealand species of the group, is named in honour of Mr. C. O. Waterhouse, of the British Museum, as a slight acknowledgment of the kind assistance rendered during many years.

Group RHYPAROSOMIDAE.

3277. **Phrynixus setipes** sp. nov. *Phrynixus* Pascoe, Man. N.Z. Coleopt., p. 432.

Convex, elongate, subovate, opaque; fusco-piceous or rufo-fuscous, covered with greyish sappy matter, the setae yellowish, suberect and conspicuous on the elevated parts, short and depressed elsewhere.

Rostrum arched, a little expanded and indistinctly tricarinate in front, not quite as long as the thorax, with a pair of small crests just behind the antennae, its basal portion more or less ridged or crested. Head narrowed anteriorly to the same width as the rostrum. Eyes flat, ubrotundate, just their own length distant from the thorax. Scape rather slender and flexuous, but clavate at the extremity; it reaches the back of the eye. Funiculus with the 2nd joint nearly as elongate as the 1st, 3–6 short, 7th suboblong, rather large. Club short, ovate, finely pubescent, obsoletely articulated. Thorax a trifle longer than broad, constricted near the front, where there is a pair of distinct crests, the interval with a few punctures and a streak of fine setae; the middle is tricristate, with a smaller crest at each side; there is a large elongate basal depression with obtusely raised borders; the sculpture consists of coarse irregular punctures and minute tubercles. Elytra oviform, vertical behind; the shoulders are slightly porrect and narrowed almost to the width of the thorax; the base seems slightly sinuate and is medially depressed; an elongate crest extends along each shoulder; on each elytron there are 6 crests, besides another on top of the declivity in line with the 3rd interstice, and 3 or 4 along the side; their punctation is very coarse and irregular, but subseriate near the suture; on the apical declivity the punctures are very much finer, but do not form striae.

Underside sparingly and rather finely setose, moderately and irregularly punctate; the 2nd segment with a transverse series of 5 coarse punctures, it is flat; the suture between it and the basal one is oblique towards the middle, where it is depressed; the 5th is more finely and closely punctured, with a well-marked subapical fovea; it is wholly, the 1st and 2nd medially, rufescent.

Legs with elongate, curled, fulvescent setae.

In *P. intricatus* (1508) the posterior declivity is striate. *P. terreus* has no rostral crests.

Length (rostrum exclusive), $5\frac{1}{2}$ mm.; breadth, $2\frac{2}{3}$ mm.

Wairiri, Kaikoura. Found by Mr. W. L. Wallace.

3278. **Phrynixus binodosus** sp. nov.

Opaque, fusco-piceous, antennae and tarsi fusco-rufous; the coarse squamiform setae irregularly distributed, chiefly ferruginous, those on the shoulders flavescent.

Rostrum arched, truncate at apex, nearly plane and indistinctly punctate before the antennae, behind these with many coarse erect setae which do not form definite crests. Thorax rather longer than broad, a little narrower in front than at the base, where it is medially depressed; the coarse setae form a fringe, irregular, however, along each side, and become more approximated and prominent in front, those on the disc are subdepressed and hide the punctures; a few minute tubercles also may be detected. Elytra short, just about as long as broad, the base distinctly bisinuate, so that the suture, though somewhat depressed, seems projecting; they are abruptly perpendicular behind, and thinly clad and striate there; disc moderately coarsely seriate-punctate near the suture, the squamiform setae there are depressed; outside this area the surface, as well as the sides, are tuberculate or tufted; exactly on top of the declivity there is a pair of large, distant, setigerous nodosities, and another of smaller ones a little lower down, quite at the sides.

Legs with curled setae, tibiae mucronate, terminal joint of tarsi as long as the basal three combined. Antennae inserted immediately before the middle, finely setose; scape moderately clavate at the extremity; 2nd joint of funiculus as long as the 1st, joints 3–6 subquadrate, 7th rather larger; club ovate, triarticulate, its basal joint half of the whole length, the others indistinct.

The abruptly vertical posterior declivity and the pair of large nodosities on its summit, in conjunction with the slight scutellar depression and basally prominent suture, show that this species should be located apart from all the others except, perhaps, *P. brevipennis* (2545).

Length (rostrum exclusive), 4 mm.; breadth, $2\frac{1}{2}$ mm.

Greymouth. I am indebted to Mr. J. H. Lewis for my specimen.

3279. **Lithocia acuminata** sp. nov. *Lithocia* Broun, Man. N.Z. Coleopt., p. 1470.

Opaque, fusco-niger, antennae and tarsi obscure ferruginous; irregularly crested with pale-yellowish setae.

Rostrum much arched, quite as long as thorax; very slightly expanded, nearly nude and punctate in front, with a pair of very elongate crests behind the antennae and a slight median carina near the eyes. Thorax of about equal length and breadth, a little constricted in front; moderately coarsely, very irregularly, but not closely punctured, medially depressed as the base; with a pair of conspicuous frontal crests, which are curvedly prolonged, but less elevated, towards the hind angles, and with a much smaller antemedian crest. Elytra quite double the length of thorax, of about the same width as it is at the base, considerably broader at the middle, and very much narrowed and acuminate behind; the discoidal punctures are subseriate, and rather coarse but not deep ; on the rather long but not vertical apical slope the sculpture is very much finer and substriate ; a pair of oblique elongate crests form the boundary of the scutellar depression, there are 4 just behind these across the disc, and a curvate series of 8 on top of the hind slope, a rather larger one just below these at each side, and some smaller ones near the apex ; their sides, near the middle, appear uneven, owing to the presence of 3 coarse tufts.

Legs elongate, moderately slender, with curled tawny setae, tibiae not distinctly mucronate.

Antennae finely setose, scape medially inserted, gradually moderately thickened apically ; 2nd joint of funiculus as long as the basal, 3–6 subquadrate, 7th larger ; club ovate, pubescent, obsoletely articulate.

Prosternum incurved in front, and fringed with coarse tawny setae ; the breast and coxae bear similar setae. Metasternum short, with a straight transverse median groove. Basal ventral segment rufescent, distinctly punctate, convex, angularly emarginate behind ; 2nd on a lower plane than the 1st, in the middle about as long as it is, flat and smooth, dull smoky black ; 3–5 reddish, with deep straight sutures ; the 5th curvedly narrowed, transversely impressed behind the middle, with fine setae and punctures.

This species does not agree exactly with the type of this genus, and cannot be referred to *Phrynixus*. The scrobes are open above as in *Lithocia*, but are oblong rather than foveiform. The eyes are longitudinally oval, free from the thorax, rather widely distant above and slightly prominent. The apex of the thorax is very distinctly incurved, and the sides, in front, are obtusely rounded so as to form ocular lobes. If similar species are discovered they will be entitled to generic separation.

Length (rostrum exclusive), 5 mm. ; breadth, $2\frac{1}{2}$ mm.

Mount Quoin. The discovery of this species, at a high elevation, is due to Mr. A. O'Connor.

3280. **Bradypatae minor** sp. nov. *Bradypatae* Broun, Man. N.Z. Coleopt., p. 1206.

Subopaque, pale brown, antennae and legs more or less rufescent ; with irregularly distributed setae, coarse and curled on some parts, quite small on others.

Rostrum arched, as long as thorax, its anterior half a little expanded, the posterior less than half the width of the front of thorax ; with numerous depressed pale-yellowish elongate squamae, and an indistinct groove along each side of the middle behind. Head contracted behind the prominent eyes, and scarcely visible above. Thorax as long as broad, base and apex truncate ; the latter bears coarse, somewhat bent, pale squamiform setae ; its sides are somewhat similarly clothed, and thus appear a little dilated just behind the subapical constriction ; disc uneven, having a slight median crest before the middle, and a pair proceeding from the centre of the base, obliquely, towards the sides in front ; the intervening depressions seem smooth ; the punctation discernible near the base is coarse and shallow. Elytra of about the same width as thorax at the base, much broader behind, posterior declivity vertical ; the scutellar depression is distinct and smooth, and bordered laterally by finely setose elevations ; on each there are 2 series of coarse punctures alongside the suture, and interrupted rows nearer the side ; this discal portion is very sparingly clothed with short setae ; near the side there are 4 or 5 somewhat rounded crests and some minute dark tubercles; on the summit of the apical declivity the yellowish setae are concentrated, so as to form a transverse series of 6 lines or small crests; the declivity is substriate-punctate, and bears minute tufts.

Legs stout and elongate, with coarse elongate setae; tibiae nearly straight, slightly mucronate at inner extremity. Terminal joint of tarsi thick, arched above, and about as long as the other three taken together, with small claws.

Underside dull fusco-piceous, abdomen nude and impunctate; the basal segment and metasternum are broadly medially depressed; the 2nd segment is as long as the basal, slightly nitid, with the frontal suture well marked, and oblique towards the sides; 3rd and 4th abbreviated, with deep straight sutures; 5th rufescent, with an apical fovea in the middle, thus appearing slightly elevated near the centre. Prosternum deeply incurved in front.

Careful comparison with *B. armiger* (2893) shows that the thoracic sculpture is quite different. The eyes are rather smaller. The antennae stouter. The hind face of the elytra is more abruptly perpendicular, and the posterior coxae more widely separated and almost in contact with the prominent intermediate pair.

Length (rostrum inclusive), 3 mm.; breadth, $1\frac{1}{3}$ mm.

Erua. Three specimens were found in a parcel of decaying forest leaves collected by Mr. W. J. Guinness, at an altitude of 2,500 ft., in April, 1910.

3281. **Clypeorhynchus calvulus** sp. nov. *Clypeorhynchus* Sharp, Man. N.Z. Coleopt., p. 1210.

Convex, moderately elongate somewhat nitid, rufo-castaneous; nearly nude, there being only a few slender greyish scales on the rostrum and sides of thorax.

Rostrum rather shorter than thorax, slightly medially narrowed, nearly smooth in front, elsewhere moderately coarsely punctate, indistinctly bicarinate, and, towards the base, obtusely elevated longitudinally. Head short, narrowed anteriorly, rugosely punctate, but at its sides, behind the eyes, nearly smooth; there is a shallow interocular fovea. Thorax of almost equal length and breadth, widest before the middle, very gradually narrowed behind, a good deal but not abruptly so in front; slightly uneven, with an obtuse but not prominent elevation near each side at the widest part, and a broad irregular depression along the middle; its sculpture consists of short irregular rugosities and punctures. Scutellum obsolete. Elytra slightly wider than thorax at the base, much narrowed and declivous behind, shoulders slightly narrowed; they are nearly double the length of the thorax, with subparallel sides; the disc is nearly plane and obviously striate, but the punctation of the striae is somewhat indefinite, more so near the suture than at the sides; interstices minutely tuberculate and rugose; the 4th, 5th, and 6th become confluent and slightly prominent at some distance from the apices, which are rounded and do not quite cover the last abdominal segment.

Legs elongate; femora strongly clavate beyond the middle but slender near the base; tibiae slightly dilated inwardly below the knees and bent inwards near the extremity; penultimate tarsal joint with elongate lobes. Scape flexuous and slender, but clavate near the extremity; basal joint of the funiculus rather longer than 2nd.

The nearly bald surface distinguishes this species.

Length (rostrum inclusive), 9 mm. ; breadth, nearly $3\frac{1}{2}$ mm.

Mount Hector, Tararua Range. Described from a specimen on cardboard sent by Mr. A. O'Connor for examination. It was found under a stone at an elevation of about 5,000 ft.

3282. **Clypeorhynchus caudatus** sp. nov.

Subopaque, piceo-fuscous, the tibiae, antennae, and apex of rostrum more or less rufo-piceous ; sparingly clothed with decumbent yellow setae.

Rostrum rather shorter than thorax, indistinctly bicarinate, longitudinally impressed medially, with ill-defined sculpture, its glabrous apical portion slightly convex and finely punctate. Head rugose. Thorax just as broad as it is long, narrower in front than at the base, rather wider before the middle than elsewhere ; very slightly uneven, with granular and rugose sculpture, the median longitudinal impression deeper near the front and base than on the middle. Scutellum small, triangular. Elytra more than twice the length of thorax, evidently broader, with rounded humeral angles, the base, nevertheless, slightly wider than that of the thorax ; they are rather gradually narrowed posteriorly, with prolonged and subacuminate apices ; on each elytron there are 5 discoidal punctated striae, the outer pair with subquadrate and coarser punctures than the others, but along the posterior declivity the punctures are absent ; the 4th and 6th interstices are a little elevated, particularly near the base, and unite before the extremity ; all bear numerous fine granules.

Underside moderately shining, pitchy brown, finely rugosely sculptured, and sparsely covered with flavescent depressed setae. Metasternum moderately convex, and as long as the basal ventral segment, which is medially incurved behind and distinctly marked off from the nearly equally elongate 2nd ; 3rd and 4th short, yet well developed ; 5th as long as the preceding two combined. Prosternum rather short, incurved in front, subgranulate. Epipleurae very narrow. Anterior coxae contiguous, intermediate distinctly separated.

This differs from *C. calvulus* in coloration, sculpture, vestiture, and flatter eyes, and from all the other described species by the remarkable prolongation of the elytral apices, which are even more robust than those of *Inophloeus inuus* (771).

Length (rostrum inclusive), 10 mm. ; breadth, $3\frac{1}{2}$ mm.

Mount Hector. A mutilated individual found under a stone, at an elevation of 5,000 ft., by Mr. A. O'Connor.

3283. **Phemus curvipes** sp. nov. *Phemus* Broun, Man, N.Z. Coleopt. p. 1214.

Elongate, moderately convex, subopaque ; nigrescent, legs rufo-piceous, antennae and tarsi pale ferruginous ; scantily clothed with slender flavescent setae.

Rostrum normal, pitchy red, slightly nitid, and very finely punctured in front of the antennae, but, behind these, with coarse and close punctiform sculpture, and fine, interrupted, somewhat asperate costae. Thorax slightly longer than broad, a little wider before the middle than elsewhere, with a broad obvious groove from base to apex ; it is coarsely and moderately closely punctated, but with smooth though rather narrow intervals behind ; its base not quite truncate. Elytra almost double the length of thorax, incurved, and rather broader than it is at the base, much narrowed behind; they are a little depressed medially at the base, with rather ill-defined sculpture; when examined obliquely there appear to be on each wing-case 4 discoidal series of coarse quadrate or oblong punctures; in other aspects they seem substriate, with rows of small distant granules; the 3rd interstices are slightly elevated near the base, rather more so on top of the posterior declivity; the 5th nearly similar; these, however, are not true costae, being formed for the most part of series of granules.

Legs with coarse shallow punctures. Tibiae flexuous; the anterior, along the inner edge, bear numerous small denticles so as to appear subserrate; the posterior are finely asperate on the hind or upper face, finely ciliate on the frontal, and distinctly curved.

Antennae elongate, rather slender, bearing fine yellowish setae, those on the club more numerous; basal two joints of the funiculus almost equally elongate, none transversed, even the 7th being rather longer than broad.

Underside shining, black, with very few slender inconspicuous setae. Prosternum coarsely punctate, mesosternum rather finely; metasternum flat, with a few coarse punctures. Basal ventral segment broadly and deeply impressed, coarsely punctured at the sides, and without any discernible median suture at its apex. Second segment covered with distinct granules, and on a slightly higher level than the following ones; 5th rather longer than 2nd, with finer granular sculpture, grooved along the middle, broadly rounded and finely ciliate at the apex, beyond which the 6th segment, though short, is quite distinct.

This is rather larger, blacker, and more nitid than the previously described species (2143 and 2561), and can be easily separated from them by its curvate hind tibiae.

Length (rostrum inclusive), 6 mm.; breadth, 2 mm.

Waimarino, 2,600 ft.; January, 1910. One specimen. Another, no doubt a male, which I found at Raurimu, 1,900 ft., during the same month, was mounted on its back, and the description of the peculiar sculpture of the under-surface has been drawn up from it.

3284. **Phemus constrictus** sp. nov.

Subnitid, nearly glabrous, the few pale slender setae hardly perceptible except on the legs; black, legs rufo-piceous, antennae and tarsi pale ferruginous, apex of rostrum shining pitchy red.

Rostrum nearly as long as thorax, with coarse shallow punctures, and a groove with subcarinate borders extending from the eyes to the antennae; its almost impunctate apical portion is not marked off, and, indeed, is prolonged behind the antennae. Thorax slightly longer than broad, a little constricted in front; behind this contraction the sides are moderately rounded; its surface is moderately coarsely and closely punctured, more finely in front, and the usual mesial groove from base to apex is rather broad but not very deep. Elytra incurved at the base and scarcely any wider than the thorax there; they are not definitely striate, but have series of coarse subquadrate punctures, which become obsolete behind; the suture and the 3rd interstices are slightly elevated near the top of the posterior declivity, the 5th terminate as minute granules.

Tibiae slightly flexuous, distinctly mucronate, the posterior almost quite straight behind, the anterior obsoletely denticulate along the inner edge. Antennae rather elongate; basal joint of the funiculus quite as long as the second, 7th subquadrate.

Underside black, its punctation distinct, coarser on the prosternum. Metasternum very short, and, like the basal ventral segment, broadly depressed; the suture between the latter and the 2nd segment is straight and very fine; 3rd and 4th on an abruptly lower plane than the 2nd; the 5th with an elongate apical fovea.

Though without any basal demarcation of the smooth clypeal portion of the rostrum, this species in other respects agrees structurally with the typical one (2143). It is distinguishable from the others by its smaller size, by the frontal contraction of the thorax, and more oviform or anteriorly narrowed hind-body.

Length (rostrum inclusive), 4 mm.; breadth, $1\frac{1}{4}$ mm.

Greymouth. I am indebted to Mr. J. H. Lewis for my specimen, found amongst decaying leaves.

3285. **Sosgenes planirostris** sp. nov. *Sosgenes* Broun, Man. N.Z. Coleopt., p. 1476.

Subopaque, with a few slender inconspicuous brassy setae; piceo-rufous, antennae and tarsi fulvescent.

Rostrum of about the same length as the thorax but not half its breadth, moderately arched, nearly plane along the middle, dull obscure reddish, with dense, very minute, granular sculpture; its apical portion shining, almost smooth, and distinctly marked off. Thorax slightly longer than broad, oviform, a little contracted in front; with a shallow groove along the middle, its punctation not very deep but coarse, the intervals distinct and slightly uneven, the basal margin depressed. Elytra a little broader than thorax at the base, and becoming rather broader near the hind thighs, they are narrowed and vertical behind; moderately coarsely striate-punctate; 3rd interstices subcarinate, more distinctly near the apex.

Tibiae slightly flexuous, finely setose, the posterior not ciliate along the inner face. Scape stout, almost glabrous. Funiculus with slender setae.

Underside slightly nitid, piceo-rufous, coarsely and irregularly but not closely punctate, nearly quite glabrous. Basal ventral segment depressed between the coxae only, the 5th very minutely, closely, and indefinitely sculptured, with a transverse impression near the apex.

When comparing this species with *S. carinatus* (2556) under the microscope I found that the rostrum of the latter has longitudinal series of coarse punctures. The pale squamae in the punctures of the rostrum and thorax are lacking in this species, which, moreover, has the thorax more oviform, the intervals between its punctures are not flat, the elytral punctures are distinctly separated, the surface is more shining, and the legs are more slender.

Length (rostrum inclusive), $2\frac{1}{2}$ mm.; breadth, $\frac{3}{4}$ mm.

Mount Ngauruhoe. Mr. W. J. Guinness gathered a small bagful of leaves and sent it to me in March, 1910. From amongst the leaves I picked out three of this minute and interesting weevil.

Obs.—In January, 1909, when at Waimarino, I found a specimen of *S. carinatus* in which, like my type from Mount Pirongia, the posterior femora are obviously fringed inwardly. This character, therefore, is not a sexual one.

3286. **Rachidiscus multinodosus** sp. nov. *Rachidiscus* Broun, Man. N.Z. Coleopt., p. 1477.

Elongate, convex, much narrowed and depressed medially; glabrous, slightly nitid, piceo-rufous, the legs and antennae pale castaneous, tarsi and club fuscous, rostrum rufo-piceous.

Rostrum a third shorter than thorax and about half its breadth, somewhat medially arched above, with shallow longitudinal sculpture, nearly smooth in front. Head bisculate between the eyes, not smooth. Thorax rather longer than broad, slightly wider at the middle than elsewhere, a little narrower at the base than in front; distinctly and closely granulate, rather rufescent. Elytra closely adapted to the thorax and of the same width at the base, considerably dilated near the middle, and unevenly vertical behind; the scutellar region is depressed, relatively large, and bounded by the oblique, slightly raised and thickened sutural margins; these are interrupted on top of the declivity but immediately reappear as a pair of slight elongate elevations, and a pair of smaller ones lower down; on the dilated part of each elytron there are 3 or 4 very irregular series of punctures; the interstices are unevenly elevated and interrupted, so that there appear to be 6 or 7 more or less elongate nodosities on each elytron; the side, near each shoulder, is nearly smooth.

Scape glabrous, flexuous, and slender, but much clavate at the extremity. Funiculus finely setose, basal joint remarkably short but stout, 2nd rather longer than broad, joints 3–5 transverse and about equal, 6th not as broad as 7th. Club large, ovate, its basal joint very distinctly marked off; 2nd large, quadrate, and finely ciliated with grey setae at its extremity, so that the terminal one seems small and conical.

Underside subopaque, nigrescent, with some fine distinct brassy setae. Basal ventral segment longitudinally depressed and smooth in the middle, its sides obtusely but distinctly elevated. In 2557 the depression is more shallow, broader, and punctate, but the sides are nearly flat.

R. granicollis has the thorax slightly longer and more cylindrical, with coarser granulation. The elytral interstices are less interrupted and nodose, and the sutural margins are entire. The lower surface also differs. In both species the tibiae are curved externally, the anterior pair especially.

Length (rostrum inclusive), 3 mm.; breadth, 1 mm.

Makatote. Mr. W. J. Guinness kindly sent me a bag of leaf-mould which he collected for me, and out of it I picked a pair of specimens, as well as some other interesting beetles.

Phygothalpus gen. nov.

Body moderately elongate and convex, setigerous.

Rostrum a third shorter than thorax and nearly half its breadth, medially narrowed, quite pterygiate at the antennal insertion, about a third of its length from the apex, and without any frontal or clypeal suture. Scrobes deep and quite open above, prolonged backwards but not reaching the eyes. Mandibles short. Eyes obliquely oval, not prominent, just free from the thoracic margin, and widely distant from each other. Scape flexuous, moderately slender, gradually thickened apically, and extending to the front of the thorax. Funiculus 7-articulate, basal joint almost as long as the following three taken together, 2nd quite half the length of the 1st, 3rd slightly longer than 4th, joints 5–7 moniliform. Club rather large, oviform, apparently triarticulate, but with an indistinctly separated 4th joint. Thorax without ocular lobes, subovate, base subtruncate, apex slightly medially emarginate. Scutellum subtriangular, rather small. Elytra more than double the length of the thorax, the base incurved and broader than that of the thorax, gradually yet considerably narrowed towards the dehiscent but not projecting apices; these, however, cover the abdomen.

Legs moderately elongate; tibiae flexuous, the anterior mucronate; tarsi of moderate length, with setigerous soles, their 3rd joint deeply cleft and lobate.

Prosternum deeply incurved in front, with contiguous and prominent coxae; middle coxae distinctly, the posterior widely separated. Metasternum no longer than the basal ventral segment, which is depressed and distinctly curved between the coxae, its apical suture quite definite and medially incurved, 3rd and 4th together quite as long as the 2nd, the 5th depressed behind.

This denizen of the cold alpine regions of the South Island, though nearly related to *Clypeorhynchus*, is distinguishable therefrom by the absence of any frontal suture of the rostrum, by the stouter and shorter antennae, less prominent mandibles, shorter and more expanded penultimate tarsal joints, and by the divaricate elytral apices.

3287. **Phygothalpus sulcicollis** sp. nov.

Subopaque, castaneo-fuscous, tibiae and tarsi rufo-castaneous, antennae obscure ferruginous; sparingly clothed with pale, slender, depressed setae, but near the extremity of the hind-body the setae are coarser and more flavescent and some quite erect.

Rostrum finely tricarinate, with irregularly punctate intervals, its frontal portion finely punctured. Head short, punctate, and more or less rugose. Thorax very slightly longer than broad, a little wider near the middle than elsewhere, with a broad median groove from base to apex; its punctation distinct but not coarse or very close; in each puncture there is a fine straw-coloured seta. Elytra distinctly punctate-striate, the suture slightly elevated and paler behind; interstices nearly plane, without any discernible sculpture.

Underside shining, finely and sparsely setose; the coxae and basal ventral segment rufescent. The punctation rather fine and not close, but in front of the metasternum there is a series of rather larger but not coarse punctures, it is broadly and deeply depressed behind. In front of the prosternum a broad slight impression, which is nearly smooth behind, is very closely and finely sculptured at the apex.

Length (rostrum inclusive), 7 mm.; breadth, 2½ mm.

Bold Peak, Lake Wakatipu. Another of Mr. H. Hamilton's interesting novelties, found under stones at an elevation of about 6,500 ft.

Group Cylindrorhinidae.

3288. **Tocris aterrima** sp. nov. *Tocris* Broun, Ann. Mag. Nat. Hist., ser. 7, vol. 14, p. 115.

Convex, moderately nitid, black; club dull, fuscous; nearly nude, having only some greyish setae.

Rostrum a third shorter than thorax, irregularly but not coarsely punctate; with 2 broad impressions extending from the point of antennal insertion and ending as a large interocular fovea; they are divided by a longitudinal ridge and bordered externally by an oblique one. Thorax a third broader than long, widest at or just before the middle, and a good deal narrowed behind, where, however, the sides are straight, or nearly so, with rectangular angles; its surface is uneven, having an obtuse nodiform elevation near each side of the fine, abbreviated central ridge, an irregular longitudinal one near each side, and, before the middle, a pair of large though shallow oblique impressions; between the distinct frontal punctures there are some minute ones similar to those on the middle of the disc, but the basal region is somewhat coarsely granulate and rugose. Scutellum obsolete. Elytra ovate-oblong, rather wider than thorax at the base, and nearly thrice its length; on each elytron, alongside the suture, there are 2 series of moderately large but not sharply defined punctures; similar ones between the 3rd and 5th and the 5th and 7th interstices have longitudinal series of granules which are absent, or indistinct, on the sutural ones; the 3rd interstices are moderately elevated from near the base to the top of the posterior declivity, but do not end abruptly there; the 5th are less distinct at the base, but extend further back; the sculpture of the declivity is much finer.

Underside shining, black, sparingly clothed with depressed yellowish setae. Mesosternum distantly punctured on the middle, closely on the sides. Metasternum, between the intermediate and posterior coxae, shorter than the 2nd ventral segment. Basal segment broadly medially impressed, with fine transversely rugose and granular sculpture; 5th closely subgranulate, and with a rather large apical depression; 6th short and thick.

Palpi robust, all of equal length, occupying nearly the whole buccal cavity, the last two joints of each pale chestnut, the terminal subacicular. Mandibles lamelliform, truncate inwardly, vertical in front.

Although similar in appearance to the typical species, *T. latirostris* (2911), this is larger, more glossy, and the underside has different sculpture as well as the upper. The basal depression of the thorax is absent, but there is a narrow central ridge. The series of punctures on the elytra are separated singly in 2911 by more or less distinct longitudinal interstices, and the rostral sculpture also differs.

Length (rostrum inclusive), 14½ mm.; breadth, 5½ mm.

Vanguard Peak, near Macetown, Lake Wakatipu. Found by Mr. H. Hamilton at an elevation of 5,000 ft.

3289. **Tocris hamiltoni** sp. nov.

Nigrescent, but, except on the suture and raised elytral interstices, densely covered with small depressed oviform pale testaceous squamae; tarsi and club infuscate.

Rostrum of normal proportions, nearly plane, with a bare linear space along the middle, its punctation concealed by the squamosity. Head with a small interocular fovea and a narrower one behind it. Thorax about a third broader than long, obtusely prominent laterally before the middle; with a broad but shallow impression between the middle and base, divided in front by a longitudinal, smooth, but hardly at all raised line; there is also a deeper impression near each side behind the middle; it is distantly punctured, but rather more closely near the base; the apical margin is rufescent and very slightly emarginate in the middle. Scutellum small but distinct. Elytra rather broader than thorax at the base, which is oblique from each shoulder to the suture; they are oblong-oval, more than twice the length of, and obviously broader than, the thorax, with minutely protuberant apices; alongside the suture, on each elytron, there is a series of rather fine punctures, and close to the sides of the dark and somewhat elevated 3rd and 5th interstices the serial punctures are rather larger and cause the interstices to appear crenulate; the 7th, or marginal one, is like the others; none reach the apex.

Tibiae nearly straight, their inner and outer apical angles somewhat prominent. Tarsi with dense brush-like soles and setose above, basal three joints rather short, the 2nd quite transverse. Funiculus with a few outstanding setae, 2nd joint rather longer than 3rd but shorter than the 1st, joints 5–7 submoniliform; club elongate-oval, triarticulate.

Underside nigrescent, with small greyish-yellow depressed scales. Metasternum hardly as long as the 2nd ventral segment, which, in the middle, is shorter than the basal one.

This elegant species may be immediately identified by the striking contrast presented by the dark interstices and dense pale squamosity of the hind-body.

Length (rostrum inclusive), 16 mm.; breadth, 6½ mm.

Vanguard Peak; elevation, 5,000 ft. My specimen was discovered by Mr. H. Hamilton, whose name I have much pleasure in attaching to it.

Heteromias gen. nov.

Rostrum rather more than half the length of thorax and about half its width, its frontal portion arched, oviform, and pterygiate, the basal narrower; it is without clypeal sutures of any kind, but at its apex a pair of lobes which partly cover the base of the mandibles seem to represent the clypeus. Scrobes subapical, widely open above, directed towards but not reaching the eyes. Head short, globose below. Eyes lateral, transversely oval, not prominent, free from thorax, widely separated. Mandibles lamelliform, vertical in front, subtruncate inwardly. Scape moderately stout, gradually incrassate, just attaining the back of the eye. Funiculus stout, its basal joint equalling the following three combined; 2nd not twice the length of the 3rd, which, as well as joints 4–6, is bead-like; 7th rather broader than the preceding. Club elongate-oval, distinctly triarticulate. Thorax truncate at base and apex, of equal length and breadth, without ocular lobes. Scutellum distinct. Elytra oblong, slightly incurved, and rather wider than thorax at the base; they are moderately narrowed posteriorly, somewhat dehiscent at the extremity, and do not entirely cover the pygidium.

Legs stout and moderately elongate. Femora subclavate. Tibiae flexuous, bent inwards near the extremity; the anterior outwardly curved at the apex and obtusely mucronate inwardly; the other pairs with a short inner calcar and densely ciliate at the apex; posterior corbels almost quite plane. Tarsi with moderately expanded and lobate penultimate joints; 2nd slender at the base; the soles of the basal two joints thinly, the 3rd thickly, setose.

Prosternum rather deeply incurved in front. Metasternum moderately elongate, its hind part and the basal two ventral segments broadly medially depressed, the basal segment curved between the widely separated posterior coxae, and in the middle hardly longer than the 2nd, its apical suture straight and fine in the middle but deep at the sides, 3rd and 4th much shorter than 2nd, 5th as long as the preceding two conjointly, rounded at apex, 6th short but distinct. Anterior coxae prominent and contiguous, the intermediate pair distinctly separated.

The only available specimen of this alpine genus has given much trouble, owing to the complex structure and my inability to find any near ally. It should, I think, be located at the end of the *Cylindrorhinidae*, so as to be near *Lyperobius*, one of the *Molytidae*, which it somewhat resembles.

3290. **Heteromias foveirostris** sp. nov.

Body moderately convex, sparingly clothed with pale depressed setae and soft elongate grey scales, these latter, however, are very easily brushed off; subopaque, nigrescent, antennae and tarsi obscure pitchy red.

Rostrum scarcely half the width of the thorax, shining and finely punctate in front, with a well-marked elongate interantennal fovea, its hind portion finely yet distinctly longitudinally rugose. Head rather closely punctured, and with a shallow fovea on the vertex. Thorax slightly wider near the middle than elsewhere, moderately rounded there, very gradually narrowed behind; the median groove somewhat interrupted, but moderately well impressed near the base and apex; its frontal punctation is like that of the head, but becomes closer, coarser, and somewhat rugose towards the sides and base. Elytra moderately striate-punctate; interstices finely and closely granulate. Antennae finely setose; club opaque, densely and finely pubescent.

Underside shining black, with some fine greyish setae. Fifth ventral segment more distinctly, but not coarsely, punctured than other parts.

Length (rostrum inclusive), 10 mm.; breadth, 4 mm.

Vanguard Peak. Another interesting weevil found by Mr. H. Hamilton at a height of 5,000 ft.

Group indeterminate.

3291. **Geochus posticalis** sp. nov. *Geochus* Broun, Man. N.Z. Coleopt., pp. 445, 1221.

Compact, convex, broadly oval, moderately nitid, sparingly and irregularly clothed with pale-yellowish suberect setae; rufo-fuscous, the apical declivity and a large irregular space on each elytron piceous; tarsi and antennae somewhat testaceous.

Rostrum shorter than thorax, narrowed near the base, stout, with coarse linear sculpture. Eyes rather flat, coarsely faceted. Thorax subconical, the width at the base a third greater than the whole length, a good deal narrowed near the front; relatively coarsely and moderately closely punctured, with a slight frontal longitudinal carina, its apex somewhat rufescent. Elytra a little broader than thorax at the base, much broader behind, the sides moderately rounded, posterior declivity vertical and considerably narrowed; their punctation coarse and somewhat rugose near the sides but seriate alongside the suture, and forming well-marked striae, with raised interstices, along the declivity.

Legs stout, the femora with depressed, the tibiae with outstanding, setae; the anterior tibiae much narrowed below, but not distinctly angulate at the middle. Tarsi triarticulate, the joints transverse, the terminal entire, without claws.

Antennae slender, club pubescent; scape much shorter than the funiculus, curved and clavate at the extremity; basal joint of the funiculus subovate and thick; 2nd as long as the 1st, but very slender; joints 3–5 moniliform, yet rather longer than broad; club triarticulate, elongate-oval, intermediate joint largest.

Somewhat similar to *G. politus* (1239), but with much coarser and different sculpture.

Length (rostrum inclusive), $2\frac{1}{2}$ mm.; breadth, $1\frac{1}{2}$ mm.

Wairiri, Kaikoura. Unique. Discovered by Mr. W. L. Wallace.

Group Erirhinidae.

3292. **Erirhinus titahensis** sp. nov. *Erirhinus* Schoenherr, Man. N.Z. Coleopt., p. 449.

Subovate, slightly nitid; rostrum and antennae fulvescent, the legs and elytra testaceous; these latter with irregular reddish marks; thorax rufescent; sparingly clothed with yellowish-grey setae, which are coarser on the sides of the thorax than on the elytra, where they are suberect and slender.

Rostrum arched, parallel, moderately slender, as long as thorax; smooth along the middle, punctate at the sides. Eyes subdepressed. Thorax about a third broader than long, without ocular lobes, base and apex truncate, its sides moderately rounded and rather more, yet gradually, narrowed in front than behind; its punctation as close but coarser than that of the head; near the apex there is a transverse impression. Scutellum fuscous. Elytra nearly thrice the length of thorax and a little wider than it is at the base, their sides very gently curved; they are punctate-striate, with feebly rugose interstices; the 3rd are acutely bent outwards at the apices; the three outside these are shortened, and appear slightly elevated just below the top of the posterior declivity.

Underside shining, rufous, with some depressed grey setae. Prosternum a little incurved in front. Mesosternum with a few distinct punctures. Metasternum finely transversely wrinkled. Abdomen finely and distantly punctured, the 5th segment more closely and with an indistinct median fovea; 2nd about as long as the 1st, but shorter than the 3rd and 4th conjointly.

Femora stout and clavate but not distinctly dentate underneath. Tibiae short and stout, not quite straight, slightly mucronate at the inner extremity. Tarsi finely setose, their 3rd joint dilated and bilobed, claws thickened at the base.

Scape inserted near the apex, and reaching backwards to the eye. Basal joint of funiculus manifestly longer and thicker than the 2nd, 3rd but little longer than broad, joints 4–7 moniliform; club oblong-oval.

Most nearly resembles *E. acceptus* (1251), but narrower, and without the interrupted fuscous fascia between the posterior femora and other dark spots.

Length (rostrum exclusive), $2\frac{1}{2}$ mm.; breadth, quite 1 mm.

Titahi Bay, Wellington. Two specimens from Mr. A. O'Connor.

3293. **Erirhinus oleariae** sp. nov.

Subopaque, rufo-castaneous, elytra more flavescent, legs and antennae testaceous, club infuscate; elytra covered with distinct elongate depressed greyish setae, the head and thorax with a few slender yellow ones disposed transversely.

Rostrum arched, parallel, rather longer than thorax, about half the width of the head, with indistinct grooves and punctures. Thorax about a third broader than long, its sides rounded, the apex narrower than the base and slightly constricted; its punctation, like that of the head, distinct yet moderately fine and not very close. Scutellum distinct. Elytra oblong-oval, wider than thorax at the base, and nearly thrice its length; they are somewhat indistinctly seriate-punctate on the dorsum and substriate behind; interstices plane, finely punctured, and with a slight swelling of the 3rd and 4th on top of the apical declivity.

Underside fuscous, punctate, and with fine grey setae. Basal ventral segment broadly impressed, the 5th with a broad median longitudinal impression.

Femora clavate but not dentate; tibiae slightly flexuous, the anterior mucronate. Scape inserted before the middle, attaining the eye, slender. Funiculus with slender elongate grey hairs; basal joint elongate and gradually incrassate; 2nd rather longer than 4th; the 7th transverse, shorter and broader than 6th. Club triarticulate, about half the length of the funiculus, densely pubescent. Ocular lobes absent. Eyes transverse, free from thorax, distinctly faceted, and rather flat.

We have no other similar species.

♂. Length (rostrum inclusive), 5½ mm.; breadth, 1⅔ mm.

Mount Quoin, Tararua Range. A single individual sent by Mr. H. Simmonds, who found it feeding on *Olearia Colensoi*.

3294. **Erirhinus exilis** sp. nov.

Slender, elongate, slightly convex and nitid, very sparingly clothed with minute grey setae; fulvescent, legs and antennae testaceous, club fuscous.

Rostrum moderately slender, parallel, obviously longer than thorax, indistinctly sulcate. Thorax about as long as broad, rather narrower in front than behind, distinctly but not very closely punctured, without ocular lobes. Scutellum small. Elytra rather broader than thorax at the base and quite twice its length, closely punctate-striate, with simple interstices.

Legs moderately stout, unarmed; 3rd tarsal joint expanded and deeply lobed. Antennae inserted between the middle and apex of the rostrum; basal joint of funiculus thick, 2nd longer than 3rd, joints 4–7 transverse, the last broadest; club ovate, densely pubescent, feebly triarticulate.

Underside fulvescent, with numerous grey setae, moderately coarsely but not closely punctured. Prosternum incurved in front, the metasternum with a short median groove behind; basal ventral segment distinctly depressed in the middle.

Female.—Rostrum more elongate and finely sculptured. Antennae implanted just before the middle.

♂. Length (rostrum inclusive), 2⅓ mm.; breadth, ⅔ mm.

Erua; January, 1910. A dozen examples shaken off shrubs. There is no species at all like this.

3295. **Dorytomus maorinus** sp. nov. *Dorytomus* Germar, Man. N.Z. Coleopt., p. 453.

Elongate, subdepressed, slightly nitid, nearly glabrous, having only some minute greyish setae; fulvescent, the thorax rufous, club infuscate.

Rostrum arched, slender, and elongate, rather longer than thorax, very slightly expanded towards the extremity, finely bisulcate behind the antennae. Eyes distinctly faceted, situated in front of the short globose head and touching the sides of the rostrum. Thorax without ocular lobes, truncate at base and apex, with moderately rounded sides; it is a little broader than long, closely and distinctly punctate. Scutellum small. Elytra very elongate, thrice the length of the thorax, gradually narrowed posteriorly, apices singly rounded, the base slightly oblique towards the suture and evidently wider than that of the thorax; they are closely and regularly punctate-striate from base to apex, with slightly elevated almost impunctate interstices.

Femora stout, the anterior with a small denticle, the others angulate and dentate. Tibiae slightly flexuous and minutely mucronate. Tarsi with pilose soles, 3rd joint expanded and deeply lobed, terminal very short, claws obviously thickened but not distinctly toothed.

Antennae elongate and slender, implanted between the middle and the apex; scape attaining the eye; 2nd joint of funiculus rather longer than 3rd but shorter than and barely half the width of the basal; 7th transverse and bead-like; club ovate, triarticulate.

Underside chestnut-red, shining, with, like the femora, numerous grey setae. Prosternum medially incurved in front; metasternum sulcate along the middle, finely wrinkled transversely, and slightly longer than the basal ventral segment, which is depressed in the middle; the punctation fine, but not close.

Female.—Rostrum minutely and distantly punctate.

Length (rostrum exclusive), $3\frac{1}{3}$ mm.; breadth, $1\frac{1}{3}$ mm.

Mount Dennan. Discovered by Mr. Hubert Simmonds.

3296. **Dorytomus consonus** sp. nov.

Elongate, subdepressed; thorax and base of elytra dark rufous, the rest of the latter bright fulvous, the legs and antennae infuscate red; with numerous fine but distinct grey setae.

This closely resembles *D. maorinus* but is rather smaller, and may be at once separated by an examination of the vestiture. The thorax is slightly longer and more gradually narrowed towards the front, its sides consequently are less rounded. The elytra are a little shorter, with more shallow striae, so that the interstices, which are not as smooth, seem less elevated. The antennae are more slender, and the setae on the legs more conspicuous.

The underside also differs, being dark red, with more distinct punctures and setae; the depression on the basal ventral segment is prolonged, though not as deeply, half-way along the 2nd, and the well-marked depression in front of the anterior coxae of *D. maorinus* is altogether absent.

Length (rostrum exclusive), $2\frac{1}{2}$ mm.; breadth, 1 mm.

Erua; January, 1910. Half a dozen found on various shrubs; none on *Oleariae.*

3297. **Aneuma spinifera** sp. nov. *Aneuma* Pascoe, Man. N.Z. Coleopt., p. 455.

Oblong, slightly convex, a little nitid, with numerous suberect slender greyish setae, which are more scanty and slender on the thorax; somewhat rufo-testaceous, legs testaceous.

Rostrum moderately arched, parallel, of about the same length as the thorax, subseriate-punctate, but smooth along the middle. Thorax subtruncate at base and apex, without ocular lobes, a third broader than long, its sides a little rounded, its surface distinctly and closely punctured. Scutellum small, minutely punctate. Elytra oblong, twice as long as thorax, and broader than it is at the base; moderately coarsely and regularly striate-punctate, interstices with minute serial punctures and slightly convex behind.

Femora stout, with a minute denticle underneath; tibiae straight. Antennae inserted before the middle; scape slender, attaining the front of the eye; funiculus very finely setose, basal joint distinctly longer and thicker than the 2nd, 3rd and 4th rather longer than broad but shorter than 2nd, joints 5–7 bead-like; club oblong-oval.

Underside testaceous, scantily pubescent, finely and irregularly punctate, the metasternum and front of basal ventral segment finely transversely rugose; the 1st and 2nd segments medially impressed, the former behind, the latter in front.

Allied to *A. fulvipes* (803), without nigrescent marks, and well differentiated by the structure of the prosternum, which is depressed but not canaliculate before the coxae, and with the apical emargination finely spinose at each side.

♂. Length (rostrum inclusive), 3½ mm.; breadth, 1½ mm.

Mount Quoin. A pair from Mr. O'Connor.

3298. **Eugnomus calvulus** sp. nov. *Eugnomus* Schoenherr, Man. N.Z. Coleopt., p. 458.

Nitid, rufo-castaneous, nearly glabrous, there being only a few inconspicuous slender greyish setae above, and some stouter and darker ones near the sides.

Rostrum rather longer than thorax, closely punctured, subcarinate along the middle, its apical portion a little dilated and nearly smooth. Head broadly impressed between the moderately prominent eyes. Thorax widest at the base, moderately narrowed near the smooth apical margin, its length and breadth about equal, the punctation close and distinct, slightly coarser than that of the head. Scutellum oblong. Elytra manifestly broader than thorax at the base, with slightly elevated obtuse shoulders, a good deal narrowed posteriorly; they are distinctly punctate-striate, the discoidal interstices are plane, more or less rugose, and bear some minute granules, which are most easily seen on the shoulders.

Underside rufous, finely punctate, with some slender grey hairs. Basal ventral segment largest, strongly curved between the coxae, broadly impressed along the middle; 3rd and 4th, singly, evidently shorter than 2nd; 5th with a large median fovea.

Scape slender, thicker near the extremity; 2nd joint of funiculus as long as the 1st, 3rd also elongate, 7th not at all larger than 6th; club elongate-oval. Femora finely pubescent, the anterior moderately, the posterior strongly, angulate and toothed below.

In form somewhat similar to *E. picipennis;* the eyes less approximated and less prominent, the thorax shorter, and the whole sculpture different.

Length (rostrum exclusive), 4¼ mm.; breadth, 1⅔ mm.

Mount Greenland. One good specimen, and another in fragments, from Mr. O'Connor, from Mr. Hamilton's collection.

3299. **Eugnomus dennanensis** sp. nov.

Derm fusco-rufous, sometimes nearly piceous; covered with flavescent hairs, which, on the head and thorax, are disposed transversely; the scutellum and a spot in front of it bear small yellowish scales; in line with the hind thighs there is an irregular fuscous fascia, but the posterior declivity is clothed with depressed elongate pale-yellow, or in some examples greyish, squamae; legs and antennae rufo-castaneous.

Rostrum slightly longer than thorax, cylindrical, a little dilated near the extremity, its sculpture rather shallow and indefinite. Head distinctly and closely punctured, depressed between the eyes. Thorax nearly a third broader than long, much narrower in front than behind, distinctly and closely punctate. Scutellum elongate and conspicuous. Elytra a good deal broader than thorax at the base, much narrowed apically, closely striate-punctate; interstices broad, each with a series of small distant granules having a dark slender seta in each.

Underside nitid, rufo-castaneous, with depressed elongated grey scales and setae.

Female.—Basal ventral segment simple, the 5th elongated and conical. Generally more brightly coloured.

Male.—Basal segment broadly depressed; 5th depressed medially near the apex, which is strongly rounded; 6th rather coarsely fringed with grey setae at the extremity.

From the common *E. fervidus* (812) this differs in having coarser thoracic sculpture, more-convex eyes, and a longer club. *E. aspersus*, though more approximated, has less prominent eyes, the hind-body is shorter, broader, and more cordiform and bears numerous erect blackish setae, and the clothing of the declivity is hair-like.

♀. Length (rostrum inclusive), 6 mm.; breadth, $1\frac{3}{4}$ mm.

Mount Dennan. Found by Messrs. O'Connor and Simmonds.

3300. **Oreocharis albosparsa** sp. nov. *Oreocharis* Broun, Man. N.Z. Coleopt., p. 864.

Elongate, moderately convex, subopaque; nigrescent, tarsi castaneous; clothed with elongate inconspicuous greyish or cinereous setae, and numerous elongate white squamae.

Rostrum of about the same length as the thorax, very slightly dilated anteriorly, punctate, and with indistinct longitudinal carinae. Head a third shorter than thorax, slightly narrowed towards the prominent eyes, closely and distinctly punctate. Thorax of about equal length and breadth, its sides only slightly rounded, with a quite definite frontal constriction; its sculpture like that of the head. Scutellum oblong, sometimes greyish. Elytra almost four times the length and nearly twice the breadth of the thorax, gradually narrowed posteriorly; with closely punctured, rather shallow striae, which are rendered indistinct by the mixed vestiture; interstices punctate and rugose; on the 2nd, in rear of the hind thighs, there is a slight nodosity.

Underside blackish, sparingly clothed with slender grey hairs and fleecy scales; metasternum slightly impressed medially behind, with transversal sculpture; abdomen closely punctate, 5th segment rather shorter than the basal, subtruncate at apex, 6th short and transverse.

Femora, intermediate and posterior, strongly angulate and dentiform; posterior tibiae arched above behind, and, below the middle, dilated along their frontal or inner face. The scape attains the back of the eye. Funiculus with black setae, basal joint largest, 2nd rather longer than the following one, 4–6 equal. Club minutely and densely pubescent, quite as long as the funiculus, triarticulate, the terminal joint about as long as the basal two combined. Palpi porrect, their apical joint less than half the bulk of the penultimate.

The conspicuous white scales which besprinkle the surface will lead to the identification of this species.

Length (rostrum inclusive), 5 mm.; breadth, $1\frac{1}{2}$ mm.

Mount Dennan, Tararua Range. Discovered by Messrs. A. O'Connor and H. Simmonds.

Obs.—A varietal form was taken by myself on Mount Egmont, at an elevation of 4,500 ft., over twenty years ago. In it the dilatation of the hind tibiae begins above the middle, and the extremity of the front pair is simply rounded and setose instead of being emarginate and angulate externally. The frontal constriction of the thorax is hardly perceptible, and the squamae are less numerous. As my specimen is unique, the specific description has been drawn up from Mount Dennan specimens.

3301. Oreocharis veronicae sp. nov.

Elongate, slightly nitid, clothed with distinct cinereous pubescence; rostrum and thorax black, hind-body subcyaneous; antennae and legs piceous, knees and tarsi paler.

Rostrum about a third shorter than thorax, with an indefinite central linear elevation, its punctation moderately close. Head shorter than thorax, narrowed anteriorly, distinctly and moderately closely punctured, with minutely sculptured interstices and a narrow interocular fovea. Thorax slightly broader than long, its sides but little curved, rather abruptly constricted in front, and with some black setae there; its sculpture similar to that of the head. Elytra double the width of thorax at the base and quite thrice its length, very slightly impressed before the middle; they are striate-punctate, but the three inner striae on each become more distinct behind; the outer series of punctures are moderately fine, subquadrate, and rather close to each other; interstices broad, finely punctate and rugose.

Pygidium uncovered, obconical, closely punctate.

Underside nigrescent, with fine greyish setae. Prosternum more closely and distinctly punctured than the abdomen; 3rd and 4th segments, at the sides, almost as long as the 2nd. Metasternum punctate and finely transversely rugose.

Femora normal, as much angularly toothed as the common *Scolopterus*, the anterior with a small denticle. Posterior tibiae incurved but not distinctly dilated along the inner face, the front pair notched and angulate at the extremity. The 2nd joint of funiculus much more slender and rather shorter than the basal one, 3rd oblong, joints 4–6 moniliform. Club as long as funiculus, its terminal joint as long as the basal two conjointly; these latter truncate at the apex.

More robust than *O. pullata*, the rostrum and thorax shorter and broader.

Length (rostrum inclusive), 6 mm.; breadth, 2 mm.

Waimarino, elevation 2,600 ft. Half a dozen taken off *Veronicae* in January, 1910.

3302. Oreocharis picipennis var.

More slender than *O. veronicae*, the thorax rather longer and relatively narrower; the elytra rufo-piceous, or of a somewhat chocolate hue.

Length (rostrum inclusive), $5\frac{1}{2}$ mm.; breadth, $1\frac{2}{3}$ mm.

Waimarino; January, 1910.

3303. Oreocharis uniformis sp. nov.

Elongate, convex, subopaque, castaneo-rufous, legs and antennae paler, club infuscate, with greyish pubescence; the base of the rostrum, the head and thorax covered with subrotundate fulvescent scales, those on the hind-body seem rather darker; the setae, though short and slender, are erect and numerous.

Rostrum of about the same length as the thorax, indistinctly sculptured, with slender greyish setae at its apex. Head punctate, with an elongate median impression behind the prominent eyes. Thorax of equal length and breadth, slightly narrowed and constricted in front, closely punctured. Elytra broader than thorax at the base and thrice its length, very broadly rounded at the extremity, and leaving the pygidium uncovered; they are closely striate-punctate, with the space between the middle and declivity irregularly and slightly infuscate.

About half the bulk of its nearest ally, *O. ferruginea* (2922), with more convex eyes, a well-marked impression on the vertex, and the elytral apices, instead of being separately strongly rounded, are subtruncate. The 3rd joint of the funiculus is rather shorter than the 2nd, joints 4–6 transversely moniliform. The base of the elytra is slightly bisinuate, with rather more prominent shoulders, the sides do not differ from the dorsum in coloration, the common pair of spots on top of the hind slope are absent, but the setae are more conspicuous.

Length (rostrum inclusive), $4\frac{1}{2}$ mm.; breadth, $1\frac{1}{2}$ mm.

Waimarino; January, 1910. Unique as yet.

3304. Oreocharis dives sp. nov.

Similar in form to 2922, rather darker, more richly coloured, the squamosity being bright dark rust-red instead of yellowish, the elytral suture and sides are almost rufo-piceous, and there is a distinct dark spot on the 2nd interstices near the summit of the declivity. The 3rd joint of the funiculus is about as long as its predecessor, the 5th and 6th bead-like and transverse. The eyes are certainly more convex and prominent, and the elytral striae, though narrow, are better marked.

Underside slightly nitid, infuscate red, the abdomen, however, is somewhat piceous; rather thickly clothed with depressed, feather-like, grey scales and slender setae. The sculpture is ill defined and close, on some parts punctate and transversely rugose, on others subgranular. The 5th ventral segment is only indistinctly flattened, the 6th rather narrow.

Length (rostrum inclusive), 7 mm.; breadth, $2\frac{1}{3}$ mm.

Waimarino; January, 1910. I found only a few specimens, all on *Veronicae.*

3305. Oreocharis castanea sp. nov.

Elongate, very scantily clad with suberect inconspicuous greyish hairs, moderately shining, rufo-castaneous, the club and claws piceous.

Rostrum about as long as thorax, closely and moderately coarsely punctate, longitudinally rugose near the antennae. Thorax of equal length and breadth, constricted in front, its sides a little rounded, the surface distinctly and closely punctured, and bearing some dark setae in front. Elytra elongate, broader than thorax at the base, slightly and gradually narrowed backwards, apices separately rounded and leaving the pale pygidium uncovered; they are regularly and distinctly striate-punctate, interstices transversely rugose and with minute serial punctures.

Scape pale fuscous; basal joint of the funiculus much thicker than 2nd but scarcely any longer, 3rd quite as long as broad, joints 4–6 transverse; club as long as funiculus, its terminal joint equals the basal two combined in length. Legs normal, middle and hind femora strongly dentate, posterior tibiae flexuous.

Length (rostrum inclusive), 5 mm. ; breadth, $1\frac{1}{2}$ mm.

Silverstream. One individual from the collection of Mr. H. W. Simmonds. A rather narrow, almost concolorous species.

3306. **Hoplocneme vicina** sp. nov. *Hoplocneme* White, Man. N.Z. Coleopt., p. 461.

Shining, sparingly clothed with slender grey setae ; head and rostrum black, thorax piceous, the elytra and femora piceo-rufous, anterior tibiae and the tarsi infuscate, antennae nigrescent but with the intermediate joints of the funiculus reddish.

Rostrum moderately dilated near the extremity, finely punctate. Head oblong, nearly double the width of the beak, a little impressed between the large prominent eyes, moderately coarsely punctate, and transversely rugose. Thorax of about equal length and breadth, gradually narrowed anteriorly and slightly constricted near the apex ; it is transversely rugose and punctate. Scutellum nude, not smooth. Elytra oblong, nearly double the width of thorax, with a pair of distinctly setose nodosities in line with the hind thighs, the humeral angles smooth and slightly elevated, the disc is slightly impressed before the middle, its punctation distinct and seriate, but the sutural series become sulciform behind ; in each puncture there is a fine greyish seta similar to those on the head and thorax.

There is but a single similar species (2166) ; both are rendered conspicuous by the short, broad hind-body.

Length (rostrum inclusive), $4\frac{1}{2}$ mm. ; breadth, $1\frac{1}{2}$ mm.

Mount Dennan, Tararua Range. A single damaged specimen found by Mr. A. O'Connor. Perhaps only a local variety of 2166.

3307. **Pactola nitidula** sp. nov. *Pactola* Pascoe, Man. N.Z. Coleopt., p. 465.

Elongate, moderately convex, shining ; rufo-castaneous, sparingly clothed with suberect elongate greyish squamae.

Rostrum obviously shorter than thorax and narrower than the head, subparallel, only slightly dilated in front, opaque, indistinctly sculptured. Scrobes just visible above. Head almost as broad as the thorax, as long as the rostrum, indistinctly punctate. Eyes prominent, longitudinally oval, widely separated from each other, and distant from the thorax. Scape inserted near the apex, attaining the back of the eye, slender, slightly curved and thickened towards the extremity, glabrous and fulvescent. Funiculus finely pubescent, basal joint long and stout, of about the same length as joints 2–5 united, 2nd small, 7th rather closely applied to the base of the large oblong-oval club. Thorax subcylindric, slightly longer than broad, a little constricted before the middle, base and apex truncate, not tuberculate, moderately coarsely and closely punctured. Scutellum small. Elytra thrice the length, and at the base nearly double the width of the thorax, considerably narrowed near the extremity ; they are rather convex behind the middle, deeply punctate-striate, with narrow, somewhat convex interstices ; the 4th–7th become confluent on top of the apical declivity. Posterior femora strongly clavate, and armed with an elongate tooth ; the corresponding tibiae very much curved.

P. humeralis (2924) has oviform elytra, which at the base scarcely exceed the thorax in width. *P. demissa* more nearly resembles this species in form, but it is smaller, opaque, densely squamose, and has differently sculptured elytra.

Length (rostrum inclusive), $2\frac{1}{2}$ mm.; breadth, 1 mm.

Waimarino; January, 1910. A solitary individual in my own collection.

3308. **Pactola fuscicornis** sp. nov.

Opaque, nigrescent, antennae, tibiae, and tarsi fuscous; squamosity dense, for the most part black, indistinctly intermingled with ashy grey, along the middle of the thorax and on a pair of small spots between the hind thighs there are some pale-tawny scales, on the legs and elytra there are a few short erect white setae.

Rostrum subparallel, shorter than thorax, indistinctly punctate. Head depressed behind, with a pair of small crests there. Eyes subrotundate, coarsely faceted. Thorax subcylindric, moderately constricted before the middle, not at all closely punctured, with a pair of pale, small, median tubercles. Scutellum small, grey. Elytra twice as broad as thorax, thrice its length, much narrowed behind; disc not quite flat, uneven, depressed before the middle, striate-punctate at the base, quite striate behind; there is a narrow small nodiform elevation on the suture in front of the middle, the interstices uneven but without conspicuous tubercles, on the 3rd there is a small pale nodosity, on each, in line with the base of the hind thigh, and on the 5th a small dark prominence just below the summit of the declivity.

Scape slightly curved and thickened towards the extremity, implanted near the apex; basal joint of funiculus stout and as long as the next four combined, 2nd joint very slightly longer than broad, joints 3–7 short and moniliform; club large, triarticulate, oblong-oval, densely pubescent.

Much smaller than the typical species (825), proportionately narrower, the thorax longer, the legs more slender, and the scape fuscous instead of being fulvescent. *P. demissa* (826) is not only smaller, but has narrower elytra, which are free from inequalities. It can hardly be confounded with *P. nitidula*.

Length (rostrum inclusive), $2\frac{2}{3}$ mm.; breadth, quite 1 mm.

Waimarino; elevation, 2,700 ft. One found during January, 1910.

3309. **Pactola binodiceps** sp. nov.

Subopaque, variegate, fuscous; base of femora, the tarsi, antennae, and apical declivity more or less fusco-testaceous; the legs and elytra somewhat speckled, these latter, before the middle, with a triangular dull sooty mark, they bear several erect white setae.

Rostrum almost as long as thorax, indistinctly carinate. Head with a pair of tawny nodosities behind, these are tipped with white setae. Thorax cylindric, slightly constricted near the front, a little longer than broad, not closely or distinctly punctured, with a pair of small tawny crests just in front of the middle and a more minute pair near the base. Scutellum small. Elytra quite double the width of thorax at the base, nearly four times its length, their apices rounded singly, quite oblique towards the suture, so that the testaceous pygidium is visible behind; they are broadly impressed before the middle, somewhat uneven, distinctly striate-punctate, more definitely sulcate behind; the 3rd interstice of each elytron has a median tawny nodosity, the 5th is less evidently nodose near the base and middle, the 2nd, 3rd, and 4th are very slightly raised in front of the declivity, the 5th terminates abruptly at the summit and appears nodiform there; there are some other smaller asperities.

Scape slender, very gradually incrassate, only slightly curved; basal joint of funiculus thick, as long as the following three taken together, 2nd very slender at the base, its breadth about half the length, joints 4–7 small and bead-like; club large, oblong-oval.

Underside subopaque, fuscous, the coxae tawny; rather finely and distantly punctate, obscurely pubescent; the intermediate ventral segments with some coarse white setae, the 5th with a shallow fovea at each side, the basal two segments slightly convex, both large, the suture between them exceedingly indistinct.

After comparison with nine specimens of *P. variabilis*, obtained at widely distant localities, I feel justified in considering *P. binodiceps* a valid species; its eyes are smaller and less prominent, the tibiae less robust, and the elytra rather narrower at the base. Ordinarily specimens of 825 have finely striate-punctate elytra with more strongly developed tubercular elevations, and simple apices; none have occipital nodosities.

Length (rostrum inclusive), $3\frac{1}{2}$ mm.; breadth, $1\frac{1}{2}$ mm.

Waimarino; January, 1910. Two examples.

Group Anthonomidae.

3310. **Hypotagea lewisi** sp. nov. *Hypotagea* Pascoe, Man. N.Z. Coleopt., p. 456.

Suboblong, moderately convex, slightly nitid; pale ferruginous, of a darker red between the hind thighs; sparingly clothed with decumbent elongate yellow setae, the sides of the thorax and after part of the elytra more thickly covered with elongated cream coloured scales.

Rostrum arched, subparallel, moderately slender, about a third longer than thorax, smooth but not carinate along the middle, almost punctate-striate at the sides. Thorax of about equal length and breadth, only moderately contracted near the front, nearly straight behind, base and apex truncate, its surface, like the head, moderately coarsely and closely punctured. Scutellum subtriangular, shining, rather small. Elytra evidently broader than thorax at the base, more than twice its length, gradually curvedly narrowed behind, with strongly rounded apices, thus leaving the pygidium slightly exposed; they are punctate-striate; the grooves, however, are not deep; the pale squamae do not entirely cover the hind portion, the suture and a broad spot on each elytron, about half-way down the declivity, being nearly bare, having only a few inconspicuous, slender, erect, infuscate setae.

Scape glabrous, slender, a little thickened near the extremity, inserted nearer the apex than the middle, and attaining the front of the eye. Funiculus with some slender outstanding setae, 2nd joint rather shorter than the basal, 3–5 almost equal, each longer than broad, 6th and 7th somewhat shorter, bead-like. Club oblong-oval, rather large, triarticulate, finely and densely pubescent.

Femora coarsely punctate, all armed with a triangular tooth underneath, the anterior pair considerably longer than the others. Tibiae flexuous, the front pair distinctly mucronate at the inner extremity and much more elongated than the posterior. Tarsi finely setose underneath, their basal joint longer than the 2nd, the next expanded and bilobed, the terminal as long as the 1st, with strongly appendiculate claws.

Eyes subrotundate, with distinct facets, just about as far apart as they are distant from the thorax. Ocular lobes absent. Prosternum not abbreviated.

The robust and remarkably elongate front legs, together with the apparently bare spots near the extremity of the elytra, are good aids to identification.

Length (rostrum exclusive), 3 mm.; breadth, $1\frac{1}{2}$ mm.

Broken River, Canterbury. Named after its discoverer, Mr. J. H. Lewis, who sent me a single individual.

Obs.—This does not quite agree with the type of the genus (804), on account of the dentate front thighs; neither can it accord with the European *Anthonomus varians*, with which I compared it, as in it the base of the thorax is strongly bisinuate, that of the elytra being correspondingly curved outwardly, &c. As the specimen is carefully mounted on cardboard it must remain so. Its systematic position is between these two genera.

Group Cryptorhynchidae.

3311. **Psepholax acanthomerus** sp. nov. *Psepholax* White, Man. N.Z. Coleopt., p. 478.

Convex, oblong, subopaque, rufo-piceous, sparingly clothed with elongate flavescent squamae and slender setae, some of which are dark and erect; antennae and tarsi pitchy red.

Rostrum with deep scrobes; the sides underneath these much thickened, and terminating abruptly some distance from the eyes; it is a fourth shorter than the thorax, with an elongate interantennal fovea which is prolonged backwards as a shallow groove, its punctation is somewhat indistinct, and becomes rugose behind the eyes. Thorax subtruncate at the base, medially emarginate at the apex, about a third broader than long, the sides curvedly narrowed anteriorly, and a good deal, but not abruptly, contracted in front; with a short smooth central line, and distinct moderately close punctures, which, however, become indefinite in front. Scutellum triangular. Elytra oblong, as wide as thorax at the base, nearly vertical behind; they are substriate, with rugose almost asperate interstices; the sides, behind the posterior femora, bear numerous spines, these are small and short where they begin, but coarse and prominent where they suddenly end, at some distance from the apex; on each elytron there are 4 series of unequal spines, the inner pair arise in line with the hind thighs and end on top of the apical declivity, the outer pair extend further back; the declivity bears some dark adpressed scales, so that its sculpture seems granular.

Antennae short and stout, with a few slender greyish setae; the scape just reaches the eye; basal joint of funiculus short and thick, 2nd rather longer and distinctly narrowed towards its base, joints 3–7 compact and transverse; club oblong-oval, densely and minutely pubescent and indistinctly triarticulate.

Femora deeply notched near the extremity, sharply angulate and strongly dentate underneath, the anterior particularly; intermediate tibiae strongly bidentate externally below the middle, the posterior pair less so.

Metasternum deeply depressed between the coxae. Second ventral segment with grey scales, the 5th finely and distantly punctate and setose.

Female.—Oblong-oval, the sides of the elytra behind the posterior femora, but not at the apex, minutely spinose or serrate, discoidal interstices not perceptibly spinose. Femora obtusely angulate and subdentate underneath. Metasternum angularly depressed behind. Second ventral segment with elongate yellow scales. $7\frac{1}{2}$ mm. by $3\frac{1}{3}$ mm.

The armature of the femora is distinctive. In the male of *P. coronatus* (852) the lateral spines extend from one hind thigh to the other; they are coarser, and just as conspicuous at the apex as at the sides; the discoidal series begin near the middle, but end in line with the posterior femora; the middle tibiae are less strongly, the femora not at all, dentate; the antennal club is evidently longer, and the squamosity is different.

♂. Length (rostrum inclusive), 7 mm.; breadth, $3\frac{2}{5}$ mm.

Mount Greenland, near Ross. Mr. A. O'Connor gave me a specimen of each sex, which had been discovered by Mr. H. Hamilton at an altitude of 2,500 ft.

1312. **Mesoreda longula** sp. nov. *Mesoreda* Broun, Man. N.Z. Coleopt., p. 1235.

Elongate, subparallel, transversely convex, subopaque; fusco-piceous, front of thorax and the tarsi somewhat rufescent, antennae piceo-rufous; the vestiture consists of nearly white and greyish scales with a tendency to overlap one another, and moderately coarse but not very elongate setae, some of which are infuscate.

Rostrum subparallel, slightly narrowed towards the base, not arched, a third of the width of the head, its length about a third less than the thorax; its sculpture subgranulate at the base, quite punctate, but less closely towards the apex, which is distinctly notched. Mandibles prominent, obsoletely dentate inwardly. Thorax a trifle broader than long, a good deal contracted in front, the base evidently bisinuate, its punctation close but not coarse. Scutellum suboblong. Elytra of the same breadth as thorax at the base, moderately deflexed and narrowed behind; substriate-punctate, the interstices finely punctured and interrupted by transverse impressions, so as to appear somewhat rugose or asperate.

Femora laterally compressed, the hind pairs angulate and subdentate underneath, the corresponding tibiae with an external dentiform projection near the base, that of the posterior less distinct than the intermediate. Antennae inserted immediately before the middle; scape slightly flexuous and gradually incrassate, it attains the eye; funiculus longer than the scape, 2nd joint as long as 1st, 3rd subquadrate, 4–7 transverse; club triarticulate, elongate, yet shorter than the funiculus.

Male.—Underside shining black, with some whitish squamae, distinctly but nowhere closely punctate. Mesosternal process lunate and elevated but not cavernous, its front face being vertical. Metasternum longer than the basal ventral segment, medially flattened, and with a well-marked angular depression behind. Second segment obviously shorter than 1st, the suture between them straight; 5th obtusely rounded at the apex, and leaving exposed the broad, densely and finely ciliated supplementary segment.

In 865, *M. setigera*, the metasternum is not flattened in the middle, the rostrum and antennae are much thicker, and the femora are more dilated underneath at the extremity. In *M. orthorhina* (1625) the thorax is emarginate at the apex, the clothing is different, &c. *M. sulcifrons* has a distinct interocular impression, a median ridge on the thorax, entirely different vestiture, and its club equals the funiculus in length. All these are shorter than this species.

♀. Length (rostrum exclusive), 6½ mm.; breadth, 2⅔ mm.

Wairiri, Kaikoura. A pair found under bark by Mr. W. L. Wallace.

3313. **Acalles conicollis** sp. nov. *Acalles* Schoenherr, Man. N.Z. Coleopt., p. 488.

Convex, subovate, somewhat nitid; nigrescent, femora piceous, tibiae fusco-rufous, tarsi and antennae rufescent; sparingly covered with inconspicuous, infuscate, elongate squamae, but on the shoulders the scales are quite pallid and form obvious crests.

Rostrum nearly the length of thorax, slightly arched and medially narrowed, distinctly marked off or constricted at the base; it is nearly nude, with very few punctures. Thorax conical, about a third broader than long; rather distantly and not at all coarsely punctured, and bearing very few scales on its basal portion. Scutellum absent. Elytra obconical, subtruncate and rather broader than thorax at the base, nearly twice its length, abruptly vertical behind: they are coarsely seriate-punctate the 3rd interstices have moderately large subapical crests, the 5th with 2 smaller ones, the hinder placed near the posterior femora, there are also 3 or 4 at the sides.

Legs elongate, anterior femora evidently longer than the intermediate; tibiae uncinate and nearly straight, and with some coarse dark setae; tarsi elongate, terminal joint as long as the basal, 3rd only moderately expanded and lobed.

Scape medially inserted, just attaining the eye, shorter than the funiculus, gradually thickened; 2nd joint of the funiculus elongate, yet shorter than 1st, joints 3–6 nearly equal, 7th broader than 6th; club oblong-oval, finely pubescent, indistinctly triarticulate. Eyes subrotundate, rather flat.

A peculiar species, which may be readily identified by the conspicuous pale humeral crests as contrasted with the shining black derm.

Length (rostrum exclusive), 2½ mm.; breadth, 1½ mm.

Makatote, near Erua. One, found amongst dead leaves collected for me by Mr. W. J. Guinness, March, 1910.

3314. **Acalles eruensis** sp. nov.

Subovate, convex, a little shining: piceous, antennae and tarsi fulvescent; covered with yellowish-grey and fuscous squamae, the darker ones most apparent on the thoracic disc and 3rd interstices of the elytra; there are no setae, the legs being clothed with suberect scales.

Rostrum broad, subparallel, rather shorter than thorax, slightly arched, coarsely punctate and squamose, but nearly bare at the extremity. Thorax truncate at base, its anterior half moderately, but not very abruptly, contracted and depressed, a little broader than long; it is moderately coarsely and closely punctured, but with the central space, near the front, more distantly, and somewhat glossy; the middle of the basal portion is dark, and seems depressed, owing chiefly to the scales being erect at each side of the middle, but there are no crests. Elytra truncate and slightly wider than thorax at the base, their sides gently rounded as far as the hind thighs, from thence much narrowed but not vertical behind, and with the extremity rather broad; they are reddish and striate-punctate, but not very distinctly so, owing to the squamosity; the 3rd interstices bear, on each, two dark slightly raised spots, the posterior declivity is somewhat laterally compressed along the middle, and is spotted.

Legs stout and elongate, thickly squamose, tibiae nearly straight; tarsi with fine hairs above, 3rd joint broadly dilated but not deeply lobed.

Scape inserted just before the middle, shorter than the funicle, reaching the front of the eye, gradually incrassate; 2nd joint of funiculus slender and elongate and as long as the thick 1st, 3rd and 4th about equal, longer than broad, 7th transverse; club oblong-oval, its basal joint large, the others small.

Rostral canal broad and deep as far as the back part of the anterior coxae, bounded behind by the raised but not cavernous mesosternal lamina. Metasternum short. Abdomen thickly squamose in its natural state, so that its structure cannot be ascertained; when scraped and cleaned the basal segment appears slightly curved between the widely separated coxae, the suture, however, is very fine, it is medially flattened, and, like the other segments, closely and moderately coarsely punctured, but there is no definite suture between it and the 2nd; the 3rd and 4th are moderately short, with deep sutures, these conjointly are as long as the 5th.

It may be placed near *A. australis* (2180), but in it, as well as Pascoe's *A. intutus*, there is a distinct scutellum, of which there is no trace in *A. eruensis*.

Length (rostrum exclusive), $2\frac{1}{2}$ mm.; breadth, $1\frac{1}{2}$ mm.

Erua. Two, picked out of leaf-mould sent to me by Mr. W. J. Guinness during March and April, 1910.

3315. Acalles peelensis sp. nov.

Convex, elongate, oviform, subopaque, without superficial inequalities; obscure fusco-rufous, rostrum pitchy red, antennae ferruginous; thickly covered with depressed infuscate grey squamae and rather long and coarse outstanding setae.

Rostrum about half the length of thorax, slightly expanded towards the extremity, coarsely punctate, less so in front, and bearing scales and setae. Thorax a trifle longer than broad, but appearing elongate; a good deal, yet only very gradually, narrowed anteriorly; coarsely and closely punctured, more finely at the base. Elytra oviform, hardly double the length of thorax, and scarcely any broader than it is at the base; they have series of coarse oblong punctures, but become substriate behind; on the suture, at the summit of the declivity, there is a blackish spot, there are also a few indistinct ones near the sides.

Legs moderately elongate, thickly setose, the tarsi more finely, their 3rd joint with moderately broad lobes. Scape implanted behind the middle and attaining the eye, gradually incrassate, and nearly glabrous. Funiculus very finely pilose, basal joint much and somewhat abruptly clavate, 2nd slender, shorter than the 1st but longer than the following one, 4–7 become shorter and broader. Club oblong-oval, indistinctly triarticulate, its basal joint more than half of the entire length.

Underside piceous, with numerous coarse setae, coarsely and irregularly punctured, the basal ventral segment rather distantly in the middle, the 2nd more finely, the 5th indistinctly and somewhat rufescent. Rostral canal deep, bounded between the intermediate coxae by elevated borders. Metasternum short. The suture between the basal two segments quite obliterated in the middle. Scutellum obsolete. Eyes rather flat, not at all transversal.

No species in my possession agrees with this. It should be located near 1282, *A. spurcus*, but in it the antennae are inserted before the middle.

Length (rostrum exclusive), $3\frac{1}{2}$ mm.; breadth, $1\frac{1}{2}$ mm.

Mount Peel. A pair forwarded by Mr. H. Simmonds.

3316. **Acalles consors** sp. nov.

Convex, densely clothed with yellowish-brown scales and paler erect setae; thorax piceous, elytra fusco-rufous, antennae fulvescent. Sometimes covered with greyish pollenarious matter, through which the setae protrude.

Very much like *A. peelensis*, more broadly oval, the elytra evidently so, and rather broader than the thorax at the base, with more obvious black spots composed of scales and setae, their sculpture more striate; generally the setae are somewhat concentrated on the 2nd and 4th interstices, on the top of the declivity, so as to form small tufts there. The rostrum is thicker, with 3 or 4 coarse erect setae near each eye, as is also the case, though less distinctly, in *A. peelensis*. The 1st joint of the funiculus is less swollen, the 2nd is almost as long, and the 7th joint only is transversal. The underside also is very similar, the effacement of the suture between the basal abdominal segments is as complete, but the 5th is not red, and bears numerous minute tawny scales.

Length (rostrum exclusive), $3\frac{1}{2}$ mm.; breadth, $1\frac{3}{4}$ mm.

Mount Greenland, near Ross. Several specimens sent by Mr. O'Connor, but collected by Mr. H. Hamilton at an elevation of 2,500 ft.

3317. **Acalles gracilis** sp. nov.

Elongate, transversely convex, subopaque; rufescent, elytra rufo-piceous, tarsi and antennae fulvescent, club fuscous; squamosity elongate, suberect, unevenly distributed on the elytra, fulvescent; setae numerous, outstanding and elongate, infuscate.

Rostrum shining, rufous, sparingly punctate, nude beyond the base, slightly and gradually dilated anteriorly, shorter than thorax, moderately arched. Thorax truncate at base, about a third longer than broad, oviform, widest just behind the middle, closely and moderately coarsely punctured. Elytra elongate-cordate, about a third longer than thorax, of the same breadth as it is at the base, a good deal narrowed, but not perpendicular, behind the posterior femora; they are deeply sulcate, with rather narrow interstices.

Scape inserted just behind the middle, short, gradually incrassate; 2nd joint of funiculus about as long as but more slender than the 1st, joints 3–7 transverse, 7th not as broad as the club but rather broader than the 6th; club ovate, triarticulate, pubescent. Tibiae nearly straight; tarsi setose underneath, their 3rd joint rather short, bilobed, broad.

Like *A. comptus* (2565), more slender, the hind-body more prolonged posteriorly, less vertical there, without rufescent scales, the club distinctly ovate and not narrowed towards the base, terminal joint of the tarsi rather shorter. There is no scutellum.

Nos. 874, 2935, 2565, and the present species form a homogeneous section of the genus, as regards form. The first two are distinguishable by a glance at the inwardly curved anterior tibiae.

Length (rostrum exclusive), $1\frac{3}{4}$ mm.; breadth, $\frac{2}{3}$ mm.

Erua. One only, found amongst dead leaves on the ground; January, 1910.

3318. **Acalles contractus** sp. nov.

Convex, rather long and narrow, somewhat contracted at the junction of the thorax and hind-body, without crests or tubercles, subopaque; fusco-rufous, antennae fulvescent, club fuscous; sparsely covered with flavescent squamae, some of which on the hinder part of the elytra are coarser and erect, those on the legs are equally coarse but paler or greyish.

Rostrum rufescent, shining, nearly smooth, slightly arched, just perceptibly narrowed towards the base. Thorax a little longer than broad, widest behind the middle, narrowed, but not abruptly, towards the apex, somewhat contracted at the subtruncate base; it is moderately coarsely and closely punctured. Elytra oviform, not twice the length of the thorax, very slightly wider than it is at the base, widest near the middle, the declivity not vertical; with distinct, seemingly impunctate, sutural striae, the lateral sculpture ill defined.

Legs long and thick; 3rd tarsal joint expanded and bilobed. Scape inserted just behind the middle, barely reaching the eye, gradually thickened; 2nd joint of funiculus slender, shorter than 1st, joints 3–7 subequal, small; club oviform, densely pubescent, not distinctly annulate. Eyes not prominent, subrotundate. Scutellum absent. There are no ocular lobes.

Its nearest congeners are 1275 and 1745, from both of which it can be separated at once by the yellow squamosity. Ultimately all three probably will be detached from *Acalles*.

Length (rostrum exclusive), $1\frac{2}{3}$ mm.; breadth, $\frac{2}{3}$ mm.

Erua. One found amongst vegetable matter on the ground in January, 1910.

3319. **Tychanus costatus** sp. nov. *Tychanus* Pascoe, Man. N.Z. Coleopt., p. 498.

Convex, broad, nigrescent, densely covered with tawny scales, on the hind-body they are rather finer and more rufescent than those on the thorax; on each elytron, near the hind thigh, a very irregularly formed patch of white squamae extends from the side half-way to the suture; antennae and tarsi piceo-rufous.

Rostrum a fifth shorter than thorax, not arcuate, broader at the base than elsewhere, opaque; its frontal half glabrous and finely yet distinctly punctate, the basal more coarsely sculptured, and finely squamose; there is an interantennal groove. Thorax about a third broader than it is long, not as broad as the elytra at the base; its apical portion, about a third of the whole length, contracted to the width of the head, which it partly covers; the basal part rather broader in front than behind, and with a pair of obtuse median elevations near the front; its punctation is invisible. Scutellum quite nude and distinct. Elytra broader than thorax, the shoulders obtusely prominent, behind each of these there is a rather large lateral prominence; the posterior declivity is not quite vertical, and at the apex is obtusely prominent at each side; along each, at a short distance from the suture, an obtuse ridge extends from the base, near which it is most elevated, and terminates at the declivity, the sutural area has some coarse punctiform impressions and minute granules; nearer the side a shorter ridge ends at the white mark; the punctures on the declivity are subseriate and much finer than those on the dorsum.

Legs thickly squamose, femora angularly dentate below. Funiculus rather stout, basal joint rather shorter than the second. Club triarticulate, rather narrow.

Rostral canal deep, limited by the raised crescent-shaped mesosternal process, which is cavernous. Coxae, prosternum, and metasternum coarsely punctate and squamose. Basal ventral segment, in the middle, nearly double the length of the 2nd, rounded there in front, flat, and coarsely punctured; 5th impressed along the middle.

Undoubtedly allied to *T. bufo* Sharp (2182), but much larger, and differentiated therefrom by the hind-body being broader than the thorax and having longitudinal ridges.

Length (rostrum exclusive), 7½ mm.; breadth, 4½ mm.

Silverstream, Hutt Valley. Found on the trunks of black birch (*Fagus*). A single example received from Mr. H. Simmonds.

3320. **Crisius humeralis** sp. nov. *Crisius* Pascoe, Man. N.Z. Coleopt., p. 500.

Variegate, piceo-rufous, thorax nigrescent, densely squamose.

Rostrum distinctly, yet finely, longitudinally punctate, still more finely in front, the punctures near the base filled with depressed pale-ferruginous scales. Head depressed along the middle. Thorax of nearly equal length and breadth, quite a third of its length, much contracted in front, the basal portion nearly parallel-sided; subcarinate along the middle, bicristate near the front, its whole surface moderately and closely punctured; it is covered for the most part with depressed ferruginous scales, the coarser ones form a pair of antemedian crests, those on the apex are paler and erect. Elytra subcordate, rather wider than thorax at the base, shoulders oblique and densely covered with slender pale-ferruginous squamae; the disc, as far as the hind thighs, is on a higher plane than the thorax, and is covered with small scales of a lighter colour; at the base there is a pair of small blackish spots, and a few minute granules near the suture; at each side of this area there are 2 moderate crests, and 2 or 3 others nearer the sides; the posterior declivity forms a long curved slope, covered with small ferruginous scales, some dark, others bright; this part is substriate-punctate, bears several minute crests and 3 larger ones near each side; the punctures near the sides are much coarser and less regular.

Femora medially angulate. Tarsi rather narrow, their basal joint quite as long as the terminal, 3rd moderately expanded and bilobed. The scape attains the eye. Basal joint of funiculus evidently shorter than 2nd. Club elongate-oval, triarticulate and acuminate.

Underside with depressed ferruginous and flavescent squamae. Pectoral canal profound, bounded by the strongly raised border in line with the back of the middle coxae. Metasternum very short. Basal ventral segment quite double the length of the 2nd, moderately coarsely and very closely punctured, subtruncate behind and more elevated there than in front; 2nd medially raised; 3rd and 4th flat, on a lower level than the preceding one, and, at the sides, nearly as long as it is; 5th deeply impressed at each side.

In form somewhat similar to *C fasciculatus* (2574), the basal portion of the thorax less sharply defined in front owing to the absence of lateral crests; the elytra broader behind but narrower at the base; the femora not distinctly dentate. It may be separated from other species by the oblique, brightly coloured shoulders.

Length (rostrum exclusive), 5½ mm.; breadth, 3 mm.

Mount Quoin. Taken off the trunks of *Fagus* trees (black birch), at a height of about 4,000 ft., by Mr. H. Simmonds, who sent me the specimen from which the description has been drawn up.

3321. **Crisius semifuscus** sp. nov.

Opaque, fuscous; the elytra from the shoulders to the apex, except on the middle at the base, thickly covered with pale-tawny scales and a few short grey setae, the legs similarly clothed; tarsi and antennae ferruginous.

Rostrum arched, subparallel, equalling the thorax in length, longitudinally rugose and punctate, more finely in front, with a few squamae at the base. Thorax only slightly broader than long, much contracted in front, very sparingly clothed; with a pair of small apical crests, and with another pair between the middle and each side across the front of the broad basal portion, there is a slightly elevated and abbreviated ridge along the centre, its punctation is moderately coarse but becomes rather finer and closer in front, the intervals are densely and minutely sculptured and appear somewhat asperate. Scutellum obsolete. Elytra subcordate, much broader than thorax at the base, their sides uneven, with 4 or 5 nodosites along each, much narrowed posteriorly; on the dark basal part the punctures are coarse, but are less so, and quite seriate, behind; on each elytron the 3rd interstice, near the base, is uneven but not distinctly nodose, but on top of the declivity there is a nodiform elevation, there are 3 others near the side, and another close to the apex.

Femora evidently angulate and dentate below, tibiae externally curvate above; tarsi rather narrow, their 3rd joint only moderately expanded. Scape rather slender, gradually thickened; 2nd joint of the funiculus nearly double the length of the 1st, 3rd and 4th oblong, 5–7 submoniliform; club elongate, triarticulate.

Metasternum very short, medially depressed. Basal ventral segment twice as long as the 2nd in the middle. Underside densely covered with pale-tawny scales and setae, but the middle of segments 2–4 with dark fuscous.

The disposition of the elytral vestiture, and rather rough thoracic sculpture, render its identification a comparatively easy matter.

Length (rostrum exclusive), 4 mm.; breadth, 2¼ mm.

Titahi Bay, near Wellington. A single individual from Mr. A. O'Connor.

3322. **Crisius decorus** sp. nov.

Variegate, densely squamose, to a great extent nigrescent; the shoulders, a large transverse space across the elytra, near the middle, and a few other specks, yellowish-grey; crimson scales predominate on the rostrum, and are distributed amongst the dark ones on the thorax and hind-body; antennae and tarsi fusco-rufous.

Rostrum arched, as long as thorax, abruptly constricted at the base, nude, pitchy red, and finely punctate near the apex. Thorax slightly broader than long, its anterior half abruptly contracted and bicristate at the apex, a pair of dark crests tipped with grey are placed in front of the broad basal portion, near the middle; its punctation is rather coarse and close. Scutellum small, rotundate, yellowish. Elytra cordiform, the elevated shoulders are obliquely narrowed to the width of the thorax at the base, the disc is on a higher plane than its base, the posterior declivity is not abrupt; they are narrowly striate behind, with fine indistinct punctures; at the middle of the base 2 short series of punctures are easily discernible, the lateral punctures are much coarser and irregular; on each elytron, at the base, there is a pair of small elevations, the outer one is prolonged and ends as a crested nodosity at the front and outer angle of the pale area, along the side and between it and the middle there are 6 nodules or crests, and on the hind slope there are several much smaller ones.

Antennae implanted before the middle, scape gradually incrassate; 2nd joint of funiculus of about the same length as the basal, 7th broader than its predecessor; club oblong-oval, distinctly triarticulate.

Pectoral canal deep, its raised borders extend to the back of the middle coxae. Metasternum short, slightly incurved behind. Basal ventral segment broadly impressed, twice the length of the 2nd in the middle, this latter slopes towards the lower level of the 3rd and 4th, 5th nearly as long as the preceding two conjointly, it is covered with pale elongated scales on the middle, but is dark and deeply impressed at each side of the apex; the squamae on the metasternum and basal segment are pale-yellowish, on the 3rd and 4th and sides of the 2nd they are dark; all, as well as those on the femora, are intermingled with crimson ones.

C. dorsalis (2952) is the nearest ally; in it the pale area on the elytra extends from the base, and the punctation is quite distinct and regular.

Length (rostrum exclusive), $4\frac{1}{2}$ mm.; breadth, $2\frac{1}{2}$ mm.

Makatote, Main Trunk Railway. Unique. Picked out of a bag of leaf-mould which Mr. W. J. Guinness kindly collected and forwarded in February, 1910.

3323. **Tychanopais flavisparsus** sp. nov. *Tychanopais* Broun, Man.. N.Z. Coleopt., p. 1379.

Convex, ovate-oblong, dull smoky black, antennae and terminal joint of tarsi fusco-rufous; sparingly clothed with depressed, irregularly distributed yellow and grey squamae, the former predominant, on the thorax there are a few that are quite black.

Rostrum not arched, a third shorter than the thorax, moderately broad, slightly narrowed medially, rather coarsely punctate, more closely near the extremity. Head with a narrow interocular fovea. Thorax subtruncate at base, its anterior half gradually contracted, of equal length and breadth; erect black squamae form an apical fringe, which, however, is notched in the middle; the discoidal punctures are distinct, but not coarse, and very unevenly distributed, leaving a central spot smooth. Elytra oblong, almost exactly the same width as thorax at the base; the shoulders minutely projecting forwards; they are somewhat broader, but nearly straight, near the middle; the posterior declivity is almost vertical and much narrowed, they are only a third longer than the thorax; the punctures are seriate near the suture, but irregular, with uneven intervals, towards the sides, all are coarse and rather distant, on the declivity they are narrow and elongate; the crests on the 3rd and 5th interstices, on the summit of the declivity, are black, tipped with grey, those before the middle of the disc are less distinct, the declivity is marked with small patches of yellow suberect scales.

Legs densely squamose, the femora angulate underneath, their basal portion and the middle of the tibiae are nigrescent. Antennae slender, their insertion subapical, scape only slightly thickened towards the extremity; basal two joints of the funiculus elongate, the 2nd slightly longer than 1st, 3rd and 4th oblong, the 7th rather broader than 6th; club oblong-oval, triarticulate.

Underside black, with a few pale testaceous scales, basal two ventral segments coarsely punctate.

Rostral canal with strongly elevated posterior borders, terminating in front of the intermediate coxae, quite cavernous there. Metasternum very short, so that the middle coxae are only slightly separated from the posterior pair. Basal ventral segment quite double the length of the 2nd, which is vertical behind, 3rd and 4th very short.

Entomologists can hardly fail to recognize this species, which, though not agreeing exactly with the type of this genus, cannot be satisfactorily located in any other.

Length (rostrum exclusive), 6 mm.; breadth, 3 mm.

Titahi Bay, near Wellington. Unique. This is another of the numerous novelties in Mr. A. O'Connor's collection.

Allanalcis gen. nov.

Body compact, convex, widest just behind the middle, not tuberculate, densely squamose.

Thorax conical, obtusely produced anteriorly, truncate at base, without ocular lobes. Scutellum absent. Elytra cordate or broadly obovate, of the same width as thorax at the base, vertical behind.

Rostrum rather shorter than thorax, but little arched, slightly narrowed medially. Scrobes not visible above, beginning at the middle and prolonged to the lower part of the eyes. Scape very short and incrassate, hardly attaining the front of the eye. Funiculus 7-articulate, twice the length of the scape, basal joint stout, obconical, 2nd slender and elongate, quite as long as the 1st, joints 3–7 gradually thickened, 7th transverse. Club unsymmetrical, oblong-oval, quadriarticulate, its basal joint large, the others small and indistinct. Eyes coarsely faceted, subrotundate or oval, situated on the upper surface, and therefore more approximated above than in *Acalles*.

Femora unarmed, long and thick. Tibiae uncinate, more or less curved inwardly. Tarsi setose underneath, 3rd joint densely so, broadly expanded, double the width of the basal ones, not perceptibly lobate, deeply excavate above, entire below; terminal joint not projecting more than half of its length beyond the 3rd, with small claws.

Pectoral canal deep and broad, extending to beyond the anterior coxae, limited behind by the elevated semicircular border of the mesosternum, and deeply cavernous there. Metasternum short. Basal ventral segment broadly rounded or subtruncate between the coxae, as long, or nearly so, as the remaining four combined, its apical suture nearly or quite straight; 2nd but little longer than the abbreviated 3rd or 4th, 5th as long as the preceding two taken together.

The short thick scape, unlobed 3rd tarsal joint, the form and position of the eyes, and the abdominal structure are sufficiently good characters for separation from *Acalles* and its immediate allies. All the species are small, rare, and terrestrial.

The following numbers indicate species that must be transferred from *Acalles* to this genus: 2570, 2571, 2572, and 2936.

3324. Allanalcis ignealis sp. nov.

Opaque, piceous; squamosity dense and variegate, for the most part bright rufous, the thorax with a few scattered white scales, on the elytra there are a few small blackish spots, the largest being close to the hind thighs, in line with these, pale greyish-blue, and more slender, squamae are somewhat concentrated but do not reach the suture, the apical declivity is also a little variegated but paler than the disc; the short suberect setae vary from greyish to black, and are most conspicuous on the legs; antennae and tarsi rufescent; the hinder pairs of femora are darker than the anterior.

Rostrum rather shorter than thorax, slightly elevated but not distinctly carinate along the middle; thickly squamose except near the apex, which is punctate and bears only a few fine setae. Thorax widest at the base, a little broader than long, its anterior half slightly but not at all abruptly narrowed, closely and moderately coarsely punctured. Elytra feebly incurved at the base, of the same width as thorax there, broader and rounded before the middle, obliquely narrowed and deflexed behind; they are seemingly striate-punctate, the true sculpture, however, is hidden by the squamosity.

A beautiful insect, somewhat similar to *A. formosus* (2936), which is rather smaller, with the rostrum flatter, the base of the elytra slightly exceeding that of the thorax in breadth, and with the 3rd interstices somewhat elevated. In *A. ignealis* the eyes appear more obliquely oval, owing partly to their being encroached upon in front by the red scales.

Length (rostrum exclusive), $2\frac{1}{2}$ mm.; breadth, quite $1\frac{1}{2}$ mm.

Erua. I found my specimen amongst decaying leaves on the ground in January, 1910.

3325. Allanalcis oculatus sp. nov.

Convex, broadly oval, opaque; piceous, femora fuscous, tibiae fusco-rufous, antennae and tarsi rufescent; squamosity testaceous, much darker on the rostrum, mingled with a few erect setiform squamae.

Rostrum broad, rather shorter than thorax, coarsely punctate, with fine setae only at the extremity. Thorax quite a third broader than long, in front narrowed to half the width of the base, moderately coarsely and closely punctured. Elytra short and broad, but little longer than thorax, and at the base scarcely exceeding it in width, their sides rounded, much narrowed and vertical behind.

Legs normal, bearing coarse greyish setae. Scape short, subclavate at the extremity; 2nd joint of funiculus quite the length of the 1st, 3rd slightly longer than broad, 5–7 moniliform and transverse, 7th broader than 6th.

A rather short and broad species, the sides of the elytra evenly and broadly rounded, the vestiture hardly at all variegated. The eyes are more rotundate and approximated above than in any other species, and consequently form a good differentiating feature.

Length (rostrum exclusive), $2\frac{1}{4}$ mm.; breadth, quite $1\frac{1}{2}$ mm.

Maketu, Hunua Range. A single example found amongst decaying leaves on the ground.

3326. **Allanalcis dilatatus** sp. nov.

Compact, convex, evidently broader between the middle and hind thighs than it is elsewhere; piceous, legs obscure fusco-rufous, antennae and tarsi much paler; squamosity thick, chiefly tawny, or yellowish, with some irregular dark spots on the elytra, the lower part of the body also fuscous: there are no setae except the coarse ones on the legs.

Rostrum rather shorter than thorax, widely narrowed medially, constricted at the base; in front rufescent, and bearing a few fine yellowish setae. Thorax of about equal length and breadth, quite a third broader at the base than the apex; moderately coarsely and closely punctured. Elytra cordate, bisinuate at the base and hardly wider than the thorax there, considerably dilated before the middle, nearly vertical and much narrowed behind; their striae are well marked, but the punctation, if present, is concealed.

Readily distinguishable from 2572, *A. incultus*, by the body being obviously narrowed towards both extremities, by the distinct posthumeral dilations, and by the absence of the dark apical marks.

Length (rostrum exclusive), 2½ mm.; breadth, 1½ mm.

Erua. One found amongst decaying leaves on the ground; January, 1910.

Obs.—An error occurs in the description of *A. incultus*, p. 1490, Man. N.Z. Coleopt. Instead of the squamosity being infuscate yellow, it is printed "infuscate red."

3327. **Metacalles crinitus** sp. nov. *Metacalles* Broun, Ann. Mag. Nat. Hist., ser. 6, vol. 12, p. 381.

Subovate, convex, slightly nitid; fusco-rufous, sides of elytra darker, tarsi and antennae fulvescent, club piceous; vestiture flavescent, hair-like, erect, somewhat patchy on the elytra, the setae slender and elongate, also erect.

Rostrum shining, red, nearly nude and smooth, with linear sculpture near the base, very slightly arched, not constricted near the eyes, parallel, only a little shorter than thorax. Head globose below, immersed up to the rather small flat subangulate eyes. Thorax without ocular lobes, subconical, truncate at base, rather wider behind the middle than elsewhere, gradually narrowed anteriorly; coarsely, rather closely, and somewhat rugosely punctured, more finely in front, with very few hairs; it is only slightly longer than broad. Elytra on a higher plane than the thorax, of the same width as it is at the base, broader and rounder at the middle, abruptly deflexed behind so that when examined directly from above they seem but little longer than the thorax; on each elytron there are 3 rather deep punctate striae, the apical sculpture is finer; the pubescence is somewhat concentrated so as to form tufts, leaving some parts nearly bare.

Legs elongate, thinly clad; tibiae rather slender and tapering towards the extremity; tarsi narrow, 3rd joint a little dilated, excavate above, with short lobes. There is no scutellum.

Scape short, moderately stout, inserted distinctly behind the middle and barely reaching the eye. Funiculus elongate, 2nd joint slender at the base and evidently smaller than the 1st; joints 4–6 small and bead-like, 7th slightly broader. Club ovate, densely pubescent.

A peculiar-looking little weevil. The short, subrotundate hind-body, with its tufts of elongate pubescence and deep sulci, is unlike any of its allies. The pectoral canal is profound and extends almost to the posterior coxae.

Length (rostrum exclusive), $1\frac{2}{3}$ mm. ; breadth, 1 mm.

Erua. Another of our rare ground-weevils, of which a solitary example only could be obtained amongst decaying leaves ; January, 1910.

3328. **Metacalles lanosus** sp. nov.

Subovate, convex, somewhat nitid ; rufo-piceous, rostrum reddish, antennae and tarsi fulvescent, club fuscous ; sparingly clothed with elongate, outstanding, slightly infuscate setae and irregular patches of pale woolly hairs.

Rostrum parallel, slightly arched, about a third shorter than thorax, pinched in at the base, beyond that shining and almost smooth. Thorax oviform, rather wider near the middle than elsewhere, rather longer than broad, base truncate ; it is closely, coarsely, and somewhat rugosely punctured, less distinctly in front. Elytra cordate, of the same width as thorax at the base, a good deal broader before the middle, narrowed and vertical behind, and only about a third longer than the thorax ; they are striate-punctate, distinctly so alongside the suture ; just before the middle, on the 3rd interstices, there is a pair of dark indistinct crests.

Legs elongate, tibiae slightly flexuous, the anterior rather slender ; tarsi not broad, 3rd joint a little dilated, scooped out above, but not perceptibly lobate, terminal elongate. Scape implanted behind the middle, a little bent, slender at the base, thickened apically ; funiculus longer than the scape, basal joint thick, 2nd only about half as large, 3–5 short, 6th and 7th transverse and bead-like ; neither of these half the breadth of the ovate club, which is triarticulate.

Easily recognizable by the pale woolly patches on the hind-body.

Length (rostrum exclusive), $2\frac{1}{4}$ mm. ; breadth, $1\frac{1}{3}$ mm.

Makatote. Unique. Another of the acceptable species picked out of the leaf-mould collected in February, 1910, by Mr. W. J. Guinness.

3329. **Zeacalles pictus** sp. nov. *Zeacalles* Broun, Ann. Mag. Nat. Hist., ser. 6, vol. 12, p. 379.

Compact, ovate, very convex, somewhat nitid, variegate ; rostrum shining, red, thorax rufo-piceous, elytra fusco-testaceous, legs obscure rufous, tarsi and antennae testaceous ; squamosity variegate, on the thorax rufescent, with a few grey scales, there are also four small dark bare spots ; on the elytra the squamae are more slender, fulvescent, and placed farther apart, small black ones form a pair of basal and median spots or minute crests, on the summit of the posterior declivity there is a pair of more prominent white crests, and smaller ones near the hind thighs, and across the declivity two black fasciae ; the setae are numerous, erect, and nigrescent.

Rostrum nearly smooth, with some linear impressions and punctures near its base, it is subparallel and rather shorter than the thorax. Eyes subovate, placed on the upper part of the head. Thorax conical, slightly broader than long, very gradually narrowed towards the front, base truncate ; the surface closely and distinctly punctured, more distantly in front. Elytra on an abruptly higher level than the thorax, of the same width as it is at the base, when examined sideways the height appears to exceed the length, the posterior declivity is vertical, the dorsum seems to be without sculpture, but the sides are obliquely sulcate.

Scape inserted just behind the middle, much shorter than the funiculus, gradually incrassate; 2nd joint of funiculus about the same length as the 1st, slender at its base, 3rd and 4th as long as broad, 5th and 6th moniliform, 7th transverse, broader than 6th, but not as broad as the club, which is oblong-oval and triarticulate.

Femora long and thick, tibiae nearly straight; 3rd joint of tarsi moderately dilated, excavate above but not perceptibly lobate.

The bright appearance, the distinct black spots and subapical bands, and the white crests on top of the posterior declivity are marks that will lead to its recognition.

Length (rostrum exclusive), $1\frac{2}{3}$ mm.; breadth, quite 1 mm.

Retaruke. Another rare ground-weevil that I picked out of leaf-mould collected for me by Captain H. S. Whitehorn; March, 1910. Unique as yet.

3330. **Zeacalles femoralis** sp. nov.

Compact, very convex, elongate-oval; rufo-piceous, legs fusco-rufous, rostrum rufous, antennae fulvescent; covered with small squamae varying in colour from yellowish to white, those of the latter hue forming a semicircular streak on each elytron from the middle of the base towards the suture, near the base this streak is bordered inwardly with fuscous scales; the setae are erect, rather coarse, and vary from grey to brown.

Rostrum rather shorter than thorax, finely and distantly punctate in front, with yellowish scales behind. Thorax conical, about as long as broad, moderately finely and not closely punctured, the scales yellowish, but with grey ones forming an indefinite streak along the middle and another near each side. Elytra of the same width as the thorax at the base, wider near the middle, twice its length, on a higher plane, vertical behind; with some small dark spots on the apical declivity and sides, and on the top of the former, near the suture, with a pair of small nodosities which, bearing dark setae, appear more prominent than they are in reality; the suture is sharply marked, but no distinct striae or punctures are visible.

Femora thick and elongate, and, like the tibiae, bearing numerous erect coarse greyish setae.

Rather larger than *Z. binodosus* (3139), with much less conspicuous nodosities, and lacking the distinct elytral striae. The penultimate tarsal joint is less expanded, the antennae are rather longer though similar in structure, but the outstanding setae on the femora are different. The dilatation of the hind-body and the presence of small sublateral nodosities distinguish 2958.

Length (rostrum exclusive), $2\frac{1}{2}$ mm.; breadth, $1\frac{1}{2}$ mm.

Mount Greenland, near Ross; elevation, 2,500 ft. One of Mr. H. Hamilton's captures, sent to me by Mr. O'Connor.

3331. **Onias irregularis** sp. nov. *Onias* Broun, Ann. Mag. Nat. Hist., ser. 8, vol. 4, p. 153.

Subovate, convex, nitid, nigro-piceous, legs obscure fuscous, tarsi and tip of rostrum slightly rufescent, antennae pale ferruginous, club darker;

sparingly clothed with pale-brown and somewhat fulvescent depressed squamae, and numerous outstanding elongate infuscate setae.

Rostrum slightly and gradually narrowed medially, fully a third shorter than thorax, very little arched, smooth but not perceptibly carinate along the middle, finely punctate in front. Thorax slightly longer than broad, widest and moderately rounded behind the middle, more, yet gradually, narrowed anteriorly than behind, the base bisinuate; it is coarsely and closely punctured, broadly impressed along the middle, with a very slender carina along the centre of the impression. Elytra cordate, of about the same width as the thorax at the base, much broader and rounded at the middle, a good deal contracted and nearly vertical behind; they are very coarsely and irregularly striate-punctate, some of the punctures coalesce and form deep abbreviated grooves, the sutural striae are more distinct behind; 3rd interstices elevated from the base to the middle, less so behind, with, on each, a nodosity just below the top of the posterior declivity.

Scape inserted immediately behind the middle and attaining the front of the eye, gradually thickened; 2nd joint of funiculus nearly as long as but much more slender than the basal, joints 3–6 subquadrate, 7th rather larger than 6th; club ovate, densely pubescent, triarticulate, basal joint largest. Legs stout and elongate. Tarsi rather slender, penultimate joint a little dilated, with short lobes.

Instead of being regularly striate-punctate alongside the suture of the elytra as in 2967, *O. latisulcatus*, the sculpture on some spots seems like deep interrupted grooves, the punctures themselves are coarser, the thoracic impression is less sulciform, and the scales are more scanty.

The longitudinal thoracic impression, with its fine central carina, is characteristic of the genus.

Length (rostrum exclusive), $2\frac{1}{3}$ mm.; breadth, quite 1 mm.

Erua, near Waimarino. I found one in January, 1910, and obtained another in a bagful of decaying leaves sent to me by Mr. W. J. Guinness in April.

Xenacalles gen. nov.

Body squamose, subfusiform. Head immersed up to the eyes. Thorax conical, its base truncate, with ocular lobes. Scutellum distinct. Elytra rather broader than thorax at the base, elongate-cordate, somewhat laterally compressed behind.

Rostrum about as long as thorax, subparallel, moderately arched. Scrobes lateral, deep, extending from the middle to the eyes. Scape inserted at or near the middle, according to sex; it attains the eye. Funiculus 7-articulate, longer than the scape, 2nd joint about as long as the 1st, 3rd and 4th rather longer than broad, joints 5–7 moniliform, increasing in width. Club well marked, ovate, triarticulate, basal joint largest. Eyes large, subdepressed, subrotundate. Femora elongate, simple. Tibiae uncinate. Tarsi rather slender; their penultimate joint moderately expanded and bilobed, their soles hairy, not at all sponge-like.

Pectoral canal profound, extending to the middle of the intermediate coxae in *X. triangulatus*, and to the front of the metasternum in *X. squamiventris*, bounded behind by the raised margins of the mesosternum, quite cavernous there. Anterior coxae placed at the base of the prosternum. Metasternum not longer than the 2nd ventral segment; the 1st angulate in front, a third longer than 2nd, its hind suture straight; 3rd and 4th together evidently longer than 2nd; the 5th not quite as long as the basal.

The well-developed scutellum, long unarmed femora, elongated abdomen, and the structure of the rostral canal distinguish this genus from *Acalles*, *Crisius*, and other cognate forms. The type is 1427, now *X. triangulatus*, to which must be added a species, *X. squamiventris*, recently discovered at the Chatham Islands.

3332. **Getacalles substriatus** sp. nov. *Getacalles* Broun, Man. N.Z. Coleopt., p. 1380.

Suboblong, convex, opaque; piceous, legs obscurely rufescent, antennae and tarsi ferruginous; squamosity dense, dark fuscous and tawny, the paler scales cover most of the front part of the thorax and basal half of the elytra; the short erect setiform squamae form about a dozen small pale crests on the posterior half of the elytra; the suture, behind the middle, bears small reddish-brown scales; the legs are clothed with greyish and fuscous coarse erect squamiform setae.

Rostrum stout, parallel, moderately arched, nearly a third shorter than thorax, closely punctate and finely setose near the apex, thickly covered with suberect short squamae from the antennae backwards. Head immersed up to the eyes, glabrous and reddish underneath. Thorax rather broader than long, its frontal half abruptly contracted; it is densely squamose so that its punctation is invisible, the erect scales do not form distinct crests, across the basal margin there is a streak formed of small somewhat flavescent squamae. Scutellum greyish. Elytra with obtusely porrect shoulders, a little broader at the base than the thorax, slightly wider behind, more than twice its length, posterior declivity a good deal narrowed and vertical; the dorsum is a little uneven, with unequal crests, and almost striate-punctate.

Underside distinctly but not very closely punctured, covered with greyish or tawny scales, but with a dark-fuscous patch at each side of the intermediate ventral segments and a quadrate spot at the apex of the 5th. The metasternum is short, hardly as long as the 2nd segment. Pectoral canal deep, extending as far as the middle of the intermediate coxae, and quite cavernous there.

Scape moderately slender, inserted between the middle and apex, barely reaching the eye. Second joint of the funiculus as long as the basal, joints 3–6 subquadrate, 6th rather broader than 3rd, 7th obconical, larger than 6th. Club oblong-oval, triarticulate.

It is larger than the type of the genus (2410), more variegated, and with more definitely striate elytra.

Length (rostrum exclusive), 4 mm.; breadth, 2 mm.

Martinborough, near Wellington. A pair found under a log in September, 1910, by Mr. A. O'Connor.

Group COSSONIDAE.

3333. **Pentarthrum impressum** sp. nov. *Pentarthrum* Wollaston, Man. N.Z. Coleopt., p. 508.

Nitid, rufous, club fulvescent; sparingly clothed with slender yet distinct yellow hairs.

Rostrum parallel, quite half the length of thorax, with a broad median impression between the antennae and eyes, rather coarsely punctate, more finely in front. Occiput nearly smooth. Thorax a third longer than broad, gradually narrowed towards the distinct frontal constriction; with a broad mesial impression extending from base to apex, its whole surface moderately coarsely and closely punctate. Scutellum subquadrate, smooth. Elytra subcylindrical, slightly broader than thorax at the base, quite twice its length. apices singly broadly rounded; they are evidently punctate-striate, interstices finely seriate-punctate and rugose.

Scape straight, gradually thickened, medially inserted, attaining the middle of the eye; 2nd joint of funiculus a trifle longer than 3rd, but shorter than 1st, joints 3–5 transverse; club oblong-oval but not elongate, obsoletely annulate. Legs and tarsi of normal structure.

This cannot be made to accord with Wollaston's diagnosis of *P. subsericatum.* The rostrum is just a little longer than that of the male *P. zealandicum*, the scape is rather shorter, and the insect itself is more slender. Its discrimination is comparatively easy, owing to the quite obvious pubescence and longitudinally impressed rostrum and thorax.

♂. Length (rostrum inclusive), quite 3 mm.; breadth, $\frac{2}{3}$ mm.

Wairiri, Kaikoura. A single male found by Mr. W. L. Wallace. It should be placed in sect. 1, "Revision of New Zealand Cossonidae," p. 156 (Trans. N.Z. Inst., vol. 41), but the vestiture renders it somewhat aberrant.

3334. **Pentarthrum tenebrosum** sp. nov.

Subcylindric, narrow, slightly nitid; rufo-piceous, tarsi and antennae dark red; pubescence elongate and slender, sparingly distributed, yellow.

Rostrum subparallel, very slightly contracted near the base, truncate at apex, a third shorter than thorax, distinctly punctured, finely in front, more closely and coarsely near the eyes. Occiput smooth. Thorax quite as long as broad, posterior angles rounded, its sides gradually narrowed towards the well-marked frontal constriction; disc broadly flattened along the middle, moderately coarsely but less closely punctured than the sides, apex smooth. Scutellum smooth. Elytra not at all broader than thorax, twice its length, cylindrical, apices obtusely rounded; they are rather closely and distinctly punctate-striate, the 3rd and 4th striae, however, are rather shallow, interstices seriate-punctate and rugose. Legs with flavescent hairs; 3rd tarsal joint but little dilated, and not perceptibly lobed.

Scape medially inserted, straight, reaching backwards to front of eye: 2nd joint of funiculus shorter than 1st and not sensibly longer than 3rd, which, like the 5th, is transverse; club pubescent, oblong-oval, not elongated, obsoletely annulate.

The rostrum is rather longer than that of the female *P. zealandicum* and much more distinctly sculptured, the eyes are a trifle more prominent, the legs are more slender, and the body smaller and narrower. The short scape, dark colour, and bright pubescence are distinctive. Though somewhat similar to the recently described *P. auripilum* from Pitt Island, this is discriminated by its medially flattened, more closely and coarsely punctate, and deeply constricted thorax.

♀. Length (rostrum inclusive), $3\frac{1}{3}$ mm.; breadth, $\frac{2}{3}$ mm.

Wairiri, Kaikoura. Unique. Discovered by Mr. W. L. Wallace.

Group Anthribidae.

3335. **Eugonissus turneri** sp. nov. *Eugonissus* Broun, Man. N.Z. Coleopt., p. 1257.

Oblong, subopaque, variegate; fuscous, legs and antennae fusco-testaceous, the club and tips of joints 3–8 more or less infuscate, as are also the extremities of the tibiae and basal joints of the tarsi ; head and thorax sparingly clothed with yellowish pubescence, which is more slender on the former : elytra with a broad lateral area, on each, before the middle, and irregular spots behind similarly pubescent.

Rostrum short and broad, flat, medially emarginate in front, moderately coarsely and closely and somewhat rugosely punctate ; it is obscurely rufescent. Thorax of about equal length and breadth, its sides medially rounded, a little narrowed anteriorly and with a slight sinuosity behind; the sculpture is ill defined, appearing to consist of irregular linear elevations and punctures ; the basal carina is almost in contact with the elytra, slightly sinuate towards the sides, and forming acute posterior angles which are directed backwards but do not extend outwardly beyond the shoulders. Scutellum small. Elytra oblong, just perceptibly wider behind than at the base, with truncate apices ; they are moderately striate-punctate, the flavescent space on each is broadly impressed, and the basal nodosities when examined sideways appear prominent, there are no other distinct inequalities ; the sutural region and shoulders are somewhat rufescent.

Antennae quite half the length of the body, very scantily pubescent ; basal joint stout and suboblong, 2nd pyriform, its basal half slender, as long as the 1st ; joints 3–7 elongate, gradually decreasing in length, 8th evidently smaller than 7th yet elongate ; 9th elongate-triangular, 10th about as long as broad, rounded towards its base, 11th conical, slightly longer than its predecessor, these three articulations form the well-marked pubescent club.

Eyes prominent, rotundate, without any discernible frontal excision. Pygidium somewhat inflexed.

This is the smallest member of the genus. The others are 2215, 976, and 977. It is easily known by the unusual shape of the thorax.

Length, $2\frac{1}{2}$ mm. ; breadth, quite 1 mm.

Huia, Manukau Harbour. One found during November, 1909, by Mr. Bert Turner or myself. It has been named after Mr. Turner, who assisted me when searching for beetles on his father's property.

3336. Eugonissus sylvanus sp. nov.

Fuscous, the legs and basal three joints of antennae fusco-rufous ; the intermediate joints of the tarsi, the extremity of the 3rd of the antennae, and the whole of joints 4–11 fuscous ; the vestiture variegate, on the head and rostrum chiefly grey, of similar colour in front and along the middle of thorax, but not sharply definite there ; the elytra irregularly covered with grey pubescence along the middle, near the extremity there is a broad dark space, another at each side behind the shoulder, and smaller spots along the dorsum, near the sides the clothing is of a pale fusco-rufous hue mixed with some grey.

Head and rostrum together about as long as thorax, rather broad and nearly plane. Thorax slightly broader than long, widest at the base, gradually narrowed anteriorly, its punctation moderately coarse and close ; the basal carina almost contiguous with the elytra, obtusely and only very slightly prominent at the middle, just a little sinuate towards the sides, and terminating as acute lateral angles. Scutellum small, grey. Elytra oblong, each a little rounded at the base, seriate-punctate, with a dark slightly raised nodosity on each near the base, and another slight elongated elevation extending from the hind thigh backwards.

Tarsi elongate, basal joint longer than 2nd and 3rd combined ; claws rufescent, distinctly toothed at the base. Eyes entire apparently, but with some short grey setae encroaching on them in front. Antennae inserted at the sides of the rostrum near the eyes.

Resembles *E. proximus* (977), which differs in vestiture, and may be separated by the absence of the dark posterior space, and by the white pubescence extending from each shoulder and along the middle of the elytra nearly to the apices.

Length, $3\frac{1}{2}$ mm. ; breadth, $1\frac{1}{4}$ mm.

Silverstream, near Wellington, and Waimarino. Mr. A. O'Connor sent me a specimen captured at the former locality ; and, at the latter, two were found by myself, on different trees, at a height of 2,700 ft., in January, 1910.

3337. Anthribus cornutellus sp. nov. *Anthribus* Geoffroy, Man. N.Z. Coleopt., p. 545.

Fuscous, legs and antennae fusco-rufous, the middle of the tibiae and apices of the tarsal joints fuscous ; vestiture variegate, the head and rostrum with yellowish hairs, but with a grey patch between the eyes and antennae ; thorax with irregularly distributed pubescence so that some parts are nearly bare, the yellowish hairs most numerous along the middle ; elytra still more variegated, yellowish hairs predominate, on the elevated parts particularly, but broad longitudinal streaks are formed of alternate blackish and nearly white spots.

Head and rostrum as broad as the front of thorax and almost as long as it is, with a pair of distinct spiniform tubercles midway between the eyes and antennae. Eyes semicircularly emarginate in front. Thorax of equal length and breadth, widest behind the middle, its sides moderately rounded, the disc distinctly and closely punctured ; the carina is distant from the elytra, angulate in front of the scutellum, oblique and indistinctly sinuate towards each side, obtusely angulate there, and extending along the side nearly as far as the middle, where it ends abruptly Scutellum yellowish, small. Elytra oblong, uneven, with, on each, a large basal, a post-median, and a pair of much smaller subapical nodosities ; their punctation moderately fine, close, and seriate.

Antennae about a fourth longer than the body, their basal two joints short and thick, and densely pubescent ; joints 3–8 elongate, decreasing gradually in length, somewhat nodiform at the extremity ; the 9th as long as the 8th and very gradually expanded, 10th and 11th longer than broad, 11th with a terminal appendage or false joint.

Nos. 969, 970, 1317, 2228, and 2229 are congeneric or nearly related. This is the most distinctly marked species of the series.

Length, 6 mm. ; breadth, 2 mm.

Tarukenga, near Rotorua. I found a male many years ago, just before the railway was formally opened for traffic.

3338. Anthribus levinensis sp. nov.

Variegate, to a great extent rufo-fuscous, the elytra particularly, legs fusco-testaceous, the middle of tibiae and the tips of tarsal joints blackish; antennae fusco-rufous, their basal two joints and the apex of the 3rd densely pubescent ; head and rostrum thickly covered with greyish-yellow hairs mixed with some of a light brown ; this latter colour is the prevailing tint of the thorax, but yellowish ones form an indefinite streak along the middle and a shorter one across it; on the elytra the pubescence is chiefly reddish-brown, with lines of grey and black spots, the dark spots being most conspicuous near the sides and apices.

Head with a pair of horn-like tubercles. Eyes just free from thorax, very prominent behind, not deeply emarginate in front, but with their inner portion projecting forwards further than that of the outer. Antennae not twice the length of the body, joints 3–7 elongate and more or less nodiform at the extremity, 9th as long as 8th and slightly expanded apically, 10th and 11th rather longer than broad. Thorax about a third broader than long, closely punctate; the carina distant from the elytra, angulate, but not sharply, in front of the scutellum, extending obliquely forwards towards the sides, obtusely angulate there, prolonged nearly half-way along the sides and terminating abruptly, so that there appears to be a small notch there. Scutellum greyish-yellow. Elytra oblong, vertical behind, finely substriate-punctate; with a large elongate callosity on each near the base, another near the posterior femur, and a third, much less elevated, on top of the declivity.

The alternate black and grey maculation of the hind-body is similar to that of *A. cornutellus*, but it may be readily separated from that species by its smaller size, shorter thorax, and different eyes. *A. decens* is much less darkly variegated, its legs and antennae are concolorous, the median elytral nodosity and the tubercles on the head are much smaller, the eyes are less convex behind, and their inner portion does not project further than the lower.

Length, $4\frac{3}{4}$ mm.; breadth, $1\frac{2}{3}$ mm.

Levin, near Wellington. Found by Mr. A. O'Connor.

3339. Anthribus obscurus sp. nov.

Opaque, fusco-piceous, unevenly clothed with obscure yellowish-grey pubescence, legs and antennae pale fuscous, but with joints 10 and 11 and the apex of 3–9 dark, the middle of the tibiae also dark fuscous.

Head and rostrum about as long as the thorax, and nearly as broad as its apex. Eyes prominent, entire, subrotundate, just free from thorax. Antennal cavities deep and close to the eyes. Antennae rather longer than the body, basal two joints short and stout, with grey pubescence, joints 3–8 moderately elongate, 9th about as long as the 8th and gradually thickened, 10th and 11th rather short. Thorax a third broader than long, closely punctured; its carina obtusely angulate in front of the scutellum, oblique towards each side, nearly rectangular there, and prolonged forwards almost to the middle. Scutellum small, grey. Elytra oblong, twice the length of thorax, finely seriate-punctate; each elytron with a moderate basal nodosity, and a slight longitudinal elevation of the 3rd interstice behind; when examined sideways there appears to be a transverse depression before the middle.

The form of the eyes at once differentiates this from *A. levinensis* and its allies. The thoracic carina is more contiguous to the elytra and forms rectangular, though not acute, posterior angles, characters which, together with the subrotundate eyes, show that it is congeneric with our northern *A. deterius* (2232).

Length, $3\frac{1}{2}$ mm.; breadth, $1\frac{1}{4}$ mm.

Silverstream. My specimen is another of the numerous discoveries made by Mr. A. O'Connor.

3340. **Anthribus wairirensis** sp. nov.

Oblong, subopaque, variegate; piceo-fuscous, legs and antennae testaceous, the tibiae and tarsi with dark spots; pubescence greyish, unevenly distributed.

Rostrum broad, shorter than thorax, flat in front, transversely impressed between the antennae and eyes, closely punctate. Thorax slightly broader than long, its basal portion abruptly, the anterior gradually, narrowed; it is moderately coarsely and closely punctured; the carina is distant from the elytra, obtusely angulate in the middle, bent, but not forming sharp posterior angles, and extending forward only about a fourth part of the length of the sides. Elytra oblong, irregularly and rather finely seriate-punctate, each elytron with a large basal and post-median nodosity, and a smaller contiguous pair in line with the others on the summit of the declivity.

Antennae evidently elongate, their 5th joint reaching backwards to the middle of the elytra, the others broken off, 3rd joint distinctly longer than 4th.

Allied structurally to *A. laetabilis* (2231), but much darker, less brightly variegated, and smaller. The eyes less prominent in front and with a small semicircular notch there. The thoracic carina a little farther from the true base. The hind legs are shorter. The nodosity behind the middle of each elytron is more prominent. *A. impar* is perhaps the nearest species, but it, too, is prettily variegated, and its antennae are shorter.

Length, $3\frac{1}{2}$ mm.; breadth, $1\frac{1}{4}$ mm.

Wairiri, Kaikoura. A single male found by Mr. W. L. Wallace.

Group Cerambycidae.

3341. **Didymocantha media** sp. nov. *Didymocantha* Newman, Man. N.Z. Coleopt., p. 568.

Elongate, moderately nitid, very sparsely clothed with pale slender hairs; head and thorax testaceous, elytra, legs, and antennae much paler.

Head impressed between the antennae, rather more closely punctured there than it is behind; it is distinctly angulate, or produced in front of each eye. Thorax of equal length and breadth, but only a fifth of the length of the elytra, with distinct median lateral tubercles, the frontal small or obsolete; its discoidal punctures rather coarse, irregularly distributed and rufescent, but becoming finer near the apex; behind the middle there is an almost smooth space, another elongate slightly raised one near each side, and a pair of smaller ones near the front, but none of these are definitely marked, and there are no discoidal tubercles. Elytra subparallel, very gradually narrowed backwards, with separately rounded apices; they are rather coarsely but not closely or quite seriately punctured as far as the hind thighs, more sparingly behind these, the punctures are reddish, there are no vein-like marks, but a pair of very oboslete costae may be detected on each elytron.

Antennae distinctly pubescent throughout, basal joint punctate, 4th of about the same length as the contiguous ones, the 9th attains the apex.

The greater length and rufescent punctures differentiate this from *D. aegrota*, whilst the double armature of the sides of the thorax and ivory-like lines on the elytra distinguish my *D. pallida*.

♀. Length, 14 mm.; breadth, $3\frac{1}{2}$ mm.

Silverstream. My specimen is one of Mr. A. O'Connor's novelties.

Obs.—Since the above description was written a male specimen has been received from Mr. O'Connor.

Male.—Thorax longer than broad, oviform, with minute lateral tubercles, a median and frontal; its surface finely and closely punctured, with, near each side, an elongate slightly raised space bordered by coarser punctures; and another smooth linear area behind the middle. The 7th joint of the antennae extends beyond the extremity of the hind-body.

3342. **Didymocantha oedemera** sp. nov.

Subdepressed, elongate; head and thorax opaque, fuscous; elytra nitid, also fuscous, but with the following testaceous marks: 1st lateral, situated behind the shoulder, oblong; 2nd large, elongate at the side, and curved inwards and backwards, but not reaching the suture; 3rd much shorter than the 2nd at the side, extending obliquely forwards and as far inwards as, but not touching, the 2nd; 4th apical, almost in contact with the suture: base of the femora and upper half of the tibiae testaceous, their other portions rufo-fuscous; antennae and tarsi infuscate red; sparingly clothed with erect, rather elongate, yellowish hairs.

Head vertical and obscurely rufescent in front, distinctly and closely punctate. Thorax of about equal length and breadth, its sides moderately rounded, and a good deal narrowed near the base; disc nearly plane, closely punctured, the basal sculpture granular or transversely rugose; it is entirely destitute of lateral or discoidal prominences. Scutellum densely and very minutely sculptured, almost nude. Elytra broader at the base than the middle of the thorax, more than thrice its length, with strongly singly rounded apices; their surface flat, closely and distinctly punctured at the base, the punctures becoming more distant and shallow towards the extremity, but not obliterated even there.

Antennae finely pubescent, and bearing some longer hairs near the base, they just reach the extremity of the body, their 4th joint quite half the length of the 5th, which is slightly longer than the 3rd. Femora extremely slender and stalk-like basally for half their length, but very strongly clavate, the middle pair almost bulbous, near the extremity; intermediate tibiae distinctly curvate.

This species stands alone, owing to the very remarkable structure of the thighs and the total absence of inequalities on the thorax.

Length, 7½ mm.; breadth, 2 mm.

Clevedon, near Auckland. The unique specimen was captured by a lad, William Horne, of Devonport.

3343. **Didymocantha fuscicollis** sp. nov.

Elongate, slightly nitid, very scantily clothed with elongate slender greyish hairs; head and thorax rufo-fuscous, elytra infuscate testaceous, the suture and scutellum nigrescent, legs and antennae pale testaceous, but with the basal joint of these latter rufescent.

Head distinctly and closely punctate, finely sulcate along the middle, its sides, in front of the eyes, acutely prominent. Thorax of about equal length and breadth, its sides not evenly rounded, there being a distinct median tubercle and a very slight prominence near the front; it is irregularly punctured, very coarsely and rugosely at the sides, closely and rather coarsely on the disc, more finely at the base; there is a slightly raised median line, and another, but shorter one, between it and each side; near the front there is a pair of rounded, but not smooth, obtuse elevations. Scutellum depressed and smooth in the middle, finely punctate and pubescent at the sides. Elytra very slightly narrowed posteriorly, nearly five times the length of thorax, evidently broader than it is at the base, apices, conjointly, rounded ; their punctures are reddish, evenly distributed but not seriate, they are not very coarse or close and are much finer at the apices ; each elytron is indistinctly bicostate, the suture is sharply marked nearly to the extremity.

Antennae finely pubescent, their basal half with longer pale hairs ; 1st joint punctate, 3rd and 4th of about equal length, the 10th reaches the extremity of the elytra.

Underside fuscous, with slender grey pubescence. Prosternum finely transversely rugose and punctate ; 5th ventral segment ciliate and, as well as the short 6th, truncate at the apex. Palpi short and quite pallid.

The thoracic sculpture, sharply defined elytral suture, and dark head and thorax are good distinguishing characters.

♀. Length, 13 mm. ; breadth, 3½ mm.

Wallacetown. A single female from Mr. A. O'Connor; probably from Mr. Hamilton's collection.

Group Lamiidae.

3344. **Somatidia thoracica** sp. nov. *Somatidia* Thomson, Man. N.Z. Coleopt., p. 600.

Variegate, slightly nitid ; the sides of thorax, the shoulders, a broad space extending from the side of each elytron to the suture and along it to the apex more or less dark fuscous ; the sides of the posterior declivity, a broad oblique space across each elytron before the middle, and an irregular area between the middle and each side of the thorax obscure fusco-testaceous, and clothed with depressed short greyish hairs, the darker areas, including the middle of thorax, with infuscate pubescence ; these dark and pale spaces are not always sharply defined and are more or less spotted.

Thorax as long as broad, with nearly straight sides for two-thirds of the length, narrowed near the base, with a transverse impression near the front ; disc a little uneven, with a pair of slight elevations near the middle, and a small almost white crest at each side towards the base ; there are only a few coarse punctures above, but they become more numerous at the sides. Scutellum triangular, infuscate. Elytra oviform, of the same width at the base as the thorax, quite twice its length, the greatest breadth near the middle ; on each there is a small, yet distinct, dark crest rather farther from the base than it is from the suture, and a smaller pair on the hind margin of the pale area ; the punctation is moderately coarse but not close on the basal half, finer and subseriate towards the extremity, and somewhat oblique near the sides.

Femora clavate, shining, pale brown, with some very fine greyish pubescence. Tibiae testaceous, with 2 fuscous spots, the base reddish, their pubescence most distinct near the extremity.

Antennae testaceous, but with nearly the whole of the 3rd joint and the apex of joints 4–11 fuscous, the 2nd rufescent, the 4th is almost as long as the 3rd.

The nearest species is *S. picticornis*. The shape and sculpture of the thorax, broad scutellum, and general coloration are, however, different.

Length, 5½ mm. ; breadth, 2½ mm.

Mount Greenland. Mr. A. O'Connor forwarded a specimen which was found by Mr. H. Hamilton.

3345. **Somatidia nodularia** sp. nov.

Elongate, convex, moderately nitid; fuscous, the elytra and base of femora paler and more rufescent; tibiae and tarsi testaceous, the base and a small subapical spot on the former dark fuscous; antennae castaneo-rufous, joints 5–10 sometimes testaceous with the apical half of each infuscate; vestiture fine and variegate.

Head vertical, sparingly punctate and pubescent in front, darker, concave, and nearly glabrous between the antennae. Thorax slightly longer than broad, convex, widest and evidently rounded near the middle; irregularly punctate, rather coarsely near the middle, where there is a pair of slight nodiform elevations, less coarsely but more closely behind; pubescence cinereous, but more distinct and quite yellow at the middle of the base, and sometimes in front also. Scutellum elongate, with fine yellowish or grey pubescence. Elytra quite double the length of the thorax, of the same width as it is at the base, widest at the middle; they are more coarsely punctured than the thorax, but the punctation becomes finer and much more distant on the posterior slope; on each, behind the shoulder, there is an elongate narrow elevation, another but more prominent one before the middle at some distance from the suture, and a much less obvious one on top of the hind slope; the pubescence is scanty, rather slender, somewhat curled, and ash-coloured on the disc but more conspicuous and yellowish behind; on the apical portion there are some faint greyish spots and erect setae.

Antennae finely pubescent and bearing some longer hairs like those on the legs, their 4th joint evidently shorter than 3rd yet longer than 5th; they nearly attain the extremity of the body.

Male.—Fifth ventral segment not longer than 4th, strongly curved at the extremity, 6th short.

Female.—5 mm. by 2 mm.; 5th segment medially impressed.

Quite as elongate, narrow, and convex as the male of *S. angusta* (1052), which, without reference to other details, may be at once distinguished by the finer and dense punctation of the thorax. and by the absence of nodules there.

♂. Length, 6 mm.; breadth, 2 mm.

Erua. Found amongst leaves on the ground, at an elevation of 2,400 ft., by Mr. W. J. Guinness and myself; the female by Captain H. S. Whitehorn at the head of the Retaruke River a couple of months later, March, 1910.

3346. **Somatidia discoidea** sp. nov.

Subopaque, rather broad, moderately convex, variegate.

Head black but not smooth behind. Thorax of equal length and breadth, with moderately rounded sides; the disc, on the middle, with a shallow impression, and at each side of this, with a dark, smooth, but scarcely elevated spot, near the front there is a slight transverse impression; its punctation moderately coarse but not close, more regular and closer at the sides; on the centre of the base there is a conspicuous angular patch of yellow hairs, and a smaller one at the apex, the rest of the pubescence is greyish, the ground-colour reddish-brown. Scutellum triangular, greyish. Elytra moderately convex, of the same breadth as thorax at the base, a good deal broader in the middle; their basal portion dull fuscous and coarsely punctured; the broad space between that and the posterior declivity is pale testaceous and less distinctly punctate; the top of the declivity is marked with light fuscous, which colour extends backwards, but less definitely, near the sides, and becomes spotted with grey pubescence near the apex; the enclosed central space is pale and somewhat maculate, it is distinctly but not closely punctured, and bears some dark erect setae; on each elytron there are 2 small elevations or crests, the first before the middle, the other at the summit of the hind slope.

This species is more robust than *S. nodularia*, and differs from it in the broad interantennal space, different vestiture, sculpture, and coloration, the less basally narrowed thorax, and the very broad process between the intermediate coxae.

Length, $6\frac{1}{2}$ mm.; breadth, $2\frac{1}{2}$ mm.

Erua. The unique specimen was found amongst some leaf-mould collected and forwarded to me by Mr. W. J. Guinness in March, 1910.

3347. **Somatidia posticalis** sp. nov.

Subopaque, fusco-niger, with an irregular, more or less maculate, area between the hind thighs covered with grey pubescence, the whole of the dark hind slope spotted with grey; tarsi and tibiae flavescent, the latter with a small subapical spot and their basal half fuscous; antennae with the basal joints fusco-rufous and feebly speckled, the remainder testaceous at the base but fuscous beyond it.

Head densely covered with yellowish pubescence in front, and with a few small but distinct punctures, the interocular space broad and quite black. Thorax slightly broader than long, widest before the middle, moderately narrowed backwards; the disc irregularly, moderately, but not closely punctured, and with a broad median impression. Scutellum greyish. Elytra of the same width as thorax at the base, more than twice its length, gradually dilated towards the middle; they are irregularly but not coarsely punctate; on each there are three small specks of brassy pubescence, and there are also a few erect setae on the hind slope.

Antennae not quite reaching the extremity of the body, their 4th joint shorter than the 3rd, but longer than the 5th.

An easily identified species, owing chiefly to the almost uniformly nigrescent and mottled surface. The thorax, before the middle, at each side of the central impression is convex, so that its frontal portion seems a little depressed. There is a fine line along the back of the head. The labrum is reddish, with elongate flavescent setae. There is no trace of the scutiform mark on the hind slope seen in *S. antarctica* and its allies.

Length, $6\frac{1}{2}$ mm.; breadth, $2\frac{1}{2}$ mm.

Wairiri, Kaikoura Range. My specimen was found by Mr. W. L. Wallace.

3348. **Somatidia corticola** sp. nov.

Subopaque, rather broad, moderately convex; dark fuscous, tibiae and tarsi obscure testaceous, sometimes quite infuscate; antennae also variable, fusco-rufous, or much darker, and mottled with greyish pubescence; the body with yellowish-grey pubescence and some erect setae, but the humeral region, a broad irregular fascia behind the posterior femora, and a much interrupted but not scutiform subapical area are dark fuscous.

Head distinctly and moderately closely punctured, broad and unimpressed between the antennary orbits. Thorax rather broader than long, wider before the middle than elsewhere, rather closely and coarsely punctate;

at each side, behind the middle, there is a minute crest. Elytra of the same width as the thorax at the base, twice its length, much broader near the middle; their punctation irregular, but rather finer and much more distant than that of the thorax, and becoming even more remote and indistinct towards the extremity.

Femora maculate, with slender setae, those on the tibiae paler and much coarser.

Male.—Antennae similar to those of *S. latula*, but in the other sex the 3rd articulation is only about a third longer than the 4th.

This belongs to the *S. antarctica* series, the antennary orbits being but little elevated, and the interval broad and plane. It is most like *S. latula*, which, however, is brighter, with fulvescent vestiture.

♀. Length, 6 mm.; breadth, 2½ mm.

Wairiri, Kaikoura Range. We are indebted to Mr. W. L. Wallace for the discovery of this species, which he found under bark.

3349. **Somatidia pinguis** sp. nov.

Robust, slightly nitid, rufo-fuscous, legs and antennae of a reddish-chestnut hue and hardly at all variegated; pubescence yellowish, moderately slender and depressed; the middle of thorax and elytra nearly nude, these latter, on the derm itself, with several small crimson marks, some linear, others rotundate; tibiae and tarsi with numerous coarse pale hairs.

Head distantly but not coarsely punctate, the vertex broad and plane. Thorax a third broader than long, rather more narrowed behind than in front, its sides somewhat rounded, with some coarse scattered punctures, but nearly smooth along the middle and in front. Scutellum triangular. Elytra nearly thrice the length of thorax, and a little broader than it is at the base, wider just before the middle; a shallow sutural stria begins near the hind thighs but does not reach the apex; there is also on each elytron a sutural series of distant moderate punctures extending to the top of the hind slope, and a few irregularly placed ones on the basal region; there are no crests, only a very slight swelling of the surface on top of the slope, near the middle of each elytron.

Legs robust, femora clavate, intermediate tibiae not notched, claws thickened at the base. Antennae finely pubescent, and bearing longer hairs on their basal half, their 4th joint about a third shorter than its predecessors; they reach the extremity of the hind body.

Smaller than 2269, with more scanty and rather finer vestiture, without crests and the dark shield-like apical mark, and with more slender claws, &c.

Length, 7½ mm.; breadth, 3½ mm.

Mount Quoin. Taken off dead trees in October, 1909, at an elevation of 3,600 ft., by Mr. O'Connor.

3350. **Tetrorea maculata** sp. nov. *Tetrorea* White, Man. N.Z. Coleopt., p. 609.

Elongate, the derm shining fusco-niger; legs rufo-castaneous, more or less spotted with grey and fuscous pubescence, basal two joints of the tarsi dark at the extremity; antennae variegate, the basal four joints slightly rufescent and maculate, joints 5–11 greyish at the base, fuscous beyond it; thorax nearly covered with fusco-cinereous pubescence and several small blackish patches, the largest of which are basal; elytra with a broad oblique area on each extending from the shoulder to the suture in line with the hind thigh, covered with paler pubescence than that on the thorax, the space behind nearly similarly clothed but with irregular dull black spots; the largest of these are near the hind thigh and the apex; there are a few erect but not very elongate white setae on the antennae, legs, and posterior portion of the wing-cases.

Head distantly punctate in front, with some yellowish pubescence between the very prominent and subcontiguous antennal tubercles. Eyes large and only moderately separated above. Thorax nearly as long as broad, with prominent lateral tubercles; on the middle of the disc there is a pair of less prominent tubercles which, as well as most of the interval between them, are smooth and shining; just behind each of these there are 4 or 5 small black granules. Scutellum dark. Elytra thrice as long as thorax, evidently broader than it is at the base, their apices broadly rounded and not covering the terminal dorsal segment; the basal nodosities are not large, and are not crested, the light-coloured but somewhat spotted area on each is broadly depressed, and behind it there is a slight longitudinal costa; the basal punctation is distinct and rather close, it is seriate alongside the suture, but much coarser and more distant near the sides.

Underside fuscous, maculate, clothed with fine grey pubescence.

Femora very slender near the base, clavate near the middle; tibiae nearly straight. Antennae elongate, their 8th joint extending just beyond the extremity of the hind-body, the 5th reaches the posterior femora, the 3rd and 4th are equally elongate.

Length, 10 mm.; breadth, $3\frac{1}{2}$ mm.

Silverstream. Two were found under bark, in August, 1910, by Mr. H. W. Simmonds.

This, doubtless, is nearly allied to 2277, *T. sellata* Sharp. The very prominent and subcontiguous antennal tubercles, much less widely separated eyes, and broadly rounded elytral apices are not in conformity with the type of the genus.

3351. **Hybolasius cupiendus** sp. nov. *Hybolasius* Bates, Man. N.Z. Coleopt., p. 609.

Elongate, uneven, subdepressed, opaque, variegate; base of femora castaneo-rufous, tibiae and tarsi slightly viridescent, with dark and grey specks; antennae maculate with grey and brown, their basal four joints fusco-rufous, the others become somewhat viridescent towards the end, and, besides the usual fine pubescence, bearing slender elongate grey hairs; the body is fuscous, but densely covered with dark- and light-brown and grey pubescence; the elytra are more variegated than other parts, the suture is spotted with brown and grey, the apices are slightly tinged with green; a greyish-yellow, irregularly formed, oblique fascia extends inwards from each side, near the middle thigh, but does not reach the suture, and becomes light brown; this is narrowly bordered behind with dark fuscous but broadly in front; the slender greyish hairs on the legs are very long and conspicuous, on the intermediate tibiae there are some short blackish setae.

Head medially depressed, with a fine groove along the front. Antennae elongate, their 8th joint reaches the extremity of the body, 4th joint nearly twice the length of contiguous ones. Thorax rather broader than long, with a large but not acute prominence at each side just behind the middle and a pair of small ones on the disc before the middle: no punctation is visible. Scutellum with a pure-white speck at each side. Elytra tapering towards the apices, which are not at all dehiscent; on each there is a large basal prominence, another, which is only slightly raised but elongate, is situated near the hind thigh; their punctation is moderately coarse and close near the shoulders, more distant and subseriate along the middle, and becomes obsolete behind.

I have not seen *H. wakefieldi*, but have no doubt that this species is nearly allied; it is, however, distinguishable by the rufescent femora, greenish tibiae, and by the absence of large fulvous patches on the elytra. No. 2265 should also be placed in this genus; it is much smaller, and has a frontal groove along the middle of the thorax and a continuous one on the head.

Length, 7 mm.; breadth, $2\frac{1}{2}$ mm.

Silverstream. One of Mr. A. O'Connor's captures; evidently very rare.

3352. **Hybolasius tumidellus** sp. nov.

Subdepressed, rufo-piceous, legs and antennae pitchy red, apical half of tibiae and the tarsi dark fuscous; the clothing variegate, on the broadly depressed antemedian area of the elytra it is mostly yellow, quite greyish behind, but more scanty and apparently darker between the hind thighs without, however, forming a distinct fascia there; on the head and thorax the hairs are yellow, but much more slender than those on the wing-cases; the legs bear numerous outstanding white setae, the antennae a few darker ones.

Head short, minutely and closely granulate. Thorax a third broader than long, the sides obtusely prominent behind the middle, between these there is a pair of just-distinguishable discoidal swellings, its surface is finely and closely punctate-granulose. Elytra evidently broader than thorax at the base, $2\frac{1}{2}$ times its length, very gradually and slightly narrowed backwards; they are irregularly punctured, and have a pair of moderate basal nodosities.

Femora strongly clavate. Antennae elongate, basal joint thick, piceous, 2nd very small, 3rd and 4th very elongate, each nearly twice the length of the 5th, 6–11 gradually decrease in length.

Small allied species are rather numerous and difficult to discriminate, and are likely to become more so, as separate localities seem to produce different species. A careful perusal of the first part of the diagnosis will lead to the recognition of this species.

Length, 4 mm.; breadth, $1\frac{1}{3}$ mm.

Silverstream. One example from Mr. H. Simmonds, its discoverer.

3353. **Hybolasius rugicollis** sp. nov.

Piceo-rufous, with a darker transverse space at a little distance behind the posterior femora bu not forming a definite fascia, tarsi nigrescent; the pubescence grey, not thick, but conspicuous.

Head with a very distinct mesial sulcus. Thorax transversely quadrate, the outline only a little uneven, owing to the presence of a minutely granulated nodosity at each side behind the middle; it is closely and distinctly transversely rugose at the base and apex, irregularly and very finely on the middle, but granulose near the sides. Elytra distinctly punctured, more closely at the base than on the middle, more distantly towards the extremity, and without perceptible depressions or basal callosities.

Femora moderately dilated. Antennae of moderate length, their 3rd and 4th joints each nearly double the length of the 5th.

This species may be identified by a careful scrutiny of the thoracic sculpture.

Length, $3\frac{1}{2}$ mm. ; breadth, 1 mm.

Silverstream. Another of Mr. Hubert Simmond's captures.

Group EUMOLPIDAE.

3354. **Pilacolaspis angulatus** sp. nov. *Pilacolaspis* Sharp, Man. N.Z. Coleopt., p. 1305.

Convex, oblong, sparingly clothed with short suberect greyish hairs; pale brown or rufo-testaceous, faintly bronzed, legs testaceous, tarsi and antennae more rufescent.

Head distinctly but not coarsely punctate. Eyes just free from thorax, large and prominent, somewhat obliquely oval. Thorax rather narrower than elytra, a third broader than long, apex subtruncate, with slightly incrassate, deflexed, subrectangular angles, base slightly curvate; the sides distinctly margined, widest and angulate just behind the middle, gradually narrowed towards the front, rather abruptly and somewhat sinuously contracted behind, posterior angles subrectangular but obtuse; its whole surface closely but not coarsely punctured. Elytra oblong, curvedly narrowed towards the apices, shoulders a little elevated and nearly smooth; they are moderately coarsely but not seriately punctate, with an obtuse subapical elevation on each near the suture.

Legs stout, tibiae very finely setose, a little expanded towards the extremity, the posterior excavate there. Tarsi stout, 3rd joint deeply bilobed, claws appendiculate.

Underside testaceous, with slender greyish pubescence. Anterior coxae distinctly separated and placed close to the front of the prosternum; the other pairs rather more widely separated. Metasternum moderately elongate, convex, grooved behind. Abdominal process rather broad, not at all abruptly rounded or subangulate between the coxae.

Antennae stout, 2nd joint small and suboviform, 3rd as long as 4th.

The darker colour, medially angulate and densely sculptured thorax, and estriate elytra render it distinct from *P. latipennis.*

Length, $5\frac{1}{2}$ mm. ; breadth, $2\frac{1}{2}$ mm.

Dun Mountains, Nelson. Two from Mr. H. W. Simmonds.

3355. **Pilacolaspis latipennis** sp. nov.

Oblong, subdepressed above, nitid, with slender greyish pubescence; rufo-testaceous, very slightly aeneous, legs testaceous.

Head, including the large prominent eyes, as wide as the front of thorax, finely, somewhat irregularly, but not closely punctured, with a shallow interocular impression. Thorax scarcely twice as broad as long, apex truncate, with obtuse, nearly rectangular angles; its sides finely margined, rather wider near the middle than elsewhere, gradually and slightly narrowed anteriorly, with a distinct sinuosity near the obtusely rectangular posterior angle; the base medially feebly emarginate; its surface slightly uneven, moderately closely but not coarsely punctate. Scutellum oblong, bronzed. Elytra oblong, with rounded apices, the base evidently broader than that of the thorax, with a depression near each shoulder; their sculpture coarser than that of the thorax, not seriate on the disc, but becoming substriate behind, with broad, indistinctly raised, and minutely punctured interstices there; on the disc itself, in certain lights, some very obsolete costae may be detected.

P. huttoni (1100) is very different in appearance, with a broad scutellum. The description of *P. wakefieldi* indicates a much closer resemblance to the present species, but the sculpture is not the same, and probably the shoulders may not be as broad. The antennae reach the hind thighs in the new species, their 3rd joint is as long as the 4th, and the 10th is thrice as long as it is broad. The claws are appendiculate, being incrassate for two-thirds of their length but slender and acute at the extremity. In 1100 they are also appendiculate.

Length, 6 mm.; breadth, $2\frac{2}{3}$ mm.

Wairiri, Kaikouras. Unique. Discovered by Mr. W. L. Wallace.

Group Galerucidae.

3356. **Luperus simmondsi** sp. nov. *Luperus* Geoffroy, Lacord. Hist. des Ins. Coleopt., tom. xi, p. 186.

Oblong, subdepressed, nude, shining; bluish-green, thorax blue, legs fuscous, tibiae usually paler, antennae nigrescent.

Head uneven, finely setose in front. Thorax nearly twice as broad as long, remotely and very finely punctured on the middle, a little more distinctly elsewhere, sometimes feebly rugose near the front and base; its sides gently rounded, with distinct margins and channels, but without any thickening of the angles. Scutellum smooth. Elytra oblong, rather broader behind than at the shoulders, with obtusely rounded apices, the suture aeneous; they are closely and distinctly but not coarsely punctate and more or less transversely rugose.

Antennae filiform, reaching backwards to the hind thighs, joints 4–11 about equal, 3rd joint evidently shorter than the 4th, yet not longer than the 2nd, the basal not much clavate, sometimes aeneous; they bear fine greyish pubescence.

Underside nigro-cyaneous, with yellowish-grey pubescence, the terminal ventral segment angularly prominent at the middle of its apex.

This should be placed near *L. oleareae*, which, however, is rather smaller and glossy aeneous.

Length, $5\frac{1}{2}$ mm.; breadth, $2\frac{2}{3}$ mm.

Mount Quoin, Tararua Range. A single specimen received from Mr. H. Simmonds, after whom it is named. It was taken off *Olearea Colensoi*: 4,000 ft. elevation.

Obs.—Var. almost wholly cyaneous: the greatly exposed conical pygidium with slender white hairs. A single example from the same source. $2\frac{1}{2}$ by $1\frac{1}{8}$ line.

3357. **Luperus foveigerus** sp. nov.

Robust, oblong, glabrous, glossy; elytra nigrescent, slightly tinged with red, the head and thorax violaceous and with irregular dark-crimson spots; legs and antennae more or less violaceous.

Head uneven. Thorax nearly twice as broad as long, only about a fourth of the length of the elytra, the anterior angles slightly thickened and prominent, with well-developed lateral margins and channels; near the middle there is a pair of obtuse nodules, the interval also smooth; the sculpture is irregular, consisting of very coarse punctures and smooth unequal interstices on the disc, but with narrower intervals near the sides. Scutellum impunctate. Elytra oblong, broader than thorax at the base; their sculpture very irregular, composed of punctures and foveae of different shapes, and short, smooth, apparently elevated interstices running in all directions right to the apices; the shoulders, however, have fine punctures only.

Antennae with fine greyish hairs, their 3rd joint rather longer than 2nd but shorter than 4th; they attain the posterior femora. Basal two joints of the tarsi narrow and subcylindric.

The remarkable, extremely coarse, elytral sculpture differentiates this from all the other species. *L. asperellus* (3020) is somewhat similar as regards size and colour. *L. princeps*, another beautiful insect, is narrower and obviously rufescent.

Length, $6\frac{1}{2}$ mm.; breadth, $3\frac{1}{3}$ mm.

Capleston, Westland. Unique. Discovered several years ago by Mr. A. T. Cavell.

3358. **Luperus o'connori** sp. nov.

Shining, nearly glabrous, having only a few slender marginal setae, legs and antennae, however, with numerous grey hairs; the head, legs, and antennae nigrescent, elytra testaceous, but with the base, suture, and margins broadly nigrescent, thorax more or less testaceous.

Head with a frontal carina along the middle, the interocular elevations distinct. Thorax nearly twice as broad as long, its sides only moderately curved, with fine margins, which are thickened in front, posterior angles rectangular; the surface obsoletely and not at all closely punctate. Scutellum smooth, black. Elytra broader than thorax at the base, with definite margins there, apices well rounded; punctation fine and moderately close; under the microscope there appear to be numerous very minute brassy setae.

Antennae elongate, basal joint moderately and gradually incrassate, 3rd longer than 2nd, but about a third shorter than 4th. Claws obviously appendiculate.

This, no doubt, comes near Sharp's *L. nigricornis* (2315), which I have not seen, but differs therefrom in sculpture and colour.

Length, 5 mm.; breadth, $2\frac{1}{2}$ mm.

Ohau, near Wellington. Two examples from Mr. A. O'Connor, in whose honour this species has been named.

3359. **Luperus atripennis** sp. nov.

Oblong, rather narrow, shining, glabrous; head and thorax cyaneous, elytra nigresent, legs and antennae nigro-piceous.

Head rather narrow, a little uneven, without definite sculpture. Thorax a third broader than long, only a fourth of the length of the elytra, its sides nearly straight, anterior angles slightly incrassate but not prominent, the posterior nearly rectangular; its surface a little uneven, distinctly but irregularly punctate, with some slightly raised ill-defined spots which are distantly punctured. Elytra rather broader than thorax, with straight sides, apices very broadly rounded and not covering the pygidium; they are irregularly punctured, rather closely near the base and sides, coarsely elsewhere, and with somewhat elevated, very irregularly rugose intervals.

Antennae stout, their 3rd joint longer than the 2nd but shorter than the 4th.

L. asperellus (3020) is most nearly allied to this species, which, however, differs therefrom in its narrower outline and by the absence of metallic red reflections. The sculpture of the thorax is not so coarse, but that of the elytra is just the reverse, nearly approaching that of *L. foveigerus*.

Length, $6\frac{1}{2}$ mm. ; breadth, $2\frac{1}{2}$ mm.

Macetown, Lake Wakatipu. A pair sent by Mr. A. O'Connor from Mr. H. Hamilton's recent collections.

Group EROTYLIDAE.

3360. **Cryptodacne ocularia** sp. nov. *Cryptodacne* Sharp, Man. N.Z. Coleopt., p. 640.

Subelongate, slightly convex, shining ; castaneo-rufous, legs and antennae paler, sparingly clothed with slender yellow hairs.

Head smooth on the middle, finely punctate elsewhere. Thorax rather broader than long, its sides finely margined, not quite straight, being slightly rounded at the middle, with rectangular posterior angles ; the apex broadly medially rounded and deeply emarginate towards the obtuse angles ; its surface finely and distantly punctured, but quite smooth along the middle, and nearly so on an elongate space between that part and each side. Scutellum flat and smooth. Elytra quite as wide as thorax at the base, gradually narrowed backwards, with many somewhat irregular series of very fine punctures.

Underside rufous, with pubescence like that of the upper surface, the prosternum coarsely punctured, the metasternum and abdomen finely.

On comparing this with one of *C. ferrugata* (3156) collected by Mr. Helms at Greymouth, and kindly purchased for me at London by Mr. George Lewis, F.L.S., I find that this species differs in being more distinctly clothed and more finely sculptured. The thorax is not of the same shape, and the eyes are decidedly more convex.

Length, $4\frac{1}{2}$ mm. ; breadth, $1\frac{3}{4}$ mm.

Wairiri. Another of Mr. W. L. Wallace's discoveries on the eastern Kaikouras.

ART. XVII.—*Some Notes on* Rotifera *not previously recorded as occurring in New Zealand.*

By C. BARHAM MORRIS, F.R.M.S.

[*Read before the Otago Institute, 1st October, 1912.*]

THIS paper deals with twenty-two species of *Rotifera* which have not so far been reported as having been found in the Dominion. It is the result of four years' pretty constant searching of between two and three hundred ponds and creeks, chiefly in North Otago, by myself and half a dozen other willing helpers. During the course of this period I have mounted some two thousand slides of pond-life, adopting Mr. Rousselet's formalin method in the majority of cases, and always with the best results so far as the preservation of the specimens was concerned ; and my slides of *Rotifera* mounted four years ago are as good to-day as they were when first rung. I have, of course, come across many other species, such as *Floscularia ornata, Melicerta ringens, Rotifer vulgaris, Hydatina senta*, &c., round about Oamaru, but as these have already been recorded in the Trans. N.Z. Inst. I have not referred to them.

North Otago appears to be particularly favourable to Rotifers, and it is interesting to note that most of the species are more numerous in the late winter months than at any other time of the year; indeed, they almost entirely disappear in autumn and early winter. This is, I believe, just the reverse of what takes place in Europe, and is probably due to the fact that most of our ponds and streams dry up towards the end of summer. Low temperatures seem to have very little effect on them, and it will be remembered that Mr. James Murray, of the "Nimrod" Expedition, found living Rotifers frozen under 20 ft. of ice in a small lake at Cape Royds, South Victoria Land. It is somewhat remarkable that there should be such a dearth of new species in the locality under consideration. One might imagine that in New Zealand especially there would be some departure from the stereotyped forms of the Northern Hemisphere, but this has not proved the case in our district at any rate, and it may be attributed to the well-known fact that Rotifers and their eggs may be conveyed long distances by wind and the feathers of migratory birds.

For assistance in procuring specimens I wish to thank Miss Gore and Miss Lory, of Oamaru; Mr. G. Howes, of Dunedin; and my assistant, Arthur Willetts.

Fam. Melicertidae.

Limnias ceratophylli Schrank.

In a small pond only a few yards in extent, full of quantities of decaying vegetable matter and muddy water. The tube-builders were in great numbers; clusters consisting of three and four generations were common. There were none in this pond the year previous. The largest measured $\frac{1}{20}$ in.

Ardgowan, North Otago, 25th April. A few in the Oamaru Creek in the beginning of November.

Oecistes socialis Weber.

These were found in great numbers in the Ardgowan pond referred to above, the clusters, which were greenish-grey in colour, frequently measuring $\frac{1}{3}$ in. in length, and adhering to dead twigs at the bottom. As this was the only occasion on which they were captured, they may be considered as rare. The individuals measured $\frac{1}{30}$ in. in length.

This species has been found in Victoria, Australia, by Mr. John Shephard.

Conochilus volvox Ehrenberg.

I first made the acquaintance of this beautiful Rotiferon in the beginning of July, 1909, when my assistant, Arthur Willetts, brought me a number which he found in a small pond in the centre of a ploughed paddock at Waikakahi, about twelve miles from the mouth of the Waitaki River. He had mistaken them for *Volvox globator*—a very natural error, seeing he had no microscope. The next specimen was procured in September of the following year in a gravel-pit at Tinwald, South Canterbury. They have been found in several localities in the neighbourhood of Oamaru this year during the months of October and November by members of the Microscopical Club, although I made diligent search for some years previously without success. The colonies measure from $\frac{1}{20}$ in. to nearly $\frac{1}{12}$ in. I have noticed that some individuals appear to be shorter and more stoutly built than others, the foot in particular being much shorter.

Fam. Asplanchnidae.

Asplanchna brightwelli Gosse.

This footless Rotiferon may be considered fairly common in North Otago and South Canterbury, although a year may be passed with frequent searching without coming across a single specimen. They are most likely to be met with between May and July in small ponds, and they seem to prefer the company of other species of Rotifers. The New Zealand representatives are smaller than the European, the females varying in size from $\frac{1}{40}$ in. to $\frac{1}{50}$ in.

Asplanchnopus myrmeleo Ehrenberg.

One of the finest species in the class, and plentiful from the Shag River to the Waitaki. Usually associated with *Hydatina senta* and various *Brachioni*. My specimens, which are all females, measure from $\frac{1}{25}$ in. to $\frac{1}{30}$ in.

Fam. Synchaetadae.

Synchaeta pectinata Ehrenberg.

A single specimen brought to me by Mr. Gordon Garrow, of Ardgowan, who found it in a pool at Balruddery, near the Kakanui River. It answers the description of the European species, but is smaller, measuring only a little over $\frac{1}{100}$ in.

Fam. Triarthridae.

Polyarthra platyptera Ehrenberg.

By no means common, and appears to affect shallow grassy puddles. Found in winter around Oamaru. Length, $\frac{1}{200}$ in.

Triarthra longiseta Ehrenberg.

This skipping Rotiferon is to be met with frequently in North Otago, and I am surprised that it has not been recorded before. It differs from Hudson and Gosse's plate inasmuch as the ciliary wreath is thicker and more noticeable. The body, without spines, measures $\frac{1}{100}$ in.

Triarthra mystacina Ehrenberg.

This species has been identified by Mr. Rousselet from specimens obtained by me from a pond on the North Road, Oamaru.

Fam. Hydatinidae.

Rhinops vitrea Hudson.

Discovered in great numbers in a horse-trough at Weston, in the beginning of November, by Miss Gore, of Oamaru. Measures from $\frac{1}{100}$ in. to $\frac{1}{90}$ in.

Notops brachionus Ehrenberg.

Obtained in many localities, from the Woodhaugh Gardens, in Dunedin, to a pond in Temuka. Plentiful from March to May. Length, $\frac{1}{50}$ in.

Fam. Notommatidae.

Furcularia caeca Gosse.

There is some doubt in my mind as to the correctness of this being *caeca*. The body is cylindrical and the toes very much recurved, but the face is oblique, as in *gracilis*. Length, $\frac{1}{200}$ in.

The single specimen, which is not well preserved, was sent to me in a sample of water from Maheno by Mr. George Howes, F.E.S., F.L.S.

Fam. Rattulidae.

Rattulus longiseta Schrank.

Common, to my knowledge, from Warrington to the Waitaki River. Length, including foot, $\frac{1}{55}$ in.

Rattulus rattus Ehrenberg.

In water collected at Pukerau, near Waipahi, by Mr. Howes. One specimen had the front portion of the lorica beset with five minute spines of equal length, and closely resembled *R. cornuta*, which is described in "Rotifera Supplement." Length, including foot, $\frac{1}{75}$ in.

Fam. Dinocharidae.

Dinocharis tetractis Ehrenberg.

I obtained a single representative of this species in a large swamp at the end of the Peebles Road, near the Waitaki River, on the 20th January, 1911. It differs slightly from Hudson and Gosse's drawing, as, in addition to the two large spurs, the first joint of the foot is covered with knobby projections. It is certainly not *D. inornata* Hilgendorf. as the faceted lorica can be easily made out with careful lighting and a $\frac{1}{4}$ in. objective. Length, including foot, $\frac{1}{83}$ in.

Brachionus pala Ehrenberg.

The largest and most interesting *Brachionus* I have seen. First brought to my notice by Miss Lory. The long-lumbar-spine variety, *B. amphiceros* of Ehrenberg, has of late become quite common here between May and September. My New Zealand specimens measure from $\frac{1}{50}$ in. to $\frac{1}{33}$ in. from toes to wreath. The *amphiceros* var., $\frac{1}{38}$ in., including spines.

Brachionus bakeri Ehrenberg.

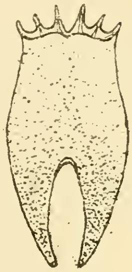
Not common, by any means. Obtained once at Richmond's Crossing, and on another occasion at Weston, in October and February. Length of lorica, including spines, $\frac{1}{110}$ in.

Brachionus angularis Gosse.

Not common usually, but found recently in great numbers in a pond near Enfield, where it was associated with *B. pala*. Hudson and Gosse have remarked on the evident fancy those two species have for one another. Length from wreath to toes, $\frac{1}{77}$ in.; lorica, $\frac{1}{150}$ in.

Brachionus variabilis Hempel var. novae-zealandiae var. nov.

I am loath to suggest making another species of this *Brachionus*, as the list is already a long one, and there is good reason to believe that many of the so-called species are really only varieties. Slight differences in the form of the lorica are not sufficient grounds for specific isolation, particularly in a genus like *Brachionus*, where vagaries in length of spines are well known in the same species. *B. pala* and *B. bakeri* readily furnish examples of this; but in the Rotiferon now under consideration not only is the posterior end of the lorica entirely different in shape, but an elaborate renal system appears to have been developed. These organs are spread out right and left of the cloaca, and afford opportunities for study such as I do not remember to have met with before. The prolongation of the lorica seems to be the result of this enlarged renal system and the necessity for more space within the case. It is quite possible that this particular form has been already described. I have none of the more recent literature on the genus, and I am sending specimens Home for further examination.*



B. variabilis var. *novae-zealandiae.*
Ventral view of lorica.

The capture was made in a small pond at Totara, where they were in numbers, parasitic on *Daphnia thomsoni*, last October. Length from toes to wreath, $\frac{1}{50}$ in.

Brachionus quadratus Rousselet.

The lorica closely approaches the one representing *B. quadratus* in the "Rotifera Supplement," though not so angular in outline. The median anterior spines are not so long, and there is a curve instead of a mid-dorsal spine at the foot of the opening; also, I have not been able to detect the "semi-jointed" foot. On the other hand, the honeycomb-like marking is very clear and distinct with dark-ground illumination and a $\frac{1}{4}$ in. objective; and this peculiar marking Rousselet has stated is characteristic of *B. quadratus*.

Secured from a small stream at Palmerston South. I have come across it once in Oamaru, so that it is, comparatively speaking, rare so far. Length of lorica, nearly $\frac{1}{100}$ in.

Fam. ANURAEIDAE.

Anuraea aculeata Ehrenberg.

Common in ponds about Oamaru, although, from its small size ($\frac{1}{100}$ in.), it is liable to be overlooked.

Anuraea cochlearis Gosse.

Occasionally found between Oamaru and Evansdale. Length, $\frac{1}{150}$ in.

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* Since writing the above I have heard from Mr. Rousselet, who states that this Rotiferon closely resembles *Brachionus variabilis*, described by A. Hempel in 1896, and found by him in the Illinois River, Quiver Lake, and Thompson's Lake, in America. The New Zealand variety has not got the square plate over the foot-opening which is conspicuous in the American species. *B. variabilis* has not been found in any other part of the world except in the two countries mentioned, which is remarkable. On Mr. Rousselet's advice, I have classed it as *B. variabilis* var. *novae-zealandiae*.

Art. XVIII.—*On the Tunicate* Styela coerulea *(Quoy and Gaimard).*

By A. J. Cottrell, M.A., M.Sc. (N.Z.).

Communicated by Professor Benham.

[*Read before the Otago Institute, 3rd December, 1912.*]

This is the first of a series of short papers dealing with the Tunicates found on the shores of New Zealand. In the earlier papers I shall deal with the specimens collected by myself, and in these cases shall therefore be able to give more exact information concerning the general appearance of the living animal. Quoy and Gaimard described several species from our seas, a few of which have not since been recorded; the species described in this article is probably one of them.

Styela coerulea (Quoy and Gaimard).

Ascidia coerulea Quoy and Gaimard, Voy. de l'Astrolabe, Zool., iii, 1835, p. 611, pl. 91, figs. 8, 9.

This Ascidian is very common on the rocky shores of the Waitemata Harbour and Hauraki Gulf. It is usually found attached to the undersides of more or less flat rocks which are propped up by neighbouring rocks so as to leave a space between the rock and the bottom. They may be found singly, or in groups of two, three, or more, but there is no organic connection between the individuals of such groups. Although so common on rocks, I have never been able to find it on wharf-piles.

The *external appearance* corresponds very well with Quoy and Gaimard's account. A mature specimen when distended measures about $1\frac{3}{4}$ in. long, $\frac{3}{4}$ in. deep, and $\frac{3}{4}$ in. wide. The body is thus long and somewhat oblong, rounded at the posterior end, and tapering at the anterior region to end in the branchial siphon. Frequently the shape is very like Quoy and Gaimard's figure, but usually it is rather more oblong. The creature is attached by a considerable part of the ventral surface, and usually slightly on the left side, but sometimes a little on the right.

The *branchial siphon* is longer than the *atrial*, and is at the anterior end, the atrial being situated on the dorsal surface a little behind the middle point of the length. When fully distended the siphons are wide, open tubes: near its outer end each becomes gradually wider, and in this condition the opening is perfectly circular, usually showing no trace of lobes. When the tube is partially closed 4 lobes can be distinctly seen, but Quoy and Gaimard's figure exaggerates this condition somewhat.

The *colour* is a beautiful bright blue, and makes this Ascidian a conspicuous object. The colouring varies much in intensity, quantity, and disposition in different individuals; generally the whole upper part is a bright blue, and towards the base this gradually gives place to a yellowish-cream colour. In other cases the blue colour is confined to the siphons, where it is always deepest, and the rest of the body is a yellowish-white or cream, often with faint tinges of blue. I have been able to collect a series showing variation in colour from a deep blue to a condition in which blue occurs only in small amount on the siphons. None of my specimens show the double violet lines in the siphons as described by Quoy and Gaimard, but the blue colour extends down inside the siphons in the branchial siphon as far as the ring of tentacles.

The *test* is smooth in the living distended specimen, and rarely has much growth of other organisms on it; the animal has thus a clean, smooth appearance. A green growth is occasionally found covering part of the test, giving it a green appearance; Quoy and Gaimard's figure shows this green colour near the base of the specimen figured. The test is strong and substantial, of a leathery nature, and frequently more or less cartilaginous. It is often about $\frac{1}{8}$ in. in thickness. The blue colour extends almost through the thickness of the test.

The *mantle* is well developed; it is not attached firmly to the test except at the siphons, and is thick, opaque, and of a yellow colour. The muscles are not grouped into strong bands, but form a close network of small bundles. Some larger bands can be seen on the inner side of the mantle.

The *branchial sac* (fig. 1) has four well-marked folds on each side; the two ventral folds are smaller than the others. About 10 internal longtitudinal

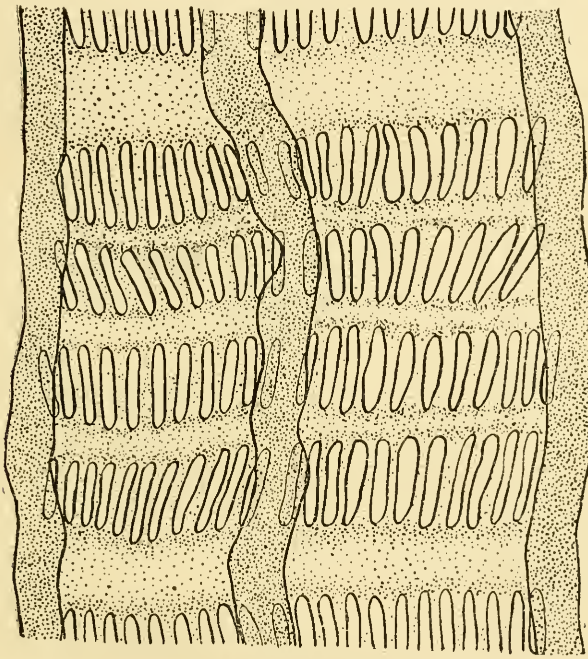


FIG. 1.—Part of the branchial sac of *Styela coerulea*, from an interspace; × 25.

bars occur on a fold, and usually 3, sometimes 4, in the interspace; the bars are wide and ribbon-like. The following table, compiled from the examination of seven typical specimens, shows the variation of the number of these bars on the folds of each side; the folds are numbered from dorsal to ventral.

Specimen.	Left Side.				Right Side.			
	1.	2.	3.	4.	1.	2.	3.	4.
1	13	11	11	7	12	11	11	7
2	8	9	7	5	11	11	11	5
3	13	11	13	8	11	13	11	8
4	9	7	8	6	8	11	8	5
5	11	11	11	6	8	13	12	7
6	11	10	9	6	12	11	9	6
7	12	9	8	5	12	11	10	7

The internal longtitudinal bars are much closer on the folds than in the interspace, and the meshes are square on the folds, but oblong transversely in the interspace. The transverse vessels sometimes branch and make parts of the sac appear rather irregular. These vessels also vary considerably in width; in some cases they are as wide as the meshes, and vary from this extreme to slender vessels, which may, though very rarely, imperfectly divide two meshes. Sometimes many wide vessels are present, but usually several narrower ones appear between the widest (fig. 1). The number of stigmata in a mesh also varies greatly, 6 up to 12 or 15 being commonly found. On the folds there are 4 to 6 in a mesh. The stigmata are wide and clearly defined, and are lined by cilia.

The *endostyle* is prominent; the groove itself is narrow, and anteriorly joins the well-marked perioesophageal ring.

The *dorsal lamina* is a plain broad membrane, slightly puckered, and generally is found bent upwards to the right, forming a groove. In one specimen examined this groove contained a strand of what was apparently food material in the act of passing from the lamina into the oesophagus.

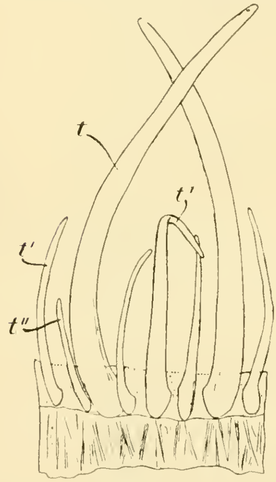


Fig. 2.

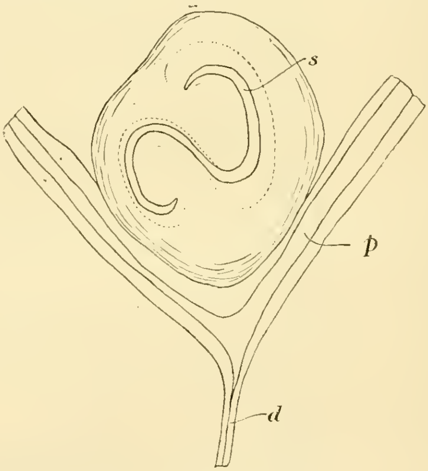


Fig. 3.

Fig. 2.—Part of the ring of tentacles of *Styela coerulea*; × 13. *t*, *t'*, *t''*, long, medium and short tentacles respectively.

Fig. 3.—Dorsal tubercle of *Styela coerulea*; × 25. *d*, dorsal lamina; *p*, perioesophageal tract; *s*, slit.

The *tentacles* (fig. 2) are simple, and, on an average, number 80. Roughly, three sizes may be recognized: (*a*.) The largest extend almost to the centre of the siphon; of these there are about 20. (*b*.) The medium-sized tentacles also number about 20, and alternate with the largest. (*c*.) The smallest tentacles, each of which lies between an (*a*) and a (*b*), number about 40.

The *dorsal tubercle* (fig. 3) is circular in outline, except for a slight indentation on the anterior surface. The slit is S-shaped, the left limb having a wider curve than the right. I have found this structure fairly constant: very few of the specimens examined showed a different form of slit.

The *alimentary canal* (fig. 4) is situated in the posterior half of the body, and is attached to the left side. It forms a narrow loop, the bend of which reaches forwards very little past the atrial siphon. The junction between the oesophagus and stomach is well marked, but the stomach tapers gradually into the intestine and rectum. There is no digestive gland. On the surface of the stomach several large blood-vessels can be seen; internally the stomach has very prominent longitudinal folds.

The *gonads* consist of two masses of short, thick, irregular, tube-like structures, which are attached to the mantle, one mass on each side (fig. 4). Sometimes these organs branch, and there are usually 6 to 9 or more of them on each side. They are usually placed near the bend of the intestinal loop, but may extend from the tentacles to the posterior end. The

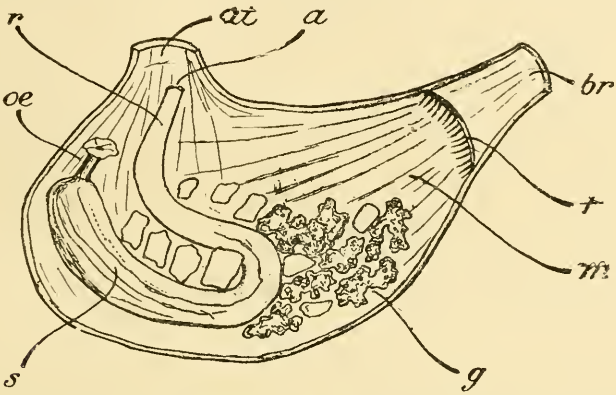


FIG. 4.—Alimentary canal and gonads of *Styela coerulea*; × nearly 2. The right side of the body and the branchial sac have been removed. *a*, anus; *at*, atrial siphon; *br*, branchial siphon; *g*, gonads of left side; *m*, mantle; *oe*, oesophagus; *r*, rectum; *s*, stomach; *t*, ring of tentacles.

gonads and the alimentary canal are closely associated with numerous pouch-like structures, which have been described under the name of "endocarps" and are common to several genera of the *Cynthiidae*

Habitat.—Rocky shores of Hauraki Gulf; Great Barrier Island; Bay of Islands (Oliver). Common under rocks at low water.

This species cannot be mistaken, as its beautiful colour makes it a very conspicuous object. On the rocky shores of Hauraki Gulf it is the common Ascidian; it is also very common at Great Barrier Island. Mr. W. R. B. Oliver informs me that this species is also very plentiful at the Bay of Islands, where he collected some specimens, and I have to acknowledge my indebtedness to him for placing these at my disposal.

Apparently this Ascidian was collected in 1835 by Quoy and Gaimard, of the "Astrolabe," who described and figured it under the name *Ascidia coerulea;* but internal structure—viz., the 4 folds of the branchial sac on each side, the condition of the alimentary canal, and the gonads—shows it to belong to the genus *Styela*. The figure illustrating their account of the species exaggerates the 4-lobed structure of the branchial opening: when partly closed both siphons are decidedly 4-lobed, but not to the extent figured. Quoy and Gaimard also describe a double violet line in the siphons, but none of my specimens shows this, nor does their figure show it.

I have collected several other species in the gulf which do show violet lines in the siphons, but externally they are quite different, and have no resemblance to this species. Aside from these two points the species under consideration fits Quoy and Gaimard's description very well. Further weight is added to the diagnosis by the fact that Mr. Oliver has found this species very common at the locality where Quoy and Gaimard collected it—viz., Bay of Islands. Shape, striking colour, and common occurrence at the Bay of Islands and Hauraki Gulf leave little doubt, I think, that this is Quoy and Gaimard's species.

Art. XIX.—*The Minute Structure of the Nephridium of the Earthworm* Maoridrilus rosae *Beddard.*

By Gladys M. Cameron, M.Sc.

Communicated by Professor Benham.

[*Read before the Otago Institute, 3rd October, 1911.*]

Historical.

The earliest account of the microscopic structure of an earthworm's nephridium of any value is that by Gegenbaur (19), in 1853, in which he showed also that what had up to that time been regarded as an organ of respiration is indeed one of excretion. This account of the nephridium of *Lumbricus* stood alone till in 1886 Benham (8) gave some account of the histology of the organ in an African worm, *Microchaeta*, though no attempt was made to trace out the course of the tubule throughout its windings; and although several zoologists about that time—Beddard, Spencer, Benham—contributed certain details as to structure in various genera, we find no further effort to trace out the whole length of the canal till in 1890 Goehlich reinvestigated that of *Lumbricus* (20). In the following year Benham published (10) a still more detailed description of the whole nephridium, stimulated thereto by certain statements of Goehlich which appeared to him to be at variance with Gegenbaur's account; and though he fell into one or two minor errors of misinterpretation* as to the structure of the funnel, his account has been accepted and his figures copied in several text-books. In that article Benham gives a summary of all that was then known about the nephridium in various earthworms, and a list of references to the papers on the organ.

* *Note by Professor Benham.*—It was stated that the marginal cells curved inwards towards the centre and then became continuous with the reflected cells of the canal, which I had termed "centrifugal gutter-cells." The same interpretation was given by Schneider in his "Vergleichenden Histologie," p. 419, but Rosen has shown that this is not the case. A re-examination of the preparation from which my figure was drawn shows me that Rosen's account is quite correct: there is a distinct gap between these two series of cells. Nor did I recognize the coelomic epithelium covering the lower lip of the funnel. I confused it with the "débris" which collects at the mouth. I can confirm Rosen (23) in these matters.

In 1894 new ground was opened by Eisen (16), who gives very elaborate figures of the nephridium of *Plutellus (Argilophilus) marmoratus*.

In 1895 appeared Beddard's "Monograph of the Order *Oligochaeta*" (7), in which there is a *résumé* of all that was known, and of the various speculations that had been put forward, in connection with nephridia.

In the same year Bourne published his account (15) of the anatomy of *Moniligaster grandis*, and described in detail the structure of the nephridium, so that another family of earthworms was now included in the list. In it there is a branching of the fine canal, forming "ductlets," which anastomose and form a network recalling that in *Microchaeta*.

In 18!5 Eisen extended our knowledge by his account (17) of the excretory organ in *Ocnerodrilus (Phoenicodrilus) taste*, *Kerria macdonaldi*, and *Pontodrilus michaelseni*: and in 1896 he described (18) it in detail for *Didymogaster (Benhamia) nana* and *Diplocardia (Aleodrilus) keyesi*, members of the *Megascolecidae*.

We now have information as to the minute structure of this organ and of the course of the canal in the following families and subfamilies:—

Moniligasteridae, by Bourne.

Megascolecidae.

Subfam. *Acanthodrilinae*. In the present paper; also, Benham, Beddard.

,, *Megascolecinae*. Eisen, in *Pontodrilus*, *Didymogaster*. Spencer, *Megascolecides*, &c.

,, *Octochaetinae*. Beddard, in *Octochaetus*.

,, *Diplocardiinae*. Eisen, in *Diplocardia*.

,, *Trigastrinae*. Eisen, in *Dichogaster*.

,, *Ocnerodrilinae*. Eisen, in *Kerria*, *Ocnerodrilus*.

Glossoscolecidae.

Subfam. *Glossoscolecinae*. Eisen, *Pontoscolex*.

,, *Microchaetinae*. Benham, in *Microchaeta*.

Lumbricidae.

Lumbricus, &c.

The present contribution deals with the Acanthodriline worms, of which hitherto no detailed account has been published.

As a result of a comparison of these various genera, we may state, in general terms, that there is a fundamental similarity in the structure and arrangement of the canals in the nephridium of the various families of worms belonging to the "Megadrilous" group of *Oligochaeta*, known as earthworms.

Apart from the above-mentioned accounts of minute anatomy, it is needless to say that the general structure of the nephridium, the disposition of the loops or coils, their relation to the bladder, the form of the funnel, and so forth, have been described and figured for many other species.

The Nephridium of Maoridrilus rosae.

The microscopic structure of the native earthworms of New Zealand is but very slightly known. I therefore decided to undertake, as a beginning, a detailed study of the nephridium, and have used this species for the purpose as it is a very common worm in certain parts of the Dominion, and an abundant supply can be obtained.

The work was suggested to me by Professor Benham,* to whom I here record my thanks for his advice and suggestions during the course of the investigation, as well as for the literature which he so kindly put at my disposal out of his own library; and had it not been for his assistance in preparing the paper for publication I do not suppose it would have seen the light.

Nephridiopores.

The pores present that alternation in their position in relation to the two couples of chaetae which is a feature of so many genera from the South Island. The alternation of the nephridiopores was originally discovered by Perrier in *Plutellus;* then Beddard noted, in 1885, the same fact in certain species of New Zealand earthworms — *Maoridrilus uliginosus* Hutton (*Acanthodrilus novae-zealandiae* Bedd.) and *M. dissimilis.* Later Benham (11) added *Plagiochaeta* to this category, and gave tables illustrating the irregularity of this arrangement in *Neodrilus* and *Plagiochaeta.* Although this was at one time regarded as a peculiarity of our native worms, yet it does not occur in all the genera, nor is it confined to those of this country. It even occurs in some of the European species, in which it was for a long time supposed (and even in text-books is still stated as a fact) that the pores were invariably in line with one or other of the couples of chaetae, according to the genus. But Borelli, as long ago as 1887, described (13) this irregularity in position in species of *Lumbricus* and *Allolobophora;* and in 1892 Hubrecht added further instances (21) amongst European worms. But in these it may rather be described as an "irregularity" than as a regular "alternation" in position.

The nephridiopores of *M. rosae* lie either in front of the dorsal or in front of the ventral chaetae, showing a broken alternation between the two positions.

The dorsal nephridiopore is in front of chaeta 3, or in front of the gap between chaetae 3 and 4 (which form a closely apposed couple); the ventral is in front of chaeta 2.

There is no third position such as is described by Hubrecht between the dorsal (upper) pair of chaetae and the median dorsal pore, for the two pores are seen to be superior or inferior in every segment, except, of course, the first and the last, in which there are no nephridia. The pores of the first pair of nephridia, however, are placed at the extreme anterior end of segment 2, in line with the prostomial furrow.

Beddard, in his "Monograph of the Order *Oligochaeta,*" says that the nephridiopores of *Acanthodrilus (Maoridrilus) rosae* are regularly alternate; but this is not so. They show, however, not a complete irregularity, but rather an interrupted regularity, similar to that of *Plagiochaeta punctata* as described by Benham. In some parts of the worm (though never at the extreme anterior end) there occurs a regular alternation between the dorsal and ventral positions for about twenty segments, and in examining such a part one is led to infer that all the pores are similarly arranged. But in the succeeding segments a break in the regularity occurs, and in this region there are generally more pores in the dorsal than in the ventral position. These segments past, the regular alternation is resumed, and is carried on, with similar interruptions, to the posterior end of the worm.

* This paper formed the basis of a thesis for honours in zoology at the University of New Zealand in 1911; but since then it has received additions, has been subject to much rearrangement, and has suffered a great deal of contraction.

Position of Nephridiopores (Anterior End).

SPECIMEN A.

Left.		Seg.	Right.	
Dorsal.	Ventral.		Ventral.	Dorsal.
		1		
•		2		•
•		3		•
•		4		•
•		5		•
•		6		•
•		7		•
•		8		•
•		9		•
	•	10	•	
•		11		•
	•	12	•	
•		13		•
	•	14	•	
•		15		•
	•	16	•	

SPECIMEN B.

Left.		Seg.	Right.	
Dorsal.	Ventral.		Ventral.	Dorsal.
		1		
•		2		•
•	•	3		•
•		4		•
•		5		•
•		6		•
	•	7		•
	•	8	•	
•		9		•
	•	10	•	
•		11		•
	•	12		•
•		13	•	
	•	14	•	
•		15		•

In specimen A the pores went on for about 20 segments in regular alternation; in specimen B the regularity is wanting, and the following table, taken also from specimen B, shows the asymmetry of the pores on either side of the same segment. It gives the position of the pores in 14 segments near the posterior end of the worm.

Left.		Seg.	Right.	
Dorsal.	Ventral.		Ventral.	Dorsal.
	•	101		•
•		102	•	
	•	103		•
•		104	•	
	•	105		•
•		106	•	
	•	107		•
•		108	•	
	•	109		•
•		110	•	
	•	111		•
•		112		•
•		113	•	
•		114		•

Besides this alternation from segment to segment, there is an asymmetry on the right and left sides of the same segment—*i.e.*, a segment may have a dorsal pore on the right side and a ventral pore on the left, and *vice versa*. This, however, is not invariable, though it is frequent. In some specimens examined the dorsal pore of the right-hand side was found more often opposite a dorsal on the left hand than opposite a ventral. In the majority of the worms examined, however, the asymmetry occurs.

In the first six nephridial-bearing segments the nephridiopores are in one and the same line—*i.e.*, they occupy the dorsal position on both right and left sides. In some cases the 8th of those segments was reached before any alternation commenced. A similar fact was noted by Benham (12) in *M. uliginosus*. But, excluding these anterior segments, there are more pores placed dorsally throughout the length of the worm (which contains about 170 segments) than ventrally. It may here be noted that in the table given by Borelli (13) of the position of the nephridiopores in various species of the European genera *Allolobophora* and *Lumbricus* there are, on the whole, fewer pores in the dorsal than in the ventral positions.

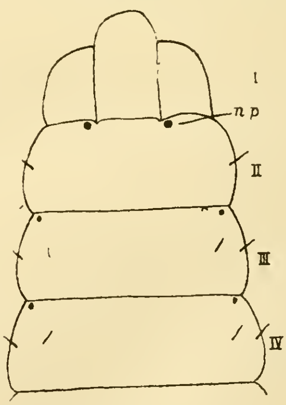


Fig. 1.

Anterior end of *M. rosae* (preserved in alcohol after potassic bichromate and acetic acid), showing the position of the anterior nephridiopores, the first of which (*n.p.*) lies in line with the prostomial furrow.

The position of the first pair of nephridiopores deserves particular notice. as it has been recorded hitherto for only a few other species. Each pore is at the extreme anterior margin of the 2nd segment, just behind the intersegmental groove, and slightly external to the furrow which limits the backward prolongation of the prostomium which crosses the 1st segment.

It has occurred to me that perhaps this groove alongside the base of the prostomium may have some function in connection with the nephridium. It is evident that the secretion discharged from the nephridiopore would readily flow along the groove which would lead it on to the food while this was being taken into the mouth. How far is this association of a "tanylobic" prostomium with a pepto-nephridium at the hinder end of the furrow widespread?

The only figure that I have been able to find showing this position is in Benham's account of *Neodrilus monocystis*, where it occupies the same position as I have here described. But he also notes that in *Plagiochaeta punctata* the "vestigial" nephridium of the 3rd segment opens by a pore in this position.

A few other instances may be noted here, for it is stated as a general rule in earthworms that the first nephridiopore lies in the 3rd segment.

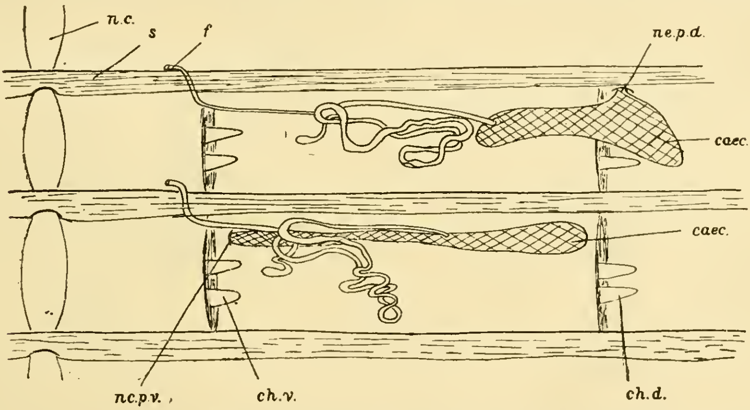


FIG. 2.—A dorsal and a ventral nephridium, as seen by opening the worm in the mid-dorsal line. Drawn from *Maoridrilus uliginosus*, in which the caecum of the ventral nephridial bladder is longer than that of *M. rosae*, though the nephridia are, in general, very similar.

Beddard (P.Z.S., 1887) states that in *Thamnodrilus gulielmi* (p. 154) and in *Plutellus (Cryptodrilus) fletcheri* (p. 544) the first pore lies in the 2nd segment, as it does too in *Argilophilus* (Eisen) and one or two others. But it seems that little attention has been paid to details of this kind.

The dorsal shifting of the anterior pores has also been noted by Eisen for *Deltania*. where the nephridiopores normally lie in front of the 3rd chaeta, but the three anterior pores are in line with the 4th. He notes similar facts for *Phoenicodrilus*.

Bourne states that in *Moniligaster grandis* the first seven pores (those of segments iii to ix) lie dorsad of the normal position, which is in line with the outer (*i.e.*, dorsalmost) chaeta of its segment. Indeed, it appears that this shifting occurs in various genera.

The Nephridia.—On the worm being opened, the nephridia are seen to be arranged in two series, corresponding to the external pores. Those nephridia which open on the dorsal surface are placed dorso-laterally; those which open on the ventral, ventro-laterally. The funnels, however, are all placed ventrally, in line. This condition has been described by Benham for *M. uliginosus*, and may be contrasted with that of the genera described by Hubrecht and Borelli, where there is only one position of the nephridia corresponding to three positions of the external pore. This position is ventral, and the terminal duct, in order to open dorsally, runs up between the muscular layers from the ventral to the dorsal surface.

In *Maoridrilus rosae* the terminal bladder opens directly to the exterior (at the points *ne.p.d*, *ne.p.v*, fig. 2). In general arrangement and position in the body-cavity they are very similar to the nephridia of *Neodrilus monocystis* as figured in a transverse section by Benham (11), pl. 15, fig. 4, and in *M. uliginosus* (12). It is probable that in both worms their minute structure is similar to that of *M. rosae*.

The nephridium of *Maoridrilus* is formed essentially on the same plan as that of *Lumbricus*, although the former is somewhat simpler in structure, and differs in external appearance from the latter. *Lumbricus* has only one series of nephridia, which are therefore all alike; but in *Maoridrilus*, as in several New Zealand earthworms, the two series exhibit slight differences of form in accordance with their position. The chief difference between the dorsal and ventral series (see fig. 2) concerns the terminal bladder (*bl*). In the ventral nephridia this has a large caecum directed dorsally, while in the dorsal series the caecum is smaller, the bladder being continued only a little way beyond the external pore.

The nephridium is made up of a small preseptal and a large post-septal region. The preseptal portion (fig. 2) consists, as usual, of a funnel, a nephrostome, and a funnel-duct, lying more or less parallel to the septum, with its opening directed upwards. The preseptal part of the nephrostomial duct is a delicate tubule which curves round from the funnel, passes immediately through the septum, and joins the post-septal portion of the nephridium.

The Funnel.—It is by no means easy to dissect out a nephridial funnel in this species, owing to its position close against the septum, and its proximity to the nerve-cord, so that its structure was studied chiefly in sections. But I was able to obtain a good view of one sufficiently isolated to exhibit its general form; and it will be noted (fig. 3) that the marked difference in the height of the dorsal and ventral lips which is familiar to us from the usual figures of the *Lumbricus* nephrostome is here absent.*

The funnel is not distinctly marked off from the funnel-duct, which is at first nearly as wide as the funnel itself, and slowly tapers towards the septum (fig. 4), which it perforates. The large lateral flaps formed by the prominent rounded lip in *Lumbricus*, &c., are here absent, and at a first glance the whole preseptal portion looks like a very long funnel; but further study shows that this really consists of the true nephrostome and its preseptal duct.

The actual opening is comparatively wide, and surrounded by a rather thick ciliated lip, formed by marginal cells. The thickness of this lip is almost uniform all the way round, except that it is interrupted on the ventral surface; though in the figure this margin is shown as it actually appeared in the preparation, undulating, so that the height of the lip appears to be

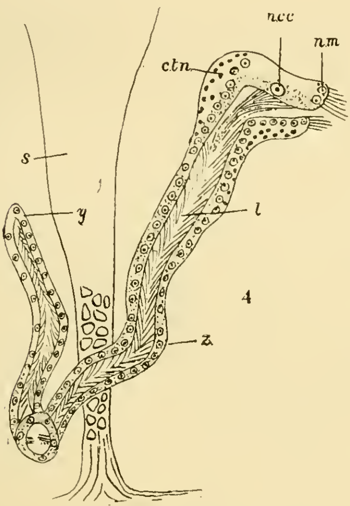
* Reference may be made to Benham's figure of the nephrostome of *Microchaeta rappi*, in which also the lips are quite ill defined (8).

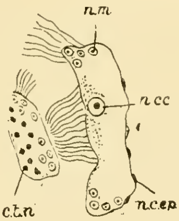
irregular. The examination of sections, however, enables one to rectify one's ideas on this matter.

The marginal cells are much shorter and less specially arranged than in other genera, but are, as usual, provided with cilia which project into the coelom and are shorter than those borne by the central cell. The marginals pass round the sides to the front of the funnel, decreasing only very slowly and very slightly in height, and here join the cells of the canal-wall.

The dorsal lip is formed by the central cell (figs. 4, 5; *n.cc*), capped by the short marginals; the ventral lip merely by the cells of the canal-wall, which here, of course, cease abruptly.

Below the margin there is a thick layer of connective tissue, as is usually the case, but in *Maoridrilus* it comes right up to the marginal cells, and, tapering downwards, gives the nephrostome a resemblance to an ordinary glass funnel, or, with its funnel-duct, to a convolvulus.





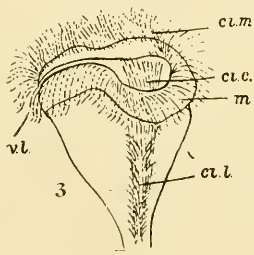


FIG. 3.—Outline of a funnel, from the side, as seen in a living nephridium. The long cilia were moving rapidly, and some of the cilia of the marginal cells, together with those of the central cell, were sweeping strongly down the funnel.*

FIG. 4.—Longitudinal section through a funnel, showing the nephrostomial duct passing through the septum. The slowly tapering character of the funnel-duct is well seen; it joins the nephrostomial duct at the point *z*, and the latter enters the nephridial folds at the point *y*.

FIG. 5.—Transverse section of a funnel from front to back. The cilia of the central cell are directed against the front wall of the funnel.

This connective tissue is variably developed: in some funnels I find that it is continued down the sides of the preseptal canal much farther than in other cases: in the section figured (fig. 4) it was feebly developed.

The dorsal lip contains very little connective tissue, but the lower lip is supported by a considerable amount. The nuclei (as has recently been described by Rosen (23) for *Lumbricus*) are here crowded, and in consequence this part of the funnel appears denser than the upper lip, which is composed only of the central cell (fig. 4).

In this figure the central cell, described in *Lumbricus* for the first time by Benham (10), and subsequently recorded in the funnels of other earth-

* For list of abbreviations used in this and subsequent figures see end of article, p. 190.

worms of various families, is indicated by its large nucleus, surrounded by granular protoplasm. But what makes this funnel of *Maoridrilus rosae* remarkable is the great tuft of cilia borne by this central cell, and directed down the nephrostomial canal: for in other earthworms this central canal is not ciliated.*

These cilia represent probably the original cilia of the flame-cell which terminated the embryonic nephridium: they have become somewhat reduced in size, and increased in number with the increasing size of the cell, but have still retained their original direction down the funnel. If this be so, the cilia represent an interesting case of the survival of an old structure in the specialized organ which has been developed from the older and simpler form. The presence of these cilia on the central cell is most unusual.

On reference to Vejdovsky's figures of the development of the nephridia of *Rhynchelmis* (25) we find that the embryonic pronephridium terminates in a large cell containing a vacuole, in which the flagellum forming the "flame" projects downwards towards the nephridial lobe, composed of a string of cells without lumen. As the embryo grows into the adult worm the vacuole acquires an opening to the coelom and becomes the cavity of the funnel, while the terminal cell forms the central cell of the funnel of the adult. In the case of *Maoridrilus* the development is probably similar, and the cilia have persisted on the central cell, which forms the chief portion of the upper lip, as does the terminal cell in *Rhynchelmis*.

Lumbricus, on the other hand, has a terminal cell in its embryonic pronephridium devoid of vacuole or flame; here, then, is perhaps the reason for the absence of cilia on its central cell.

The *post-septal* portion of the nephridium (figs. 6 and 8) consists of two folds, anterior (*a.f*) and posterior (*p.f*) respectively, a large terminal bladder (*bl*), and a smaller fold, or "spur" (*sp*), which comes off from the ventral end of the posterior fold.

The anterior and posterior folds are connected by a single tubule, the "bridge" (*b*), which is ciliated throughout its length (fig. 8); and the anterior fold is connected with the bladder by a single wide duct, the "outlet-duct" (*o.d*).

The anterior and posterior folds consist of tubules embedded in connective tissue; they lie parallel to each other, and transversely across the body. I have used the nomenclature given by Eisen (17), but these two folds together correspond to the second or middle loop of *Lumbricus* (10). The single

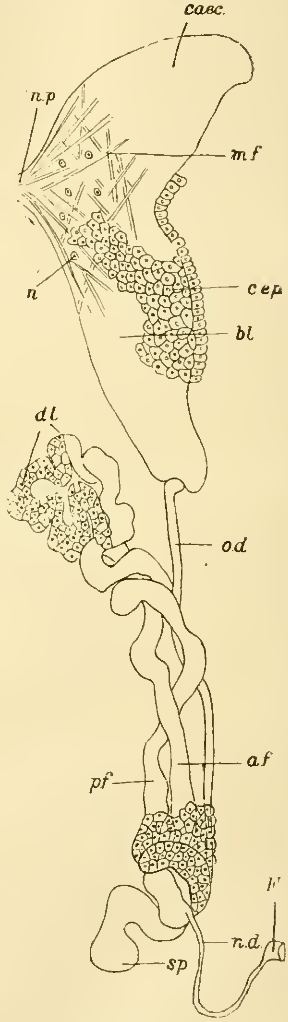


Fig. 6.

Outline of dorsal nephridium mounted in glycerine. The covering of coelomic epithelium (*c.ep*) is shown in part; the bladder is turned over, so that the pore appears to be facing the posterior instead of the anterior end of the segment.

* The general shape of the funnel recalls that of many of the *Enchytraeidae*, but in them the long cilia (? borne by the central cell) project freely through the opening. (*Vide* Vejdovsky, Eisen.)

tubule which connects them corresponds to the short "ciliated middle tube" of *Lumbricus*, or the "bridge canal" of Eisen. The third fold, or "spur" (*sp*), represents the third loop of *Lumbricus*, in which genus it is, however, much longer. In *Maoridrilus* it is short and curved outwards, and lies approximately at right angles to the posterior fold (*sp*). The nephrostomial duct, after passing backwards through the septum, traverses the body for a short distance, and joins the ventral end of the anterior fold at the point where the outlet-duct leaves it. This latter duct lies parallel to the folds and anterior to them: it crosses the coelom independently, and enters the bladder.

The shape of the bladder, or the muscular duct, differs in accordance with the position of the nephridium. In the ventral series it is long and straight, somewhat club-shaped, and comparatively narrow (fig. 2, *bl*). At its inner end it bends down into the intermuscular gap of the body-wall through which the chaetae (*ch*) project, and opens at this point to the exterior. The pore is terminal, and the outlet-duct enters it at about the middle of its length, or slightly nearer the dorsal end. The extension of the bladder beyond the point of entrance of the outlet-duct I have called the caecum (fig. 2, *caec*).

In the dorsal series, however, the bladder appears to be a direct continuation of the outlet-duct, very much enlarged (figs. 2, 6). It is wider than the ventral bladder, but not so long. It is continued beyond the pore as a short dilated caecum (*caec*).

The nephridia lie practically freely in the body-cavity, being joined by blood-vessels and occasional delicate strands of connective tissue to the body-wall. There is no trace here of the large coelomic sacs or peritoneal masses on which the nephridia of some earthworms are supported.

The description given above refers to the nephridia from about the middle of the length of the worm. There is no alteration of form, beyond details of the coiling of the folds, towards the posterior end, though the muscular bladder appears to become larger in comparison with the folds; nor is there any decrease in size of the nephridia, which occupy, therefore, a greater part of the cavity of the segments, which are smaller at this end of the worm. The septa in this region are greatly thickened, and obscure a general view of the nephridia.

In *Maoridrilus* there are no proctonephridia. Their absence was established by examination of a series of horizontal sections through the posterior end of the worm. Fig. 11, taken from such a series, shows the opening to the exterior of the third nephridium from the posterior end. There is no trace of a longitudinal duct connecting the terminal portions of the posterior nephridia, and opening by one common opening into the alimentary canal, such as has been recorded by Beddard (6), who discovered the anal nephridia of *Octochaetus multiporus*, and found that they opened not only to the alimentary canal, but also to the exterior, and in each case by many pores, as is characteristic in that genus.

I could not find in the wall of the rectum of *Maoridrilus* any indication of a network of nephridial tubules opening by intercellular ducts into its cavity.

The nephridia of the clitellar region are similar to those of the post-clitellar. In the preclitellar region, and particularly in the first six segments, the nephridia are much larger, and present a distinctly different appearance (figs. 7 and 8). In segments 3–6 the septa, being inclined backwards. thrust the nephridia out of their normal transverse position; the bladders are considerably extended, the pores terminal, and the outlet-canal opens at the opposite end, so that there is no caecum. The nephrostomial duct is particularly long.

In the 2nd segment of the body lies the first nephridium, in which the arrangement of the folds is lost, and the result is a compact mass of tubules, coiled in a complicated manner, and bound together by connective tissue to the ventral surface of the body-wall. This nephridial mass is subspherical, and of quite a noticeable size, communicating with a large bladder which lies longitudinally in the segment; this can be traced quite easily to the anterior end of the segment, and is seen to penetrate the body-wall to open to the exterior by a pore on the dorsal surface of the 2nd segment. This first nephridium appears from the position of its pore as well as from the modification, though slight, to act as a "pepto-nephridium" (Benham)—*i.e.*, its secretion is made use of in the process of digestion of food.

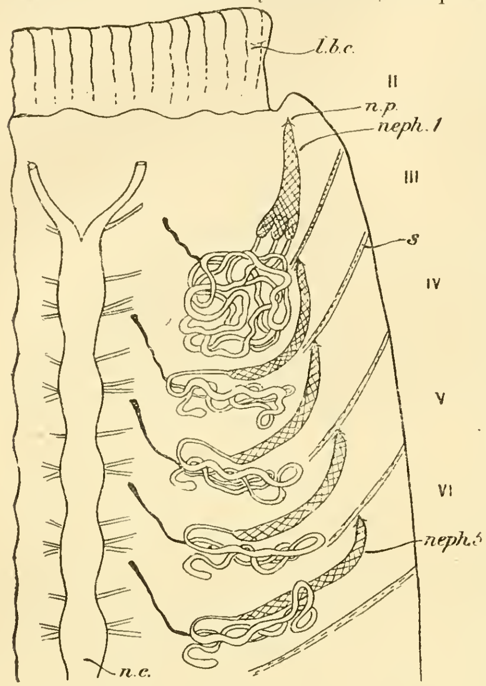


Fig. 7.

Dissection of the first six segments of *M. rosae* to show the nephridia: drawn under a dissecting microscope.

Course of the Nephridial Tube (fig. 8).

The whole nephridium consists, as usual, of the winding of one long excretory tube through the various folds. This tube is embedded in connective tissue. The post-septal region is composed of the same four regions as are found in *Lumbricus*—viz., (*a*) long narrow tube, (*b*) short ciliated middle tube or "bridge," (*c*) long wide tube, (*d*) muscular duct or bladder opening by the nephridiopore to the exterior. These different regions of the excretory organ are best seen in fresh specimens, and do not show well in preserved worms, though the windings may be traced out in unstained nephridia, in which, too, the extent of ciliation is seen, while specimens stained in picro-carmine or picric acid and afterwards mounted in glycerine show well the different parts of the tube. I found that this method of preparation gave better results than with borax or alum carmine for a stain and a Canada-balsam mount.

The course of the excretory tubule may be seen in fig. 8. The long narrow tube (*a*) commences at the proximal end of the funnel in the preceding segment as the nephrostomial duct (*n.d*), which passes through the septum, and enters the anterior fold as the outer narrow canal (*a.o*). This lies on the anterior or outer side of the anterior fold (*a.f*), and is straight: there is no branching of the narrow duct in *Maoridrilus* as there is in *Microchaeta* (Benham), in *Moniligaster* (Bourne), and in *Argilophilus* figured by Eisen, where the duct breaks up into a spongy mass of tubules encircling the other canals.

In the dorsal lobe (*d.l*), where the anterior and posterior folds become continuous, the outer narrow canal commences to loop round and wind in and out of the inner narrow canal (*a.i*). This looping often continues for a considerable distance down the posterior fold (*p.f*), though in the majority of specimens examined it was restricted to the dorsal lobe. The outer narrow canal continues down the outer (posterior) side of the posterior fold, and enters the "spur," in which it crosses over (at point *X*, fig. 8) from the posterior to the anterior side.

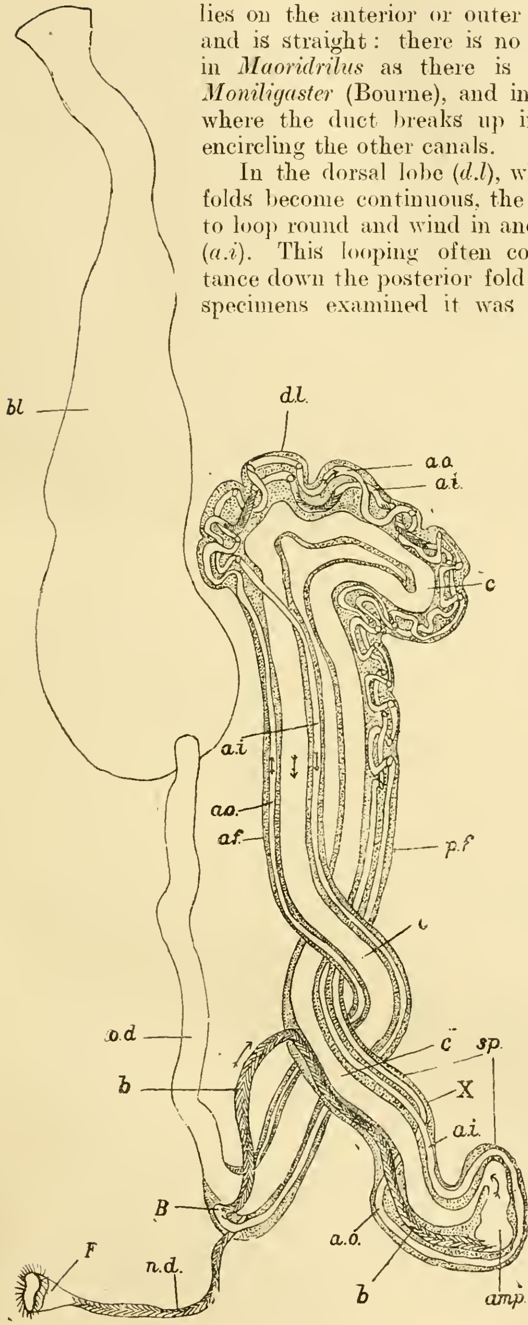


FIG. 8.

An anterior dorsal nephridium from one of the segments 3 to 7, greatly enlarged, to show the course of the nephridial canal through the various folds.

At the apex of the spur the duct turns back along the anterior or inner surface, and without change of diameter returns along the posterior fold as the "inner" narrow canal (*a.i*) lying parallel to the "outer" canal. In the dorsal lobe this part of the canal is ciliated at certain points. After the "windings" in the dorsal lobe it is continued into the anterior fold, where it passes across the wide tube (*c*), and and comes to lie on the inner side of the fold, separated by the wide tube from the outer canal.

In some of the nephridia examined the inner narrow canal was, in this fold, of slightly greater diameter than the outer canal; in the majority, however, both ducts were approximately of the same dimensions.

At the point where the nephrostomial duct enters the nephridium—*i.e.*, at the lower end of the anterior fold—the inner canal turns sharply back, as shown in fig. 8, to form what I have termed the "bridge" canal (*b*). This does not lie in either of the nephridial folds, but passes outwards for a short distance between them, and suddenly turns back on itself to enter the posterior fold. The bridge canal is ciliated, and this ciliated tube passes to the apex of the spur, where it becomes suddenly much enlarged to form the "ampulla" (fig. 8, *amp*). This is merely a sudden and large increase in the diameter of the bridge canal, marked, it is true, by the absence of cilia, and not otherwise modified histologically as is the ampulla of *Lumbricus*.

From the ampulla at the apex of the spur the excretory canal turns back with slight decrease of diameter as the "wide tube" (*c*). This wide tube forms a considerable part of the nephridium, and is very conspicuous in the folds. It often contains globules of excretory fluid. Its course along the posterior fold, through the dorsal lobe, and down the anterior fold is seen in fig. 8. Meantime it has become gradually wider throughout its course from the apex of the spur to the inner end of the anterior fold; and, arrived at this latter point, it leaves the fold, turns back upon itself, and passes freely outwards towards the bladder as the outlet-duct (*o.d*). The last region of the excretory tube, the bladder (*d*), is a much dilated muscular sac with a wide lumen and a thin wall. It puts the nephridium in communication with the exterior by the nephridiopore, which is placed, as described above, at the dorsal or ventral end of the sac according to the position of the nephridium in the body.

Fig. 8 is a drawing made up from the study of a number of nephridia, for on account of their transparency the ducts could not be traced clearly in any one nephridium unless the preparation were particularly fortunate. In no two nephridia is the position of every region of the excretory tube exactly the same in detail; the dorsal lobe especially shows great variation in shape and in the details of coiling of the narrow tubes, while in the anterior fold one or other of these ducts is often completely hidden by the wide tube. In the figure the ducts are represented as being farther away from each other than is actually the case, for they could not otherwise be clearly shown.

I may here revert to the structure of the first nephridium. A microscopical examination proves it to be a nephridium without doubt, for there is no development of the glandular tube at the expense of the other tube, though all tubes are lengthened to a very great degree. The same regions of the excretory duct (*a*, *b*, *c*, and *d*) are represented, apparently in the same proportions as they occur in succeeding nephridia, except that the muscular bladder is very much smaller in comparison with the size of the nephridium. It is impossible to unwind the folds, bound together as they are by interlacing tubules, blood-vessels, and connective tissue; but in all the folds the two narrow canals are to be seen, winding in and out of each other in parts in a manner recalling the dorsal lobe; accompanying them is the wide tube, with its usual straight course. In certain isolated parts of the narrow tube cilia appear, and are seen in living specimens to be actively moving; while a single, rather wider, densely ciliated duct may be observed which evidently represents the connecting bridge canal of the ordinary nephridium.

The posterior end of the bladder in the first nephridium is three-lobed, and one of the coils passes under this end, so that, with the outlet-duct which enters the middle lobe, it looks as if the bladder received three tubules; but closer examination shows that two of these are the sides of a U-shaped loop formed by this coil.

Ciliation in the Canals.

It may be as well to emphasize the fact that, as in *Lumbricus*, the cilia are restricted to a comparatively small part of the excretory tube. The funnel is ciliated throughout; not only the marginals, but even the central cell, as well as the epithelial cells surrounding the lumen in the proximal part, bear cilia. The nephrostomial duct from the funnel to its point of entrance into the anterior fold is finely ciliated. From sections, these cilia appear to be in two rows, but I could not ascertain the exact arrangement from a living specimen. The narrow canal has few ciliated regions, and these are confined to the dorsal lobe. In the inner narrow canal (*a.i*) cilia were observed moving in three short lengths as shown in fig. 8, the direction of the excretory current being towards the anterior fold. No other cilia could be seen in the narrow duct. The bridge canal is ciliated from its commencement up to the ampulla (fig. 8), the cilia being directed towards the ampulla. The cilia in this canal form the chief means of distinguishing it and tracing its direction and limits. At the sharp bend (fig. 8, *B*), where the narrow tube is continued into the bridge canal, are two peculiar structures; they have the form of two combs of cilia (fig. 9, *co*), which lie almost at right angles to the course of the tubule. They are formed, as can be seen from the figure, of fused cilia, some of which are free, or have become frayed out to form the teeth of the comb. Their function is evidently to create a stronger current than could be given by separate

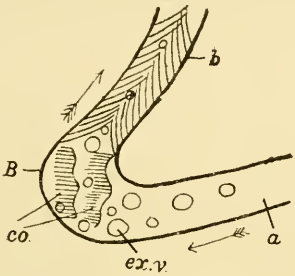


FIG. 9.

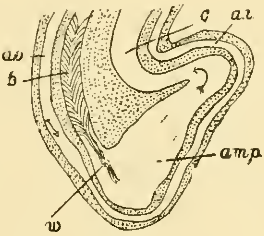


FIG. 10.

FIG. 9.—Enlarged drawing of the commencement of the bridge canal (*b*), showing the combs of cilia (*co*) lying across the entrance to the canal. The arrow indicates the course taken by the excretory vesicles.

FIG. 10.—Enlarged view of the apex of the spur, showing the entrance of the bridge canal into the ampulla.

cilia at the sharp turning; and on this account they may be compared, I think, with the membranella or undulating membrane of *Paramoecium*, which is often frayed at the edge. I thought at first that they could be compared to the "undulating structures composed of bundles of long cilia-like filaments" of *Moniligaster grandis* (15, p. 339), but these, though placed obliquely across the lumen of the excretory duct, are attached at both ends, and have no comb-like appearance; while the waves of undulation work in the direction of the current—*i.e.*, from the nephrostome outwards.

The combs of *Maoridrilus* work unceasingly with an undulation along the comb—*i.e.*, across the current—while the cilia forming the teeth work strongly backwards and forwards, sweeping the contents of the tube on towards the nephridiopore. The inner narrow canal (*a*, fig. 9) contains excretory droplets or globules (*ex.v*), and as these arrived at this point they were seen to be gradually forced round the bend by the action of the combs. The cilia worked more energetically on coming into contact with the droplets, while the undulating motion also became brisker. It was some time before the larger globules were forced round, the smaller ones being more easily disposed of and brought round by the sweep of the cilia into the bridge canal. Thence the long cilia in this region carried the excretory products into the ampulla and wide tube.

The ciliation stops just before the dilatation which forms the ampulla; the cilia at the end are much longer, and have the form of a whip or flame which projects into the cavity of the dilatation (fig. 10, *w*). They do not fuse to form the whip, though the appearance presented in the living nephridium would indicate a fusion, for the vibration of the cilia is very rapid, and they vibrate in unison, undulations passing from end to end in rapid succession, as in the flame-cells of the *Platyhelmia*. When the vitality becomes more feeble, however, the action becomes slower, and the separate cilia now vibrate individually, revealing the real structure of the flame.

The extraordinary vitality of the tissues is demonstrated by the fact that cilia were still moving briskly in the nephridium of a worm which had been killed in weak alcohol and dissected three days previously. They were still sufficiently active to indicate clearly the direction of the current in the nephridial canals.

Histology.

The nephridium has a continuous covering of flat coelomic epithelial cells (fig. 6, *ep*). This epithelium is indicated by the small darkly staining nuclei, which cover the whole nephridium and the blood-vessels connected with it.

The irregular outlines of the angular epithelial cells are very easily seen in nephridia from a worm preserved in acetic-bichromate. The nephridia may be mounted whole in glycerine, which shows clearly the boundaries of the separate cells, while the nuclei shine out conspicuously. The epithelium was particularly well seen in this way on the bladder, as shown in fig. 6, where the cells are only partly filled in. The muscle-fibres seen in the figure shine through the flat cells; below these again are seen the nuclei of the epithelium bounding the lumen of the sac.

I have remarked on the fact that the pavement coelomic epithelium is so easily shown on the bladder of *Maoridrilus* because it appears to be so difficult to demonstrate on the muscular sac of other genera.

In *Moniligaster grandis*, for instance, Bourne has said that there is a layer of pavement epithelial cells over the bladder, but that these are very delicate, and therefore difficult to demonstrate; while in *Lumbricus* Benham was unable to find a continuous epithelium outside the muscular coat, and was of the opinion that the granular protoplasm of the bladder-wall in which the muscle-fibres are embedded represented not only the vesicular connective tissue, but also the coelomic epithelium.

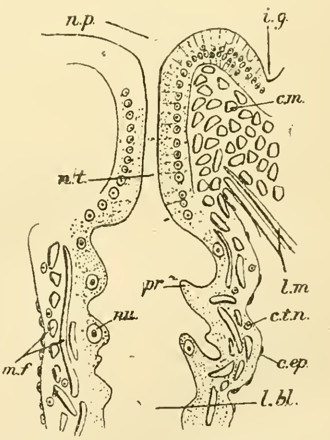


Fig. 11.—Section through a nephridiopore, drawn (under the oil immersion) from a series of sections through the posterior part of the worm. The figure shows the third pore from the posterior end. The irregularity of the lining of the bladder is due, no doubt, to the contraction of the muscular wall.

To continue now the description of the structure of the bladder (see fig. 11). Below the pavement-cells is a layer of granular protoplasm containing small nuclei (*c.t.n*). This nucleated layer represents the connective tissue of the bladder-wall; it is not vesicular in *Maoridrilus*. In it the muscle-fibres are embedded: these fibres form a network over the wall of the bladder; they are long and fine, and cross it in all directions—longitudinally, transversely, and obliquely. Towards the pore the fibres converge, and are seen in section to become continuous with the muscles of the circular layer (*c.m*) of the body-wall.

On the inner side of the muscular coat are seen large nucleolated nuclei (fig. 11, *nu*) embedded in a layer of protoplasm slightly more granular and more darkly staining than the connective-tissue layer. The nuclei are often contained in the processes (*pr*) of the inner wall of the bladder which project into the lumen; these are very noticeable in a transverse section of the bladder, the lumen of which has a most irregular outline.

The structure of the wall at this point presents the same difficulty of interpretation as was experienced in *Lumbricus*, for in *Maoridrilus* also it is difficult to detect the outlines of the cells. Although in section one nucleus, or at most two or three, are seen, the lumen is of an intercellular nature, the cells forming the epithelium being large and comparatively few. As may be seen in a glycerine preparation, where they shine through the muscular fibres and coelomic epithelium (fig. 6), they are clearly too numerous to belong to a series of perforated cells. In fig. 11, taken from a series of longitudinal horizontal sections, the external pore of the nephridium is seen to be formed by an invagination of the epidermal cells. The short duct formed thereby is without the slightest doubt intercellular; and this duct joins the short tubular region (*n.t*) of the distal end of the bladder, where the cells are becoming very similar to the epiblastic cells, and are clearly forming an epithelium round an intercellular lumen. As this part widens out to form the dilated bladder the nuclei become larger and farther apart, till they become relatively scarce and the cells of the epithelium relatively enormous; but the cell-boundaries cannot be detected in the dilated region.

The histological structure of the various parts of the canal agrees with the descriptions given by previous authors for the nephridia of other genera, so that it is unnecessary to describe it once again.

In many specimens I noted excretory vesicles in the lumen of the inner narrow tube, and globules of fluid were seen in the protoplasmic wall of the canal. But excretory globules are chiefly confined to the wide duct (*cf.* Benham, 10).

The bridge canal does not differ greatly in its structure from the narrow tube, except that it is ciliated in two rows, and that it contains a number of vacuoles lying against the boundary of the lumen. These are probably excretory globules which discharge their fluid into the lumen of the duct.

The structure of the nephrostomial duct (fig. 4) is rather noteworthy. It is not, as is generally the case, formed of perforated cells, but is relatively wide, and is surrounded by a distinct epithelium of fairly large cells. The nuclei are not placed as closely together as is general in an epithelium, and from four to six only appear in a transverse section. Such a structure for the nephrostomial duct does not seem to have been recorded in other earthworms.

Vascular Supply of the Nephridium.

The general course of the vessels connected with the nephridium agrees with that in *Lumbricus* as given by Benham, and with that in *Moniligaster* as described by Bourne, so that it is needless to go into details.

The nephridium is supplied by two vessels—one connected with the dorsal, the other with the ventral, blood-trunk (fig. 12). The former trunk gives origin to a dorso-parietal vessel, which courses down the body-wall, and at a little distance below the lateral line divides into three branches—(*a*) to body-wall, (*b*) to septum, and (*c*) to the nephridium. The ventral system is built up on the same plan. It is inadvisable to use the names "afferent" and "efferent" in regard to these vessels, for although no doubt one of them takes blood to the organ and the other one takes it away, yet we are in ignorance as to which does which. A comparison of the literature on the matter shows that Harrington* and Bourne agree to differ from the views expressed by Benham for *Lumbricus*. The statement of the latter as to the course taken by the blood in the dorso-parietal and ventro-parietal vessels is diametrically opposed to the views of Harrington, who made a most careful and elaborate study of the vascular system in *Lumbricus*.

On the other hand, the only earthworm which agrees with *Maoridrilus* in being without a subneural blood-vessel in which the vascular system has been pretty fully described is *Microchaeta* (Benham), and in the disposition of the vessels it agrees quite closely with *Maoridrilus*. So far, however, as the course of the vessels on the nephridium are concerned, we do not know the details. But in *Maoridrilus* the arrangement of the nephridial vessels is so similar to those in *Lumbricus* that it is unnecessary to reproduce the figures which I prepared for my thesis. It will suffice to give a brief account, and a figure representing the origin of the vessels in transverse section (fig. 12).

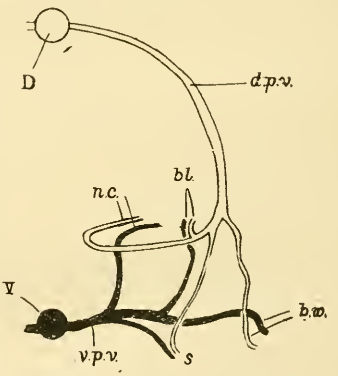


Fig. 12.—Diagram of the blood-supply to the nephridia in all parts of the worm with the exception of the most anterior ones.

The nephridial vessel arises from the dorso-parietal vessel, and runs alongside the septum towards the ventral end of the nephridium, where it enters the "spur"; it divides into two or three branches, one of which traverses the "folds" to reach the "dorsal lobe." Here it breaks up into a mass of small vessels (capillaries), which subdivide again and again so as to cover the winding ducts, and then unite to enter a corresponding vessel connected with the ventral blood-trunk. This vessel lies parallel with the former. Similarly, the other branches referred to, which go to the spur and to the outlet-duct, divide into capillaries, all of which enter corresponding vessels connected with the ventro-parietal vessel. This passes through the septum at the level of the nephrostome, and thence passes to the ventral blood-trunk.

There is a great fascination in tracing out the capillaries of this elaborate blood-supply, because it is remarkably beautiful under the microscope, and because, on account of the parallel arrangement of afferent and efferent vessels, one may be traced with ease into the other. Perhaps I may be permitted to quote here a sentence from Bourne (15, p. 327) which seemed, as I read it, so peculiarly applicable to *Maoridrilus*. Speaking of the peripheral vascular networks of *Moniligaster grandis*, he says, "Perhaps the

* Harrington, "The Calciferous Glands of the Earthworm, with Appendix on the Circulation." *Journal of Morphology*, suppl. to vol. 15, 1899.

most striking feature of these networks is the strict parallelism which obtains throughout between 'artery' and 'vein': they are not, indeed, strictly speaking, 'networks'; each small 'artery' loops round and becomes a small 'vein.'" In *Maoridrilus* such loops are easily recognizable.

Though the other parts of the nephridium have such an elaborate vascular system, with a complete investment of capillaries, yet the bladder has very few vessels. The first two nephridia are supplied with blood by a large branch from the extreme anterior end of the lateral vessel: this breaks up on the underside of the nephridia into a number of small branches, which reunite to form the efferent vessels, taking back blood to the anterior end of the ventral vessel.

In all the nephridia examined it was particularly noted that there were no dilatations in the blood-vessels such as are to be seen on the nephridium of *Lumbricus*. On the other hand, in *Plagiochaeta montana*, afterwards examined, these dilatations were numerous and large, though they occurred irregularly, and were not present in every nephridium.

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List of Abbreviations.

a. Narrow canal.
a.f. Anterior fold.
a.i. Inner narrow canal.
amp. Ampulla.
a.o. Outer narrow canal.
b. Bridge canal.
B. Commencement of bridge canal.
bl. Bladder.
c. Wide canal.
c.ep. Coelomic epithelium, or nucleus thereof.
ci.c. Cilia of central cell.
ci.l. Cilia of lumen of funnel canal.
ci.m. Cilia of marginal cells.
ch. Chaetae.
c.m. Circular muscles.
caec. Caecum of bladder.
co. Ciliated combs at entrance to bridge canal.
c.t.n. Nuclei of connective tissue.
D. Dorsal blood-trunk.
d.l. Dorsal lobe.
d.p.v. Dorso-parietal vessel.
ex.v. Excretory vesicles.
F. Funnel or nephrostome.
i.g. Intersegmental groove.
l.bl. Lumen of bladder.
l.m. Longitudinal muscles of body-wall.
m. Marginal cells.
m.f. Muscle-fibres of bladder.
n.c. Nerve-cord.
n.cc. Nucleus of central cell of funnel.
n.c.ep. Nucleus of coelomic epithelium.
n.d. Nephrostomial duct.
neph. 1–5. First to fifth nephridium.
n.p. Nephridial pore.
n.m. Nuclei of marginal cells.
n.t. Narrow tube connecting the bladder with nephridiopore.
nu. Nucleus of bladder-wall.
o.d. Outlet-duct.
p.f. Posterior fold.
pr. Protoplasmic processes of lining of bladder.
s. Septum.
sp. Spur.
X. Point in the spur where the outer narrow canal passes under the other canals to reach the opposite side.
V. Ventral blood-trunk.
v.l. Ventral lip of funnel.
w. Whip or flame of cilia at entrance to ampulla.
y. Junction of nephrostomial duct and anterior fold.
z. Junction of nephrostomial duct and funnel-duct.

Art. XX.—*The Nephridia of* Perieodrilus ricardi *and of* P. montanus.

By W. B. Benham, F.R.S., and Gladys Cameron, M.Sc.

[*Read before the Otago Institute, 5th November, 1912.*]

The genus *Plagiochaeta* was established by Benham in 1892 for a species which was termed *P. punctata*, and a full account of its anatomy will be found in the journal cited (2). In this article a brief account of the nephridium was given. The worm is meganephric, with alternating nephridiopores, but differs from *Maoridrilus* in the perichaetine multiplication of the chaetae. It was, however, found later that the worm to which Captain Hutton had given the name *Megascolex sylvestris* belongs to this same species. In 1902, Benham (3) described four new species which he attributed to *Plagiochaeta*, and gave a history of the matter, with references to previous literature.

Of these four species, *P. lateralis* is meganephric, but has the pores in a single series, as in *Eodrilus* of Michaelsen. *P. rossi* was described as micronephric, as also were *P. ricardi* and *P. montana*; but in the case of the last two Benham, in a footnote to a paper (4) on "Some Edible and other Worms" (1904, p. 229), stated that a re-examination of these had shown him to have been in error; they are really meganephric, though the organ is small in comparison with the size of the worm, and is thrown into a series of coils which simulates the scattered individual nephridia of a micronephric worm.

Dr. Michaelsen (9), who has discussed so fully the systematic position of the New Zealand worms, suggested in 1907 (p. 140), by his tabular arrangement of the "holoandric Acanthodriline" genera, that the meganephric *P. lateralis* should be placed in a new genus, on the ground that the nephridiopores are in line, instead of being alternate as in *P. sylvestris*.

In 1909, in his memoir on the earthworms of India and neighbouring lands, he again discussed (10, p. 202) the systematic position of these four worms, and suggested that the three "micronephric" species should be removed from the genus *Plagiochaeta* and placed in his genus *Hoplochaetella*; and finally, in 1910, after examining material which Benham had sent him, he recognized the distinctness of *lateralis* by erecting the genus *Pericodrilus* for it (11, p. 61). As a result of this examination he confirms Benham's statements for *lateralis* and *rossi*. In the case of *montanus* he was unable, owing to the poor state of the specimen, to satisfy himself as to the true condition of affairs, but was inclined to believe that it is micronephric. As will be seen below, in this he was misled by the difficulty of tracing out the tubules, owing to the presence, as he says, of the numerous cysts of Gregarines.

As to *P. ricardi*, he had no specimens at his disposal, and accepts Benham's statements as to its being meganephric, and therefore places it in the genus *Pericodrilus* along with *P. lateralis*. During the expedition to the subantarctic islands Benham obtained and described (1909, p. 275) a new species, which he places in the genus *Plagiochaeta*; but according to Michaelsen's definition it should be called *Perieodrilus plunketi*. At the same time, apart from the condition of the nephridia, it may be noted that it differs from the other species in having a mere vestige of a gizzard, whereas in *P. lateralis* this organ is well developed. As he has separated *Eodrilus* from *Microscolex* (*Notiodrilus*) owing to the condition of the gizzard, perhaps this worm ought to be placed in a new genus; but for the present it may be left in *Pericodrilus*, as it is possible that the state of the gizzard may be due to its mode of life—that is, it may be adaptive.

Consequently the seven species which have been attributed to the genus *Plagiochaeta* will be distributed among three genera, belonging to two subfamilies of the family *Megascolecidae*.

Subfam. ACANTHODRILINAE.

Plagiochaeta Benham.
  P. sylvestris Hutton.
  P. lineatus Hutton.
Perieodrilus Michaelsen.
  P. lateralis Benham.
  P. ricardi Benham.
  P. montanus Benham.
  P. plunketi Benham.

Subfam. OCTOCHAETINAE.

Hoplochaetella Michaelsen.
  H. rossi Benham.

There still remained some doubt as to *montanus*, but, as will be shown below, it is really meganephric, though the nephridia are very small and the tubule clustered so as to simulate a micronephridium.

* * * * *

The three species of earthworm dealt with in this paper have been found only in quite out-of-the-way localities—*H. rossi* was collected on the western shore of Lake Te Anau ; *P. montanus* in thick forest, 1,100 ft. above sea-level, between that lake and George Sound ; while *P. ricardi* comes from Resolution Island. Those who are at all familiar with the geography of this part of New Zealand will recognize the great expenditure of time and money that would be required to obtain fresh material from such inaccessible places. This must be the excuse for the poor state of preservation of the material, sent as it was in formalin, and for the attempt to work out the finer anatomical points on such material.

Note on Hoplochaetella rossi.

We take this opportunity of giving a figure of the nephridium of this species, as seen under a dissecting microscope : it is clearly micronephric, as Benham has already stated.

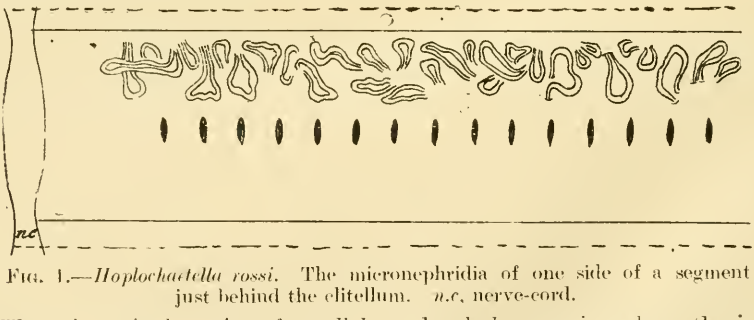

FIG. 1.—*Hoplochaetella rossi.* The micronephridia of one side of a segment just behind the clitellum. *n.c.* nerve-cord.

There is a single series of small looped tubules running along the inner surface of the body-wall, just behind the septum, and lying wholly anterior to the chaetal row. This series starts from a short distance outside the nerve-cord, and reaches almost to the mid-dorsal line (fig. 1).

In the posterior region of the body the tubules are smaller and more densely packed.

Perieodrilus (Plagiochaeta) ricardi.

This worm was originally stated to be micronephric (3, p. 287); but, as has been pointed out in the introductory note, this is not the case, for, though the appearance of the nephridia suggests separate tufts of tubules arising independently from the body-wall, these tufts are all connected, and constitute the looping of one long bundle of tubules. The worm, therefore, though the nephridium is diffuse, is meganephric; but compared with the very great size of the worm it is exceedingly small, is concentrated near the nerve-cord, extends for about one-fifth of the semicircumference of the body-wall, and takes up but little space in the body-cavity. A specimen measuring 13 mm. in diameter, when laid open, has its body-wall 40 mm. wide; the nephridium commences at a distance of 5 mm. from the nerve-cord, and the coils of the organ occupy only a length of 4 mm.; the duct passes outwards to the pore in a straight line.

It shows no trace of the distinct regions presented by such worms as *Lumbricus*, *Maoridrilus*, &c. It consists of one long tubule of nearly uniform diameter, which is looped or folded vertically upon itself, the separate folds being connected by horizontal tubules lying on the body-wall near the base of the septum. The ventral ends of the upright folds and the horizontal connections are bound together by blood-vessels and connective tissue, and we may call this part of the nephridium the basal portion.

The various folds have a diameter of about the same size as that of the anterior or posterior folds of *Maoridrilus*, and the canals contained therein are similar to those in the latter worm. The specimens of *P. ricardi* which were examined were all preserved, and the regions of the excretory tube could not be clearly seen in all parts of the nephridium, nor could they be traced individally from funnel to pore. But the tubule is differentiated into the narrow tube (*a.o* and *a.i*, fig. 2), the ciliated middle tube (*b*), ("bridge" of *Maoridrilus*), and the wide tube (*c*), as usual in earthworms. The tubes follow the course of each fold, bending back on themselves at the apex or spur. There are several of these single folds in each nephridium, and this fact, together with the similarity in structure between the excretory canals of *Perieodrilus* and *Maoridrilus* or other meganephric genera, leads one to think that the nephridium of *P. ricardi* represents a transition state between a meganephric and micronephric condition. The one large nephridium is still single, but has become diffuse in form, and has lost the specialized regions of its original form, though it has not yet broken up into separate tufts of micronephric tubules.

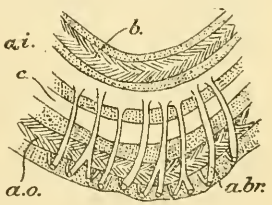

FIG. 2.—*Perieodrilus ricardi.* Portion of a loop of a nephridium mounted unstained in glycerine.

The outer and inner narrow tubes wind in and out of each other at the apex of a fold in a manner which recalls the dorsal lobe of *Maoridrilus*: the wide tube is not affected by these windings, but retains its direct course round the fold. The narrow canals pass above and below it as they loop round each other, and there is sometimes a loop round the wide canal. Over a great part of the nephridium the inner narrow canal (fig. 2, *a.i*) sends out processes (*a.br*) which loop round the other canals on the convex side of the fold and return to the one from which they are given off. This branching does not form a network such as occurs in the excretory tubules of *Microchaeta* (1), where the narrow duct, indeed, is made up of a network of anastomosing canals; but each branch is separate, and forms a single loop round the ducts which lie between the narrow canal and the outer side of the tubule. Sometimes, however, the branch divides into two before it bends round; but, as a rule, there is no connection between the individual loops (*cf.* also Eisen's figure of *A. marmoratus*).

Each such excretory loop is accompanied by a fine capillary blood-vessel, and when seen in optical section the vessels form a perfectly regular trelliswork radiating from the inner to the outer side of the fold (fig. 3), and the appearance presented when the nephridium is mounted in glycerine is remarkable, for the blood-vessels shine out very clearly and form a striking characteristic of the nephridium.

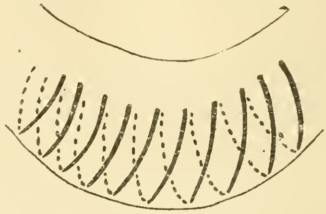

Fig. 3. — *Perieodrilus ricardi.* Sketch of the appearance presented by the blood-capillaries as they follow the branches of the narrow canal.

But for this regular trelliswork of blood-vessels the looping of the excretory canal might be easily overlooked—at any rate, in preserved specimens—for the canals are so transparent that they are seen with great difficulty except in that part of a fold where the ciliated regions occur; but the canals are here easily distinguishable, and the direction of the current may be deduced from the direction of the cilia. A more minute examination of the blood-vessels proves, however, that each capillary accompanies a loop from the narrow duct, and that both have a semicircular course, passing outwards to the edge of the fold and back again to the duct round the intervening tubes.

These capillary blood-vessels are exceedingly fine, and their actual connection with the main blood-supply cannot usually be seen. It was observed, however, in a few cases, and these were sufficient to set at rest any doubts of a possible misinterpretation of the appearance presented.

It is worth noting the behaviour of similar outgrowths from the narrow canal in the various genera which possess a branching system of tubules.

In *Microchaeta rappi* (1), the nephridium of which, excluding the well-developed bladder, is not unlike that of *P. ricardi*, there occurs in each looping fold of the rosette an anastomosing system of ducts which ramify over and around the wider canals of the fold. In this species there is no narrow canal sending outwards regular processes from its lumen; the branching has become quite irregular, and the duct itself has become lost in its branches.

In *Moniligaster grandis* (7) the narrow canal is not branched in such a complicated manner; it is still distinguishable in most regions, but in the distal portion of the glandular lobe transverse connections appear between the two parallel regions of the narrow tube, though in some parts the outgrowths of ductules are irregular.

In *Argilophilus*, as described by Eisen (8), we find a condition which resembles more nearly that of *P. ricardi*. Here, however, the branching is limited to a definite portion of the narrow tube—viz., along the whole length of the anterior fold—in accordance with the perfectly definite form of the nephridium, while in *Pericodrilus* it appears to occur in many regions and in any.

Fig. 4, a transverse section of a fold containing three canals, shows the branching of the inner canal (*a.i.*) to form a loop round the thick-walled wide canal (*c*). It appears from this that the loop is not perfectly straight, but has a slightly wavy outline, so that it is cut across in parts of its course (*a.br*).

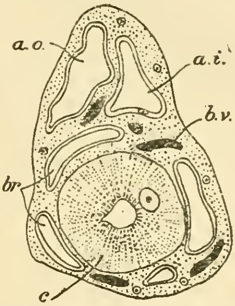

Fig. 4.—*Perieodrilus ricardi.* Transverse section through a loop of a nephridium.

The narrow canal has the same histological structure as that of *Maoridrilus*, &c.—a thin wall surrounding a very wide lumen : *i.e.*, a cell so largely perforated that but a small part of its outer wall remains, and this part carries the nucleus. The small amount of protoplasm forming the wall of the lumen is granular.

The wide canal (fig. 4, *c*) has a very characteristic appearance when seen cut across. The lumen is intracellular, but it is comparatively very small, being reduced to a mere slit between the thick surrounding walls. The granular protoplasm is radially striated, the striations appearing very distinctly, so that the protoplasm seems to be arranged in lines radiating outwards from the lumen to the outer wall of the duct. Similar striations have been recorded in the nephridium of *Lumbricus* and some other earthworms.

There is no muscular bladder or terminal vesicle of any kind : the nephridium ends in a long narrow outlet-duct which opens to the exterior at some distance from the main portion. At first sight the duct appears to be threefold, suggesting that the nephridium is formed of three closely opposed nephridia whose ducts lie parallel to each other and open by a common pore ; but towards the distal end of the duct one of the three canals turns back upon itself, forming a loop, and passes back again into the nephridium, while the now single outlet-duct passes through the body-wall to the nephridiopore.

The length of the outlet-duct is remarkable, and the appearance presented in the opened worm recalls immediately the figures given by Bourne (6) of the nephridia in the embryo of *Mahbenus*, where the long narrow excretory duct grows out from the neck of the embryonal nephridium and passes for some distance along the body-wall before it communicates with the exterior. The absence of any muscular sac in *Perieodrilus* marks this genus off from *Maoridrilus*, in which the terminal vesicle is exceedingly well developed.

The nephridiopores are not arranged, as in *Maoridrilus*, in a dorsal and ventral series ; they show no alternation, but open laterally, or slightly nearer to the dorsal surface than to the ventral, at some point between the 14th and 18th chaetae. The chaetae are numerous, and form a continuous circle round the body. Between these small limits, however, there is no definite position for the nephridiopore. It opens to the exterior either at the level of a chaeta or at any point between two chaetae. From the other end of the nephridial coil the short nephrostomial duct passes from the nephridium through the septum and ends in the preceding segment in an extraordinarily minute funnel—minute, that is to say, in comparison with the size of the worm, which is very large, and even with the size of the nephridium, which is small for such a large worm. Seen in section, the funnel lies right against the muscular layer of the body-wall, and not far removed from the nerve-cord. It is much smaller and less well developed than that of more typically meganephric worms, but there is only one in each segment, which fact is a further indication of the meganephric condition of the worm. Unfortunately, the preservation of the worm was not sufficiently good to allow of the study of detailed histology: what could be observed of the nephrostome is given in fig. 5, taken from a series of sections cut transversely and stained in borax carmine. The funnel is seen to consist of a central cell and marginals. It is cup-shaped, and not unlike the distal portion of the funnel of *Maoridrilus*, except that the latter is larger and its marginals are more distinctly seen. There appear to be no cilia on the central cell of *Perieodrilus*. The marginals are bent inwards from the back of the cup to form a hood over the cavity of the funnel—fig. 5 (*b*)—so that a section from side to side near the back of the funnel does not show an opening to the coelom.

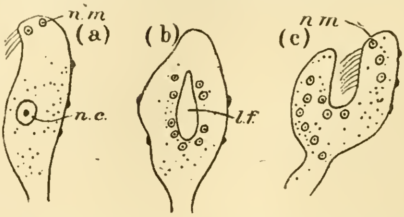

Fig. 5.—*Perieodrilus ricardi.* Three consecutive sections—(*a*), (*b*), (*c*)—through the funnel.

There is no doubt as to the presence of a central cell, the nucleus of which may be distinctly seen (*n.c.*) in fig. 5 (*a*).

Perieodrilus montanus.

The nephridium of this species is similar to that of *P. ricardi*. It has the same diffuse form, on account of which the worm was originally considered to be micronephric (see figs. 6, 7). *P. montanus* is smaller than *P. ricardi*, and the size of the nephridial tube corresponds with the smaller

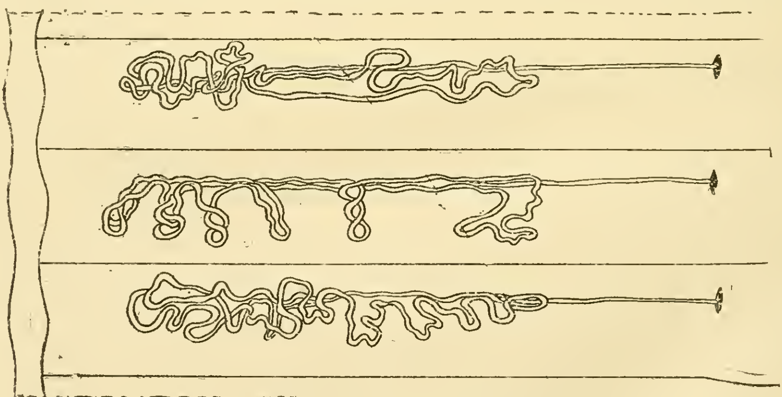

Fig. 6.—*Perieodrilus montanus.* Three segments, not consecutive, from the mid-body, showing the variation in the looping of the nephridia.

size of the worm, the tubules being much finer and more delicate in the former species. A worm 12 mm. in diameter, the body-wall when laid open and flattened out measures 30 mm. across, the nephridial coil is 5 mm. in length and commences 2 mm. from the nerve-cord.

The various loops of tubules are so extended that under a No. 8 dissecting-lens of Leitz they appear to be independent of one another. They are variously and irregularly arranged from segment to segment (*cf.* fig. 6). Though usually concentrated near the nerve-cord, there is frequently a second bunch, or it may be only two or three loops, farther away; and in other cases the loops are more evenly distributed along the body-wall. The coil is, however, usually limited to the lower half of the body.

In the segments immediately following the clitellum the nephridial loops are larger and more closely packed (fig. 7).

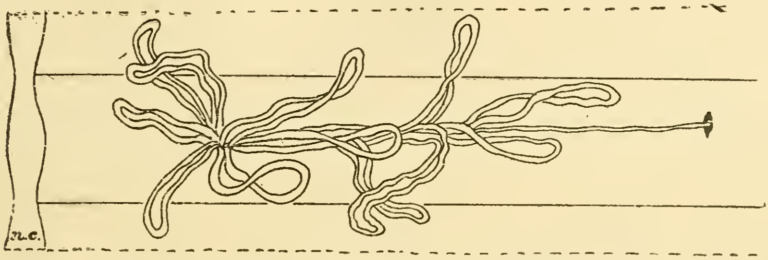

Fig. 7.—*Pericodrilus montanus.* The nephridium, distinctly meganephric, of one side of a segment just behind the clitellum.

A very fine duct, overlooked at first, passes upwards to penetrate the body-wall at about the level of the 12th or 13th chaeta, and there is no bladder.

A funnel was detected, but owing to the poor state of preservation of the tissue and the rather imperfect condition of the sections we are unable to figure it or do more than note its existence.

We have not observed any branching of the narrow duct in the form of processes looping round the other ducts of the fold; nor are there any blood-capillaries having the characteristic arrangement observed in *P. ricardi*.

The most prominent feature of *P. montanus* in preserved specimens is the elaborate investment of blood-vessels which ramify over all the folds, forming a closely covering network. This makes the nephridium an extremely beautiful object when viewed through the microscope, as each capillary shines out clearly in the transparent folds, especially when glycerine has been added to the preparation.

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3. Benham. "On the Old and some New Species of Earthworms belonging to the Genus *Plagiochaeta*." Trans. N.Z. Inst., vol. 35, 1902, p. 277.
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Art. XXI.—*New Species of New Zealand* Empididae (*Order* Diptera).

By David Miller.

[*Read before the Otago Institute, 3rd December, 1912.*]

Plate I.

The following are descriptions of four new species of *Empididae*. Generically they agree with the characters given by A. L. Melander in his "Monograph of the North American *Empididae*," with the exception of one species, *Brachystoma adelensis** (Plate 1, fig. 2). In this fly the eyes are holoptic in both the male and female, and do not approach below the antennae; the anal angle is not gone; and connecting the 2nd and 3rd longitudinal veins is a supernumerary cross-vein. The other three species belong to the genus *Hilara*—*H. kaiteriensis*,† *H. philpotti*, and *H. benhami;* the second is named after Mr. A. Philpott, of Invercargill, who has generously presented to me a large collection of *Diptera*, and the third after Dr. W. B. Benham, of the Otago University, to whom I am greatly indebted for his kind assistance.

In all cases the antennae, legs, and wings were mounted dry, and examined under a compound microscope.

Fam. EMPIDIDAE.

Genus Hilara Meigen.

Melander, Trans. Amer. Ento. Soc., vol. 28, p. 262 (1902).

Table of Species.

Thorax with 4 brown stripes	*H. benhami.*
Thorax yellow, without stripes	*H. kaiteriensis.*
A minute grey littoral species	*H. philpotti.*

Hilara benhami sp. nov. Plate 1, fig. 3.

Head spherical, eyes bare, dichoptic, and deeply emarginate at the base of the antennae. Frons greyish-brown with a central darker spot just above the antennae, the orbits dark brown, and 2 rows of delicate greyish and divergent fronto-orbital bristles, the outer extending from just above the antennae to a little below the ocellar triangle, the inner occupying the first third of frons from the triangle (fig. 1), which is rounded and promi-

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* Captured on the mainland, opposite Adele Island, Tasman Bay.

† At Kaiteriteri, in Tasman Bay, a large collection of *Empididae* was obtained.

nent, occupying the greater part of the vertex; the ocelli are orange, and between them are delicate bristles, a pair of which are larger and divergent, representing the ocellar pair. Face greyish-brown with silvery reflections, slightly hairy, and in profile rounded at the epistome; the oral margin is dark brown with a light-brown tomentum and scattered brown hairs, while the lower margin of the head is slightly sinuated and comes into contact with the lower corner of the eye (fig. 2). Antennae dark brown, with a greyish tomentum, about as long as the height of the head; the 1st joint, bearing short stiff and delicate bristles, is longer than the 2nd and about one-half as long as the 3rd, minus the flagellum; the 2nd joint is spherical, with stiff delicate bristles; and the 3rd, which is broad at the base but tapering distally, is black with a greyish tomentum; the flagellum is less than one-half the length of the 3rd joint, but has more tomentum, and bears a minute naked terminal appendage. Proboscis horny and shiny-black, tapering to a point, and about as long as the height of the head; the palpi

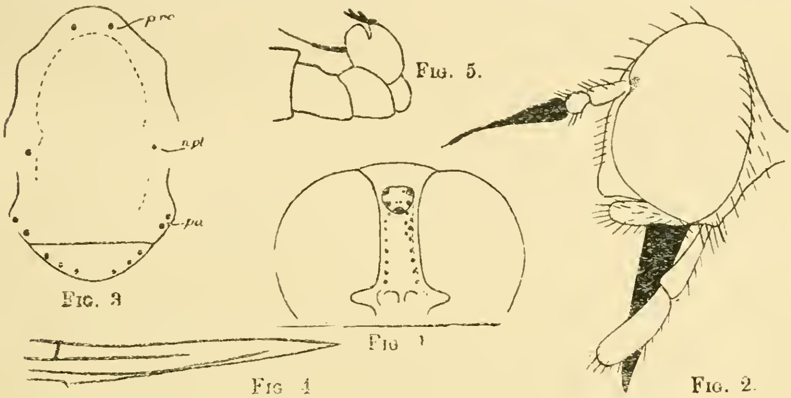


FIG. 1.—Dorsal view of head, showing chaetotaxy.
FIG. 2.—Profile of head.
FIG. 3.—Dorsum and scutellum, showing chaetotaxy. *pro*, pro-thoracic bristles; *npl*, noto-pleural bristles; *pa*, post-alar bristles.
FIG. 4.—Showing auxiliary vein and structure of 1st longitudinal.
FIG. 5.—Hypopygium in profile.

are brown with scattered hairs, about as long as the proboscis, broad and flattened distally, and notched in the centre of the posterior margin. Occiput with brown and greyish reflections, and bearing delicate short bristles.

Thorax prominent, but not humped, grey, with 4 dark-brown almost black stripes, the outer ones being anteriorly shorter than the inner, while before the scutellum the dorsum is brownish-grey, with a delicate median stripe in certain lights. On the dorsum are rows of short delicate bristles, a pair of divergent pro-thoracic bristles (fig. 3, *pro*), a single noto-pleural (*npl*) below the line of the dorsal suture, a pair of post-alars (*pa*), and a few hairs on the humeri and pro-pleurae. Scutellum broad and greyish-brown, but darker towards the base, bearing convergent marginal bristles except on the apex, towards which they strengthen. Halteres long, with light-brown stalks and darker heads.

Wings faintly tinged with brown, the stigma and veins dark brown, the latter lighter towards the articulation. Auxiliary vein evanescent at the tip, not reaching the costa; the 1st longitudinal appears as two veins which are approximated for a short distance beyond the origin of the 2nd vein, but are separated both proximally and distally, the upper branch being lost in the pigment of the stigma, while the intervening space is dark brown (fig. 4); 2nd vein almost straight, being but slightly upturned distally to meet the costa; 3rd vein forked, the anterior branch leaving at right angles, curving forward almost immediately and then gradually upwards to the costa, the posterior branch being slightly down-curved; the anterior transverse vein oblique, the posterior, which is strongly sinuated, is one and a half times its own length from the margin of the wing; anal cell shorter than the 2nd basal, the anal cross-vein, which is parallel to the posterior margin of the wing, forming an obtuse angle with the anal vein, the anal angle being developed.

Legs brownish-black, slightly shiny and hairy with a lighter tomentum, the femora not thickened, the anterior legs being the shortest. A few bristles ventrally on the posterior and dorsally on the middle femora but none on the anterior, the coxae of which are horter; in certain lights, the tibiae with a brownish appearance proximally and dense longer hairs distally on the ventral side of the anterior tibiae, which are thickened to carry the enlarged metatarsi, the following tarsal joints of this pair of legs possessing a few bristles amongst the hairs of the vestiture; the posterior tibiae bear a dorsal pre-apical bristle,* while ventrally the apical corner is produced to a tubercle; the posterior metatarsi are nearly three times as long as the following joint, while those of the middle legs are not twice as long.

Abdomen long and linear, of a dark-brown colour, lighter below; on the sides long and scattered hairs, denser on the 1st segment; on the anterior corners of each segment and on the sides of the last two a grey tomentum; dorsally and ventrally convex, but beyond the 4th segment the ventral surface is flattened, the connecting membrane of the dorsal and ventral plates disappearing. The hypopygium, which is prominent, swollen, and upturned, is hairy with a scattered grey tomentum; projecting forward is a narrow, pointed, shiny-black process, from the apex of which extends a long stiff golden hair (fig. 5), while on the upper side is a black chitinous plate toothed on its upper side and projecting over a deep notch in the hypopygium.

♂. Length, 7 mm.; wing, 8 mm.

Hab.—Captured on manuka above a beach at Astrolabe, Nelson, January, 1912. Not common.

Hilara kaiteriensis sp. nov. Plate 1, fig. 1.

Head a little broader than long, eyes bare and dichoptic, deeply emarginate at the base of the antennae, and occupying the greater part of the side of the head. Frons tawny, with a yellow tomentum and a medio-longitudinal darker line in certain lights, the orbits being tawny without tomentum and the fronto-orbital bristles being arranged as in *H. benhami.* Ocellar triangle rounded but not occupying most of the vertex between the eyes, with yellow reflections (darker n certain lights) and a pair of strong but not long ocellar bristles and a pair of weak post-ocellar ones; ocelli orange. Face easily seen in profile, tawny with a yellow tomentum, and ending considerably above the lower eye-margin; the epistome projecting slightly; cheeks narrow and tawny with a yellow tomentum, the oral margin rounded

* In the illustration it is drawn on the ventral side.

and posteriorly angulated, bearing stiff bristle-like hairs. Proboscis as long as the head (fig. 6), tawny proximally but shiny-black distally, the palpi as long as and applied to the proboscis, tawny with a darker tomentum, and shaped as in *H. benhami.* Occiput with a yellow tomentum and a row of post-orbital bristles, while on the lower portion are scattered bristles and golden hairs. Antennae nearly as long as the height of the head, the 1st and 2nd joints tawny with a yellow tomentum, not long and of about equal length, each having a pre-marginal whorl of short black bristles; 3rd joint black but tawny at the base, shaped as in *H. benhami*, about two and a half times as long as the first two joints together and with a scattered yellow pubescence, the pubescent flagellum is 2-jointed and about a quarter the length of the 3rd antennal joint; the 1st joint is short, and the 2nd ends in a terminal appendage nearly one-half the length of the second.

Thorax not prominently humped, of a yellow colour, due to a dense tomentum, but tawny on the margins of the humeri and dorsum before the wings where the tomentum is absent. On the dorsum is a pair of rounded longitudinal ridges, not reaching the yellow scutellum, but ending in a

FIG. 6.

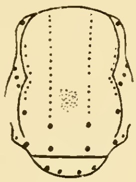


FIG. 7.

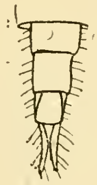


FIG. 8.

FIG. 6.—Profile of head.
FIG. 7.—Dorsum and scutellum, showing chaetotaxy.
FIG. 8.—End of abdomen.

median transverse depression, between which and the scutellar suture is a short tubercle-like ridge. Each ridge carries a row of closely set dorso-central and post-sutural bristles ending in 2 large widely separated convergent bristles (fig. 7), the acrostichals being represented by 4 rows of short closely set bristles, which terminate in an irregular clump just posterior to the line of the dorsal suture; there is a single humeral bristle and short stiff black hairs, a single supra-alar bristle, a pair of post-alars the anterior one on the angle being a stiff hair, a row of strong noto-pleurals, a row of weak pre-suturals (?) with a corresponding row posterior to the dorsal suture, while on the dorsum between the pre-suturals and the noto-pleurals and also between the anterior dorso-centrals and the humeral are scattered a few weaker ones; on the pro-thorax is a pair of straight and divergent tawny bristles, while the scutellum bears 4 convergent marginal bristles, the apical pair being crossed. The pleurae are bare and halteres tawny.

Wings hyaline, but distally the marginal cell is faintly clouded with yellow, and near the origin of this cell, in line with the apex of the auxiliary vein, is a brown fusiform spot; the 1st section of the 3rd vein, the anterior transverse and the lower margin of the 2nd basal cell are also bordered with brown, giving a banded appearance to the wing. Auxiliary, 2nd, and 3rd veins formed as in *H. benhami;* anterior transverse vein not oblique, the posterior sinuated, not parallel to the hind margin of the wing, and nearly twice its own length from the margin in which ends the last section of the 5th vein; the 1st basal cell partially closed anteriorly by a half-formed transverse vein from the 1st longitudinal, the 2nd basal cell a little longer than the anal cell, the anal cross-vein curved into the anal vein and parallel to the posterior margin of the wing. At the articulation there are a few bristles on the costa.

Legs tawny, the vestiture being yellow on the ventral side of the anterior tibiae, while the tibiae and tarsi of all the legs have a dense yellow tomentum. Dorsally on all the femora is an apical semi-whorl of longer bristles; and ventrally on the posterior, middle, and anterior tibiae is a similar arrangement of black apical bristles, while dorsally is a pair of apical bristles. Anterior coxae almost two-thirds as long as the femora, the metatarsi not dilated, and longer than the following joint, as are those of the other legs, but on each joint of the posterior and middle tarsi is a semi-whorl of apical bristles, while the anterior tarsi possess a few longer hairs.

Abdomen black, with a thin grey tomentum and scattered yellow hairs; dorsally and ventrally convex, tapering apically and terminating in 3 tawny segments with a pair of apical styliform lamellae (fig. 8) which are darker in certain lights. Six abdominal segments visible from above, the posterior margin of each, excepting the 1st, being brownish, while the base of the 2nd and the apex of the 6th are tawny in certain lights, and dorsally on each side of all the segments is a pair of black spots, the anterior one being more lateral than the posterior.

♀. Length, 4·5 mm.; wing, 5 mm.

Hab.—Captured on a mapau-tree, in the sun, near Dunedin, October, 1912. Not common.

Hilara philpotti sp. nov.

♂. Head globular, notched in front to receive the antennae. Eyes bare, dichoptic, and deeply emarginate at the antennae, forming a part of the lower margin of the head, and in profile confined to the anterior half (fig. 9). Frons wide, not much narrowed anteriorly, but depressed and slightly notched, with a rounded ridge-like portion at the antennae. Ocellar triangle not prominent, but very wide and narrow; consequently the ocelli and the long divergent yellow ocellar bristles are widely separated; fronto-orbital bristles represented by a row of stiff greyish hairs extending from above the antennae to below the ocellar triangle. Antennae black, with a thin grey tomentum; 1st joint short, with a very few hairs; 2nd joint globular, with a whorl of greyish hairs; 3rd black, broad at the base and tapering to a point; arista terminal, not a quarter the length of the 3rd joint, the short terminal appendage being black at the tip. Face seen in profile projecting at the epistome, which is above the lower margin of the eye. Occiput large and rounded, bristly and with light-brown hairs, the lower posterior angle of the head produced to a rounded projection, while the lower margin bears long silvery hairs. Proboscis

Fig. 9.—Profile of head.*

* In this diagram the antennae are enlarged, being drawn out of proportion.

black, not so long as the height of the head, the palpi brown and hairy, as long as and applied to the proboscis, ensheathing the tip.

Thorax not prominently humped, with rows of minute black bristles, among which are a few upright grey hairs which on the scutellum form 4 marginal convergent bristles. Wings greyish with a light-brown stigma, the veins being very light greyish-brown and weak towards the articulation. Auxiliary vein very weak, otherwise as that of *H. benhami ;* 1st vein comparatively thick and apparently bifid distally (fig. 10) ; 2nd vein almost straight, but slightly upturned at the costa ; 3rd vein forked and slightly angled at the bifurcation, the anterior branch leaving at an acute angle, and slightly sinuated ; anterior transverse vein at right angles, the posterior but faintly sinuated and about twice its own length from the margin,

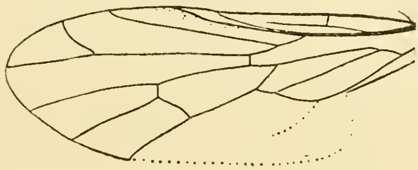


FIG. 10.—Wing.

the last section of the 5th vein reaching the margin ; anal cell shorter than the 2nd basal, the anal cross-vein parallel to the posterior margin of the wing and curved into the anal vein. Halteres light greyish-brown.

Legs grey, but darker brown in certain lights, with a vestiture of greyish short hairs, the anterior and posterior femora being laterally flattened and angulated at the middle ; the anterior metatarsi are about twice as long as the following joint, both of which are flattened and slightly enlarged, the middle metatarsi about one and a half times as long as the following joint, and those of the posterior legs about one and three-quarters the length of the following.

Abdomen ending in a cone-shaped protuberance (in profile), grey with spots, short delicate bristles and lateral tufts of silvery hairs.

♀. Broader and darker than the ♂. the vertex wider and the frons considerably narrower at the antennae, the 2nd antennal joint greyish-yellow, and the abdomen is apically pointed.

♂ and ♀. Length, 2·25 mm. ; wing, 3 mm.

Hab.—Captured on marram-grass and sand, Purakanui, January, 1910. Not abundant.

Bio.—On account of the protective greyish colour of this species, it is seen with great difficulty when at rest.

Genus BRACHYSTOMA Meigen.

Melander, Trans. Amer. Ento. Soc., vol. 28, p. 259 (1902).

Brachystoma adelensis sp. nov. Plate 1, fig. 2.

General colour dull-shiny brownish-black.

♂. Head about as wide as the thorax, the eyes bare, occupying the whole of the side of the head, and emarginate below the antennae, where they are dichoptic, but holoptic above ; ocellar triangle rounded, prominent in profile, of a dull-black colour, with a thick tomentum ; ocelli prominent, of a very dark madder-brown ; a pair of strong proclinate ocellar bristles and a similar but larger pair of post-ocellars ; frons narrow, wedge-shaped and small, with dense brownish tomentum. Antennae dull black, microscopically pubescent, the distal portion of the flagellum and the terminal appendix dark brown ; 1st joint short and bristly; 2nd joint globular and bristly, the outer ones longer ; 3rd joint about twice as long as the 1st and 2nd together, the terminal flagellum almost as long as the 3rd. Face not seen in profile, black with a greyish-brown tomentum ; the lower margin of the head with grey hairs ; proboscis and palpi withdrawn, but in profile is a hairy shiny-black knob-like protuberance somewhat resembling a palpus (fig. 11) ; occiput black with a greyish-brown tomentum and stiff hairs, the lower corner being considerably produced.

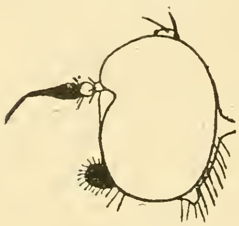


FIG. 11.—Profile of head.

Thorax short, prominently humped (fig. 12), the dorsum brownish-black, but lighter just before the scutellum, and with a lateral light-brown stripe from the post-alar callus to the humeri, widening anteriorly ; the chaetotaxy is represented by a few stiff humeral hairs, 2 rows of short light-coloured hairs, lengthening posteriorly, each ending in 2 stronger bristle-like post-suturals just before the scutellum ; the post-alars weak, but those opposite the base of the wing more distinct, as well as the marginal ones of the scutellum. Pleurae greyish-brown, due to a tomentum, bare but for 3 bristle-like curved hairs above the anterior coxae (fig. 12). Scutellum light brown on the margin, but darker towards the base.

FIG. 12.—Side view of thorax.

Wings brown, the stigma very dark, a clearer space between the end of the 2nd and the anterior branch of the 3rd vein, in the 2nd, 3rd, and 4th posterior cells, in the discal cell, and less distinct ones in the other cells ; the veins dark brown, but lighter distally ; the auxiliary vein, which on account of the folding of the wing appears approximated to the 1st vein, ends in the costa ; 2nd vein strongly upturned at the tip ; 3rd vein forked, the strongly sinuated anterior branch arises at an acute angle, and, curving forward for about half its length, bends backward to the costa, the posterior branch being straight ; a little before the middle distance between the insertion of the anterior transverse vein and the bifurcation of the 3rd longitudinal is a supernumerary cross-vein at right angles connecting the 2nd and 3rd veins ; this singular cross-vein is constant in both wings of all the specimens of this species in my possession ;* the anterior branch of the

* I have observed supernumerary cross-veins in other species of *Diptera*, but, as a rule, they are not constant in both wings, and, as in the case of *Calliphora hortona*, are absorbed as the fly matures after pupation. Is it therefore possible that the cubital appendices, which in some cases form specific characteristics, are not trustworthy features ? Space permitting, I could enumerate a few cases of New Zealand *Tachinidae*, for example, where the cubital appendix of the 4th vein is sometimes present or longer in one wing and absent or shorter in the other. In *B. adelensis*, the anterior branch of the 3rd vein and that of the 4th vary in the strength of the sinuation. Plate 1, fig. 2, is a moderate form?

4th vein is strongly sinuated into the 1st posterior cell, after which it continues its original course to the costa; anterior transverse oblique, the posterior sinuated into the discal cell and parallel to the posterior margin of the wing; the 1st basal cell is closed proximally by a cross-vein from the 1st longitudinal; anal cell longer than the 2nd basal, the anal cross-vein forming an acute angle with the anal vein, which is slightly curved at the tip to meet the posterior margin of the wing; the anal angle developed. Halteres with a light-brown stalk and a brown head.

Legs not especially elongate, blackish-brown, but lighter in certain lights, more particularly the femora. Posterior legs the longest, but not thickened: femora with dorsal and ventral bristles, the former short and extending the full length of the femora, the latter longer and occupying the proximal three-quarters only; tibiae slightly thickened distally and clothed with a dense vestiture of short bristle-like hairs. while ventrally is a long pre-apical bristle and dorsally a double row of 4 long bristles with numerous shorter ones; metatarsi about three times as long as the following joint, and bearing a double row of longer bristles and a pre-apical, upright slightly curved bristle on each of the other joints. Middle legs short: femora swollen, narrowing distally, and constricted at the articulation with the coxae; the dorsal bristles short, the ventral on the proximal half a little longer, and those on distal half nearly straight and much larger, with smaller ones interspersed: tibiae of a uniform thickness, slightly curved and angulated at the knee, but not with a dense vestiture; ventrally on the distal two-thirds is a double row of short but strong bristles, becoming smaller apically, and dorsally a pair of very long spines, one proximal, the other central; there are no apical bristles, but the lower corner is slightly produced tooth-like: tarsi shortened, the vestiture of brownish hairs with longer bristles like those of the posterior tarsi, but the apical spines are short. the metatarsi not quite twice as long as the following joint. Anterior legs: femora club-shaped, tapering distally, with long bristles on the ventral distal half only; tibiae slender, of a uniform thickness, with 3 long dorsal spines and a 4th very long proximal one; tarsi slender, the metatarsi elongate, about three times as long as the following joint, and with a vestiture similar to that of the middle tarsi; anterior coxae not greatly elongated.

Abdomen elongate, linear, and brownish-black, but greyish on the sides of the base, not ventrally dilated, and with a few white hairs on the sides, longer on the 1st segment; on the anterior margin of each segment is a row of spots (sometimes hidden by the overlapping of the preceding segment), and a pair of discal ones on each side, the anterior spot being nearer the lateral margin. Hypopygium prominent, in profile (fig. 13) the upper portion, roughly speaking, cone-shaped, from the upper side of which projects a curved knobbed hairy structure with a pre-apical posterior tubercle, the lower portion being a massive shiny-black chitinous claw strongly upturned towards the apex; from above is a pair of massive claws, one opposed to the other (fig. 14) (between the bases of which arises the knobbed structure), the inner edge of each bearing short strong spines, the intervening space being occupied by the lower claw, which is apparently

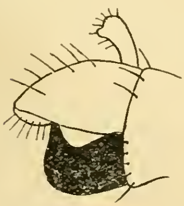


Fig. 13.—Side view of hypopygium.

Fig. 14.—Dorsal view of hypopygium.

spatulate at the tip; the lower claw excepted, the hypopygium is dull and bristly with a few long hairs.

I have a specimen, which I take to be a female, differing from the male in the broad (and shrivelled) pointed abdomen and in the greater length of the wing.

♂. Length, 6½ mm.; wing, 5½ mm.

♀. Length, 4 (?) mm.; wing, 6 mm.

Hab.—Common on the sea-beach near Adele Island, Tasman Bay, January, 1912.

Bio.—This fly darts hither and thither over the surface of still pools, and occasionally jumps into the air. Usually there are a number together

EXPLANATION OF PLATE I.

Fig. 1. *Hilara kaiteriensis* sp. nov.
Fig. 2. *Brachystoma adelensis* sp. nov.
Fig. 3. *Hilara benhami* sp. nov.

Art. XXII.—*A New Species of* Macquartia (*Order* Diptera).

By David Miller.

[*Read before the Otago Institute, 6th August, 1912.*]

This description follows the system adopted by Charles H. T. Townsend in his "Taxonomy of Muscoidean Flies."* I take this opportunity of expressing my indebtedness to the Smithsonian Institution for the assistance which I have received.

Fam. TACHINIDAE.

Genus Macquartia R. Desvoidy (1830). Hutton, Trans. N.Z. Inst., vol. 33, p. 46.

Macquartia kumaraensis† sp. nov.

Head.

Ptilinal suture narrowed and rounded at the top; its sides, for the greater part, divergent, but slightly convergent towards the termini, which are below the level of the lower eye-border, and in line with the vibrissal angles; the cheek-sutures consequently ascending (fig. 2, *k*).

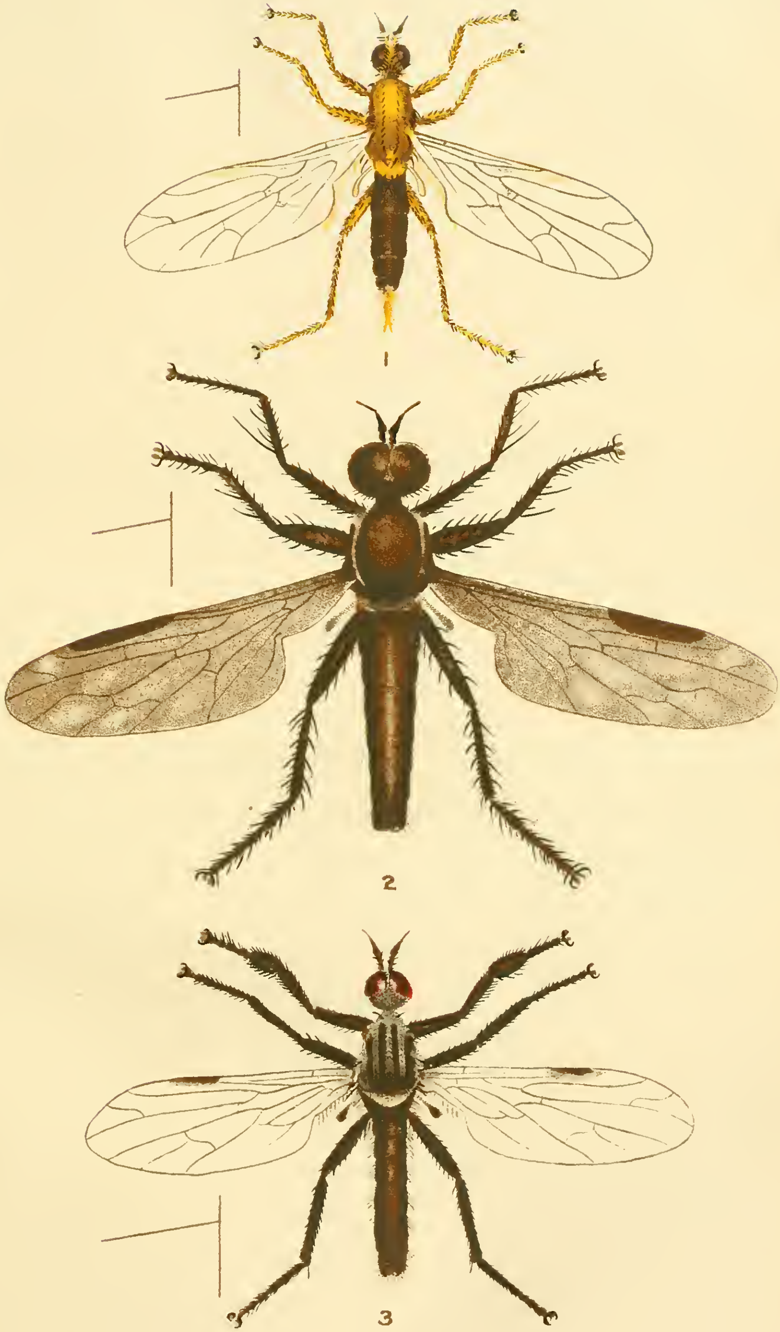
Ptilinal area oval, occupying about one-third of width between the lower corners of the eyes.

Longitudinal median line of *facial plate*, in profile, projecting forward below the antennae (fig. 1, *a*), but restricted and flattened at vibrissal angles.

Foveae double, deep and elongate, flattened upon the inner and rounded upon the outer edge (fig. 2, *d*).

* Smi. Inst. Coll., vol. 51 (1908).

† This species was captured in the vicinity of a promontory known as Potato Point, hence the name *kumaraensis*, "kumara," in the Maori vernacular, signifying a sweet potato.



D. Miller del[t].

New Species of Empididae.

Face p. 206.]

Facialia unarmed, rounded, divergent, but gradually convergent below.

Vibrissae approximated well above the oral margin, on a level with termini of ptilinal suture (fig. 1, *e*; fig. 2, *i*).

A row of strong and a divergent row of weak *peristomal bristles* (fig. 1, *g* and *f*).

Oral cavity moderately deep, narrowing anteriorly but widening posteriorly.

Clypeus an elongate plate, anteriorly extending over full width of oral cavity, but narrowing towards the rostrum.

Proboscis horny, slender, projecting forward, slightly longer than the head, geniculated; *rostrum* brown; *haustellum* with a few golden hairs at the tip, shiny, dark brown except for a proximal whitish patch (fig. 1, *c*).

Palpi dark tawny, slender, elongate, well developed, projecting beyond epistome, and bearing long, thin, stiff, black bristles (fig. 1).

Longitudinal axis of head, at insertion of antennae, equal to axis of oral margin.

Facio-peristomal profile angular.

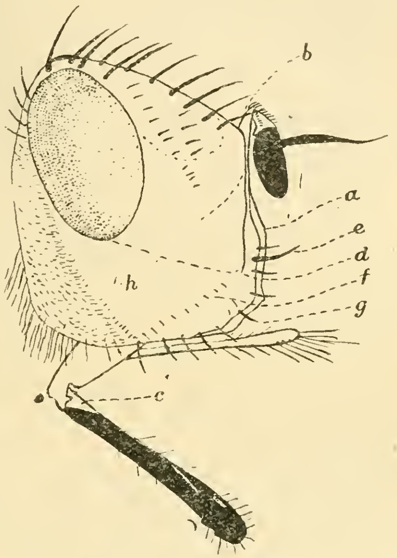


FIG. 1.—Head profile of *M. kumaraensis*; × 12 times.

Antennae approximated; 1st joint reddish-brown, projecting almost at right angles to frontalia, and with a few short bristles projecting forward on distal margin (fig. 1, *b*); 2nd joint of same colour as preceding, about half as long as 3rd, bearing closely set short bristles on front edge and a row of smaller lateral ones; 3rd joint dull-piceous, reddish upon inner proximal margin, occupying about one-third of the length of facial profile.

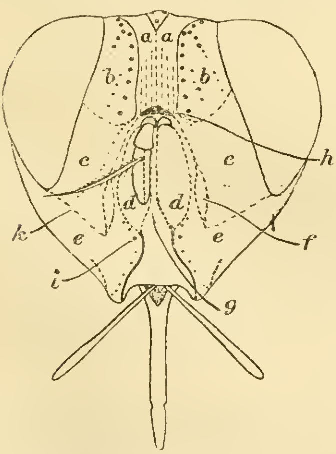


FIG. 2.—Front view of head of *M. kumaraensis*; × 12 times.

Arista piceous, minutely pubescent, tapering beyond two-thirds of length towards distal extremity; 1st aristal joint short, 2nd elongate.

Lunula crescent-shaped, rounded, in colour shining reddish-brown.

Eyes dichoptic, with sparse microscopic hairs, and receding to about the level of the middle of the face.

Vertex wide, inner vertical bristles very long, post-ocellar bristles delicate and divergent.

Front conically projecting; ocelli separated; ocellar plate triangular, of moderate dimensions, with weak bristles; pre-ocellar bristles absent.

Frontalia reddish-brown, opaque, rectangular, narrowing towards the vertex, longitudinally corrugated for about two-thirds of the length from notched lunula (fig. 2, *a*, *a*).

Post-vertical bristles absent.

Para-frontals tawny, with fuscous reflections; triangular, being narrowed towards the vertex; bare but for *frontal* bristles, which are convergent in a single row, extending to about the base of antennae (fig. 2, *b*, *b*); *lower fronto-orbital* bristles weak, the *upper*, 3 in number, divergent, in line with *middle fronto-orbitals*, themselves weak and convergent.

Para-facials bare, ochreous-yellow with tawny reflections, slightly swollen, rectangular in profile but narrowing slightly towards the orbit (fig. 2, *c*, *c*).

Cheeks of same colour as para-facials, bare but for a secondary divergent row of weak peristomal bristles, wide towards occiput, narrowed towards the facio-peristomal angle, height less than that of eye.

Posterior orbits bare, tawny, widened below; lower margin of the head straight.

Occiput tawny, flat above, swollen beneath, causing posterior margin of cheek to bulge slightly, and bearing stiff golden hairs above, which are longer and slender below; *occipital area* restricted to occiput; *post-orbital* bristles proclinate.

Thorax.

Sterno-pleural bristles strong, 3 in number, a pair being approximated a little anterior to the line of meso-pleural suture (fig. 3, *a*), and a single larger and longer bristle posterior to the line of this suture (*a′*); surface of sterno-pleurae with scattered bristles.

Ptero-pleural bristles long, 4 in number, a pair of strong (*c*, *c′*) and a pair of weak bristles (*d*) being arranged alternately near wing-articulation (*e*); around the insertion of these bristles are scattered black hairs, otherwise this segment is bare.

Meso-pleural bristles long, strong, 7 in number, 6 placed along mesopleural suture (*g*), the 7th, which is shorter, inserted in the vicinity of the upper anterior angle of pleura (*g′*).

Pro-pleural bristles strong, 3 in number (*k*).

Noto-pleural bristles strong, reclinate, 2 in number (fig. 4, *a*).

Post-sutural bristles long, 8 in number, 4 in each row (*b*); the posterior ones very long, extending beyond the scutellum, not exactly in line with the others, but inserted slightly towards the post-alars.

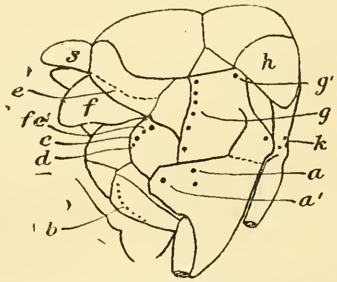


FIG. 3.—Side view of thorax of *M. kumaraensis*; × 6 times. *f*, tegula; *h*, humerus; *s*, scutellum.

Dorso-central bristles long, 6 in number, 3 in each row (*c*).

Acrostichals (*d*) strong, 8 in number, 4 in each row, shorter than the post-suturals; the posterior pairs are nearer to the scutellar than to the dorsal suture, the posterior ones being more erect.

Humeral bristles strong, reclinate, 5 in number, the most anterior more erect than the others; a pair upon lateral margin, one upon anterior margin, another in the centre of the humerus, and a delicate one between but in from the anterior and central chaetae (*e*).

Post-humeral bristles 3 in number, the anterior and posterior ones weak, not being in line with the strong intermediate bristle (*f*).

Pre-sutural bristles 2 in number, the one nearer to the dorsal suture weak (*p*).

Intra-alar bristles long, 3 in number (*g*).

Supra-alars (*h*) consisting of 3 long reclinate bristles and a weak shorter spine between the two anterior chaetae and slightly toward the intra-alar system.

Post-alar bristles long, 2 in number (*l*).

Scutellar bristles long; two pairs of lateral (*am* and *pm*), one pair of apical (*n*), and one pair of short discal bristles (*o*); the anterior lateral (*am*) and apical chaetae are of equal length; the posterior laterals (*pm*), being the longest of this system, extend to the posterior margin of the 2nd abdominal segment.

Thorax tawny, with fuscous reflections, which are darker posterior to the transverse suture; 4 dark-brown longitudinal stripes upon the dorsum. As the thorax is covered with short bristles, and those of the dorsum have a dark spot at the insertion, this portion is rendered darker in certain lights.

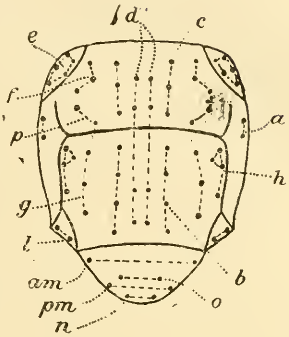


FIG. 4.—Showing chaetotaxy of the dorsum and scutellum of *M. kumaraensis*.

Scutellum ochreous-yellow, with cinereous reflections.

Wings.

The wings clear, costal spine absent, margin normal; costa ending just before the tip of wing, veins tawny; 3rd longitudinal vein bristly between its origin and the middle transverse, which, situated about the middle of the discal cell, is slightly oblique; 4th longitudinal vein normal,

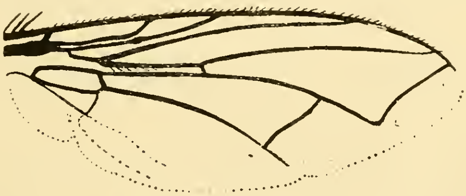


FIG. 5.—Wing of *M. kumaraensis*; × 12 times.

reaching the costa before tip of wing, rounded at the bend, and slightly curved into the first posterior cell, which, being open, is roughly a right-angled triangle; 5th longitudinal vein curved toward the 4th vein, not forked and not reaching the margin of wing; posterior transverse sinuate, parallel to last section of 4th vein, about two-thirds of the distance from middle transverse to bend of the 4th vein (fig. 5).

Tegulae moderately large; greyish-white, with a narrow yellow hairy margin, otherwise bare.

Abdomen.

Oval, broad, greatest breadth across posterior margin of 2nd segment, the basal segment narrowest; dorsally and ventrally convex; 4 segments visible from above; apical segment triangular; a broad black irregular medio-longitudinal stripe, otherwise marked with dark-yellow and golden reflections; macrochaetae strong, bristle-like; lateral bristles on all the segments, marginals and discals on 3rd (fig. 6) and 4th segments.

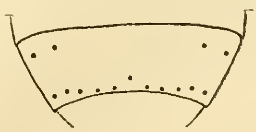


FIG. 6.—Third abdominal segment of *M. kumaraensis*, showing chaetotaxy; × 12 times.

Legs.

Bristly, elongate, especially the posterior pair, the anterior being shortest: tawny, femora lighter from the proximal end, the tarsi becoming darker distally on account of short closely set bristles; *hind femora* flattened laterally and slightly convex anteriorly, covered with minute bristles also bearing upon the under side a double row of large divergent spines, and upon the upper side an irregular row; *hind tibiae* straight, with minute bristles, which upon the upper side are arranged regularly in a double row between two rows of large bristles, 4 in the inner and 6 in the outer row, diminishing in length toward the proximal extremity; also a pair of pre-apical and a pair of short apical bristles; *middle femora* straight, rounder and less bristly than the hind femora; *middle tibiae* with larger outer spines and a few smaller inner ones, also with a whorl of strong pre-apical bristles; *front femora* less bristly than hind femora, posteriorly convex and rounded, anteriorly flat; *front tibiae* with a whorl of strong pre-apical bristles: *tarsi* elongate and slender; *pulvilli* tawny, well developed, almost oval but for the straight inner margin, not projecting beyond the claws: *empodium* a slender bristle as long as the pulvilli; *claws* well developed, curved, black towards the tip, otherwise reddish-brown; *metatarsi* long, slender, attaining greatest length in the hind tarsi.

Length, 11½ mm.; wing, 10½ mm.

Art. XXIII.—*On* Deinacrida rugosa *Buller.*

By A. Hamilton.

[*Read before the Wellington Philosophical Society, 1st May, 1912.*]

The type of this species was found at Wanganui in an underground burrow and was originally described by Sir Walter Buller in the 3rd volume of the "Transactions of the New Zealand Institute," 1871, and also figured.

Subsequently, in vol. 29 (1896), Sir Walter was able to complete his description from a pair found amongst the stones on the beach at Stephen Island, Cook Strait, and which were presented to the Canterbury Museum by the late W. T. L. Travers.

The species is a very well defined one, and of considerable interest.

The specimens which I exhibit to-night were also found on an island in Cook Strait, by Mr. Grei, of Willis Street, who has kindly presented to the Dominion Museum the pair now shown. They were found amongst the decaying vegetable growth on the sides of the gullies.

The original male specimen was figured in vol. 3, pl. 5B, figs. 1 and 3.

Unfortunately, no trace of the original or holotype can be found in the Dominion Museum at the present time, and therefore one of the pair in the Canterbury Museum should probably be regarded as the neotype of the species. I therefore suggest the male of Buller's heautotypes at Christchurch be the neotype of the species.

Footprints of Moa.

[Face p. 211.

ART. XXIV.—*Footprints of the Moa.*

By K. WILSON, M.A.

[*Read before the Manawatu Philosophical Society, 19th August, 1912.*]

Plate II.

A HEAVY fresh which occurred on the 13th August last in the Manawatu River, by washing away the bank (there 15 ft. high) near the foot of Fitzroy Street, within the Borough of Palmerston North, disclosed some very distinct impressions of the footprints of a moa on a bed of stiff blue clay. Four of these footprints were particularly distinct, in a line at right angles to the bed of the river. They were discovered by Mr. Coles, of Palmerston, who at once communicated the fact of the discovery to Mr. Gardner, the President of the local Philosophical Society, and at his instigation the footprints were carefully cut out and placed in the Society's museum. Before removal they were photographed, and accurate measurements taken.

These measurements were: Across the foot from toe to toe, 18 in.; from point of middle toe to heel, 12 in.; and from heel to heel, 30 in. Plaster casts have been taken, and copies may be obtained if required.

As has been stated, the footprints were 15 ft. below the level of the surrounding land, on which there had been heavy bush.

Note by Professor Benham.

Footprints of a large bird, no doubt one of the species of moa, were described by Archdeacon W. L. Williams as long ago as 1871 (Trans. N.Z. Inst., vol. 4, p. 124) at Turanganui, Poverty Bay. The length of the middle toe from tip to back of heel was $7\frac{7}{8}$ in., while across the foot from the tip of the outer to tip of inner toe was 7 in. The interval between the steps was about 20 in. The block of stone containing these prints was presented to the Auckland Museum The same and other prints were seen, and described in the same volume, by the Hon. T. G. Gillies, who also presented the specimens to the Museum.

In 1894 Mr. H. Hill saw and described and figured foot-marks near the right bank of the Manawatu River at Palmerston North (Trans. N.Z. Inst., vol. 27, p. 476). They were then about 6 ft. above the water, but "must be covered with water, or nearly so, during winter." He then notes that "the top of the river-bank would be about 18 ft. above the deposit containing the footprints." These were somewhat numerous, but only about eight of them were clear and distinct at the time of his visit. The length of the middle toe to heel was 15 in., and the distance from tip to tip of outer and inner toes about the same. The length of step was about 26 in. These measurements were taken, we are told, by Mr. Gilberd, near whose place the footprints were found. The slight discrepancy between them and those of the present specimens are possibly due to the depth and distinctness of the impression. It is not an easy matter to take very accurate measurements of impressions in a softish mud. It seems likely that the prints seen by Mr. Hill have been worn away by the river, and that the new ones discovered under what was then the river-bank are a continuation of that series. Mr. Hill places the age of the bed in which they occur as "later Pleistocene."

Unfortunately, we know so little of the foot-bones of the North Island species of moa—at any rate, Hutton in his account of them gives no measurements, and makes no reference to the toe-bones—that it is not with certainty that they can be referred to any particular species; but from a comparison of the measurements given by Mr. Wilson with the foot-bones of the skeletons of *Dinornis robustus* in the Otago University Museum it seems probable that they were made by either *D. giganteus* or *D. ingens*. The toes of *D. robustus* measure from tip of middle toe to back of heel 12 in., and the stretch of inner and outer toes is 15 in.; but in the skeleton the proximal phalanx is not accurately fitted to the distal end of the tarso-metatarsus: the spread should be greater than this. But this is quite near enough to the measurements of the print to allow us to attribute them to one of the above large species of North Island moa.

I think that the members of the Manawatu Philosophical Society are to be congratulated on having so promptly had these interesting relics cut out and preserved in their museum, so that casts can be obtained of them by other museums.

Art. XXV.—*On Two New Echinoderms.*

By H. Farquhar.

Communicated by Mr. F. G. A. Stuckey.

[*Read before the Wellington Philosophical Society, 23rd October, 1912.*]

Plates III, IV.

A very handsome new asteroid was placed in my hands for identification by Mr. F. G. A. Stuckey, Inspector of Schools, in September, 1911. Mr. Stuckey obtained it from a fisherman, who secured it in his net while fishing at Island Bay, near Wellington. Having examined the specimen, I concluded that it was a new and distinct species of the genus *Odontaster*. As, however, much of the literature of Echinoderms is not accessible to me, I have availed myself of the kind assistance of Dr. Herbert Lyman Clark, of the Museum of Comparative Zoology at Cambridge, U.S.A., and submitted to him photographs of the specimen. He has stated that he believes it to be the type of a new genus, and he forwarded the photographs on to Dr. Fisher. Dr. Fisher also regards the species as the type of a new genus of the *Odontasteridae*, for which he has kindly suggested the name *Eurygonias*.

Dr. Koehler has recently established the new genus *Pseudontaster* in his report on the Echinoderms of the Second French Antarctic Expedition, having numerous small marginal plates. Accepting Dr. Fisher's definition of the genera,* a synopsis of the family may be made thus :—

A[1]. Two recurved hyaline spines at each mouth-angle.
- b[1]. Marginals decreasing in size towards extremity of rays .. *Asterodon.*
- b[2]. Marginals increasing in size towards extremity of rays .. *Deplodontia.*

A[2]. One recurved hyaline spine at each mouth-angle.
- b[1]. Marginals prominent, well developed.
  - C[1]. Marginals decreasing in size towards extremity of rays *Odontaster.*
  - C[2]. Marginals increasing in size towards extremity of rays *Eurygonias.*
- b[2]. Marginals very numerous, feebly developed .. .. *Pseudontaster.*

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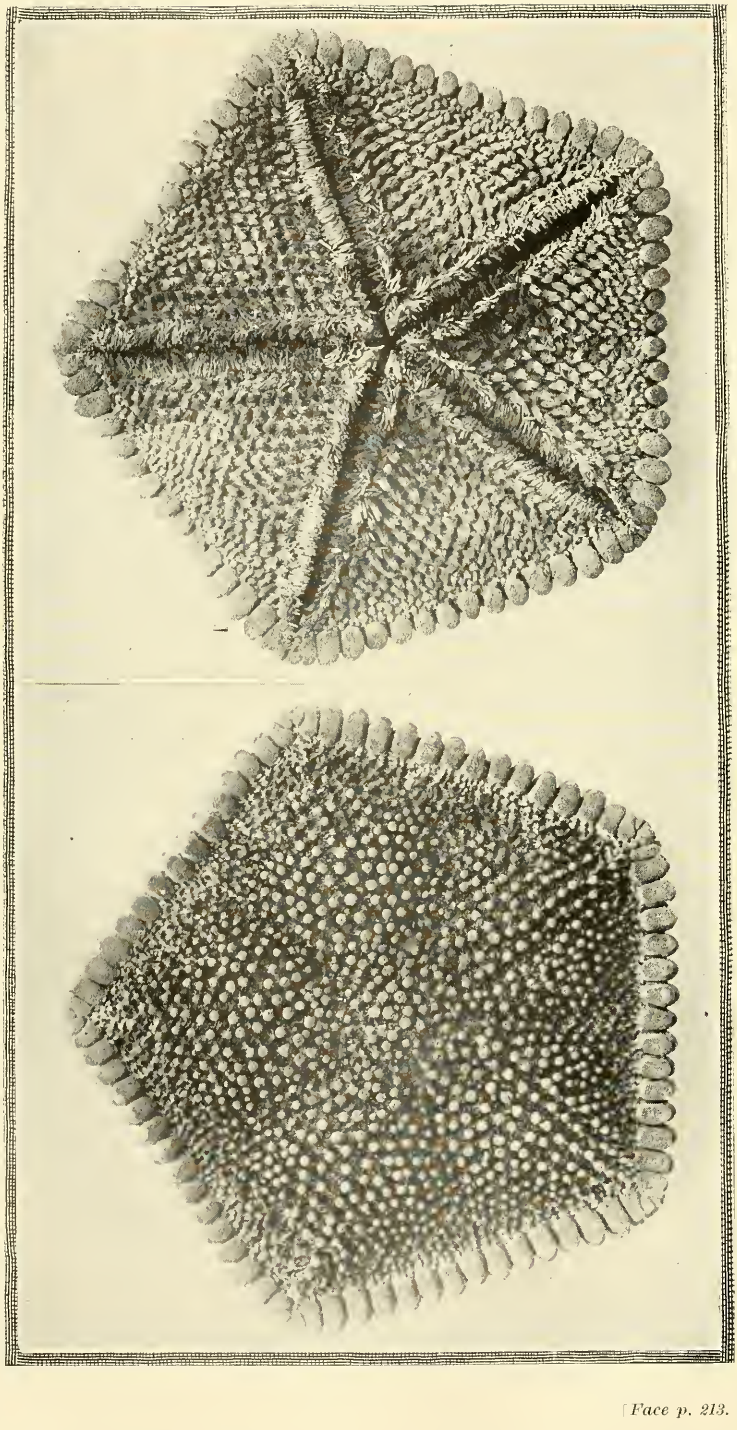
* Bulletin U.S. National Museum, No. 76, p. 153.



Oral View (reduced).

Dorsal View (reduced).

Eurygonias hylacanthus.

[*Face p. 213.*

Eurygonias gen. nov.

Odontasteridae with one conspicuous, recurved, hyaline, keel-shaped median spine on the suture of each pair of mouth-plates; the form is pentagonal; the marginal plates are few, large, and prominent, increasing in size towards the apex of the rays, with one unpaired plate in both series on the medial interradial line; the abactinal intermediate plates are large, angular, forming a meshwork, arranged in longitudinal rows, and bearing large paxillae crowned with spinelets; the actinal intermediate plates are slightly imbricating, bearing groups of spines.

Eurygonias hylacanthus sp. nov.

The form is pentagonal with straight sides, much depressed, somewhat inflated over the radial areas, with a distinct depression along the median interradial line.

R = 61 mm.; r = 51 mm.; R = $1{\cdot}2r$, approximately.

The supero-marginal plates are broader than long; the one on the median interradial line is triangular, with rounded angles; the 6 plates on each side of this one increase in size towards the apex of the ray, the last three being very distinctly larger than the others. Outside of these there is 1 smaller plate and 2 or 3 very much smaller ones at the apex of the ray. The marginal plates bear small, smooth, conical tubercles with minute granular papilliform spinelets between them; the outer part of each plate is without the tubercles, but with a closely packed mass or papilliform spinelets.

The sides are bare, and the sutures between the plates broad and well defined. The infero-marginal plates correspond in number, form, and armature with the supero-marginals, the only difference being that the increase in size of the plates towards the apex of the ray is somewhat more marked than in the supero-marginals. The dorsal plates are irregular in form, tumid, and angular, forming a distinct meshwork. They carry large club-shaped paxillae. In the middle of the disc these paxillae are irregularly placed. There is a single row along the median radial line, and parallel rows to this on each side, with a few much smaller ones scattered here and there between the rows. The largest are at the middle of the disc and along the median radial line, and they decrease in size towards the edge of the disc and towards the median interradial line, those on the edge of the disc being very small indeed. The paxillae are covered at the top with numerous granular papilliform spinelets, closely packed together, about 100 on the largest ones, forming large hemispherical knobs. The papular areas have 3 or 4 pores each.

The plates on the oral surface are irregular in form and size, pavement-like, somewhat angular, tumid, and imbricating. They bear a closely placed group of 7 or 8 rather long, cylindrical, granular, slightly tapering, blunt spines, with a wreath of small granular spinelets at the base; the size of the spines decreases towards the edge of the disc. There is 1 large, stout, keel-shaped, hyaline spine on each pair of oral plates, with 3 or 4 small, somewhat flattened, slightly tapering spines at the apex of the mouth-angle, a row along the edge on each side, and 2 or 3 larger ones between this row and the large median spine. The specimen is dry, and the adambulacral armature a good deal displaced, but it evidently consists of 4 or 5 rows of rather long, cylindrical, blunt spines; some of them taper somewhat, while others are flattened and chisel-shaped. The madreporiform plate is fairly large, somewhat convex, finely striated, and situated almost on a median interradial line. The skin on the dorsal surface is red, the marginal plates purplish-grey, the paxillae grey, the madreporiform plate white, and the oral surface creamy-white. When the specimen had been placed in alcohol for a short time and then dried it became brownish-grey above and yellowish-grey beneath.

The unique type specimen is at Victoria College, Wellington.

Amphiura arenaria sp. nov.

The disc is pentagonal, with only the slightest constrictions in the interbrachial spaces; it is about 10 mm. in diameter. The arms are very long and slender, tapering towards the extremities; about 180 mm. in length, and 1·5 mm. wide near the disc without the spines.

The scaling on the dorsal surface of the disc is very irregular; on the outer sides of the radial shields and on the margins of the disc the scales are imbricating and larger than elsewhere; at the middle parts of the disc and in the interbrachial spaces remote from the margins the scales are small, roundish, and isolated, closer together in some specimens than in others. One scale in the centre is usually larger than those around it. The radial shields are very long, truncated without, where they meet, and tapering to a rounded point within; the scales between them are elliptical, isolated, and rather larger than the general scaling, being about the same size as those on the outside edges of the radial shields. The scaling on the oral surface is very fine.

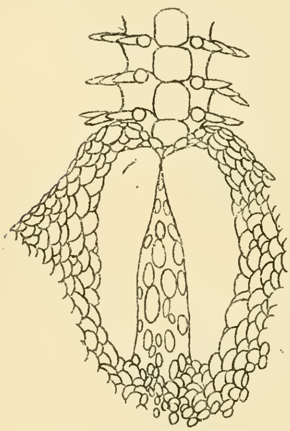


Fig. 1.—*Amphiura arenaria.* Dorsal shields; × 9.

There are 2 stout squarish mouth-papillae at the apex of the mouth-angle, and 1 rather long, rounded, cylindrical, and tapering on each side. The mouth-shields are small, oval, leaf-shaped, with a small point within and a longer one without, and the madreporiform plate is very large, irregularly round, much swollen, and very conspicuous. The side mouth-shields are rather large, triangular, with long angles and re-enteringly curved sides; they do not meet within. The under arm-plates are squarish, with rounded angles, those near the mouth being somewhat longer than broad. The upper arm-plates are broader than long, rounded within, narrowing and sometimes truncated without, except near the disc, where they are sometimes squarish. The side arm-plates bear 7 rounded, cylindrical, pointed spines near the disc, decreasing in number outwards to 3 towards the extremities of the arms; the uppermost spine stands vertically on the arm. The tentacle-pores have 1 small, leaf-like scale; some have 2. Some young specimens have imbricating scales over the whole of the dorsal surface

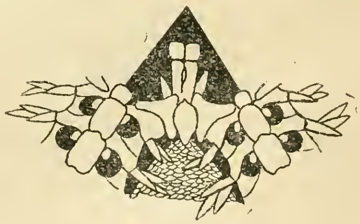
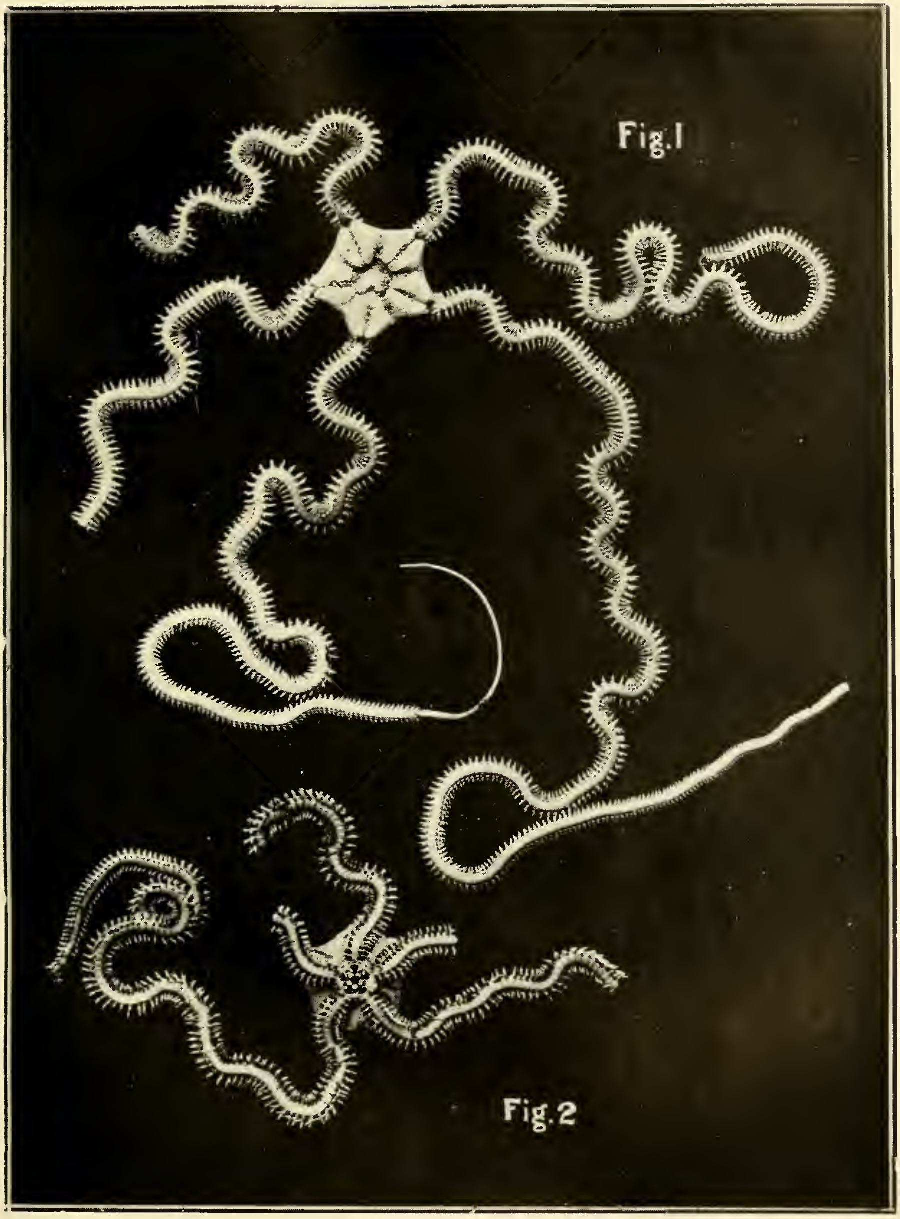


Fig. 2.—*Amphiura arenaria.* Mouth-plates; × 9.



Amphiura arenaria.

Fig. 1.—Dorsal View (enlarged). Fig. 2.—Oral View (enlarged).

of the disc. The colour in life of the skin on the disc is blue, and the scales reddish-brown. The arms are pale-reddish, with darker bands, the outer parts being sometimes pale-yellowish with grey bands, and the upper arm-plates have a dark reddish-brown median longitudinal stripe. Beneath the colour is pale reddish-yellow, sometimes with a purplish tinge. Dried and spirit specimens soon become pale yellowish-grey.

This species is near *A. aster*, but differs in the scaling of the disc and the shape of the mouth-parts.

Professor H. B. Kirk, of Victoria College, discovered this species in the sand at low water at the entrance of Porirua Harbour, on the north side, where it is fairly abundant. I went out with him in March, 1912, and we dug out a number of specimens. They lie vertically in the sand, about 4 in. to 6 in. below the surface, with 2 arms on one side of the disc and 3 on the other side. A specimen placed on the wet sand wriggled itself out of sight in a few minutes, and was about half an inch below the surface in twenty minutes.

The type specimens are in the Dominion Museum, at Wellington.

ART. XXVI.—*Notes on New Zealand Fishes: No. 3.*

By EDGAR R. WAITE, F.L.S., Curator, Canterbury Museum.

[*Read before the Philosophical Institute of Canterbury, 4th December, 1912.*]

Plates V–IX.

10. Trachichthodes affinis Günther.

ON receipt of a copy of my "Additions to the Basic List of the Fishes of New Zealand," Mr. McCulloch informed me that the generic name *Austroberyx*, there used, was antedated by Dr. Gilchrist, and that he correction will be noted before this paper is printed.

The position, therefore, as affecting our "Basic List" stands as follows:—

Page 18. TRACHICHTHODES Gilchrist, 1904.

106. TRACHICHTHODES AFFINIS Günther.

Beryx affinis Günther, Cat. Fish. Brit. Mus., I, 1859, p. 13.
Austroberyx affinis McCulloch, Zool. Results "Endeavour," I, 1911, p. 39.
Trachichthodes affinis McCulloch (in the press).

11. Polyprion americanus Bloch and Schneider.

Plates V and VI.

The first intimation I had of this fish as an inhabitant of New Zealand waters was the following information, contained in a letter from Mr. George M. Thomson, M.P., under date 24th December, 1912, after this paper was read: "The fishermen who go out to the 100–150-fathom water off this coast frequently catch gigantic trumpeter, nearly 3 ft. long [the common trumpeter is *Latris lineata* Forster], and also a huge groper, which they call 'bass groper,' and which appears to be specifically distinct from the ordinary hapuka [*Polyprion oxygeneios* Bloch and Schneider]. They say it is common off Wellington, and is there known as 'black bass.'"

On receiving this information, I at once made inquiries of the local fish-merchants, and learned that among the consignments from Kaikoura a large groper was occasionally received, and was called a "bass," distinguishable by its "wider" body—that is, deeper, or "wider" as it lies on the fishmongers' slabs—larger eye, and bigger scales.

Being desirous of obtaining a description of the fish for the present paper, I journeyed to Kaikoura at the first available opportunity, and, though I went out with the deep-sea fishermen on several occasions, we were not sufficiently fortunate to obtain the specimen sought, though the extra-deep water (120–150 fathoms) in which the bass is caught was prospected.

At the close of one day which I had spent ashore investigating the numerous and large rock-pools with which the peninsula abounds, one of the boats brought in the much-desired bass. I at once saw that it was quite distinct from the groper, and made notes and measurements, but refrained from preserving the specimen, as I was told that one of the other fishing-boats had secured two better specimens. To hesitate was to lose: when the vessel landed its cargo at the wharf I found that the two bass on which I had counted had been decapitated and "cleaned" while still aboard. I therefore had to return to Christchurch, certainly with a description, but without a type to support it. I had, however, deeply interested the fishermen in the object of my quest, and received a promise that the first specimen obtained would be sent to me. This did not occur until seven weeks later, when I received notification from Messrs. Jensen and Kingsnorth that a bass was being sent to me

The specimen was received on the 5th March, 1913, and furnishes material for the accompanying figure and following description.

B. vii; D. xi, 12; A. iii, 9; V. i, 5; P. 18; C. 15+4. L. lat. 96; L. tr. 16+43. Vert. 13+13=26.

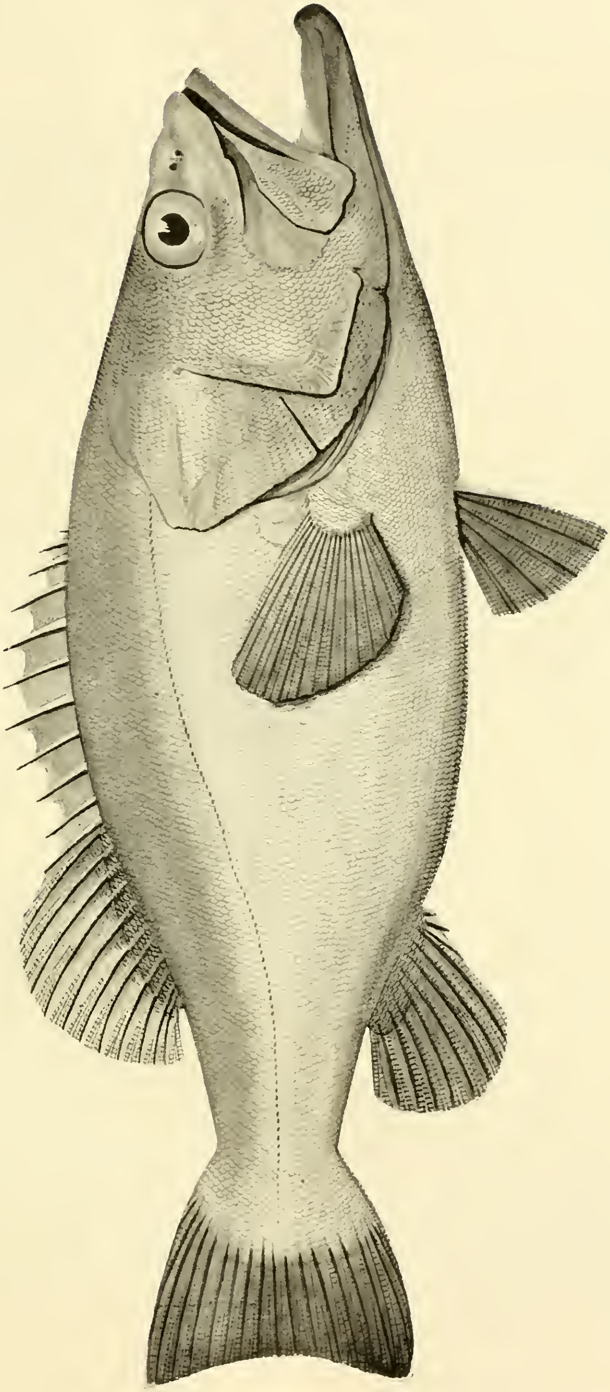
Length of head, 2·45; height of body, 2·78; and length of caudal, 6·85 in the length; diameter of eye, 6·1; interorbital space, 4·38; and length of snout, 3·8 in the head.

Head very massive, slightly compressed and flat above, eye large, near the upper profile, wholly in the anterior half of the head. Nostrils round, close together, a short distance in front of the eye, the anterior provided with a lip behind. Mouth very large, horizontal, protractile, the lower jaw strongly projecting; the maxilla is very broad, its widest portion equal to the diameter of the eye; it has a large supplemental bone, and its distal extremity is notched; it extends to below the hinder edge of the eye. Opercles thick, and roughly serrate with a flat horizontal bar. Gills 4, a slit behind the fourth. Gill-rakers none, replaced by spinous bosses, which coalesce anteriorly into a band, two at the angle of the outer arch much enlarged; pseudobranchiae present.

Body somewhat compressed and very deep, its highest point being about the insertion of the fifth spine.

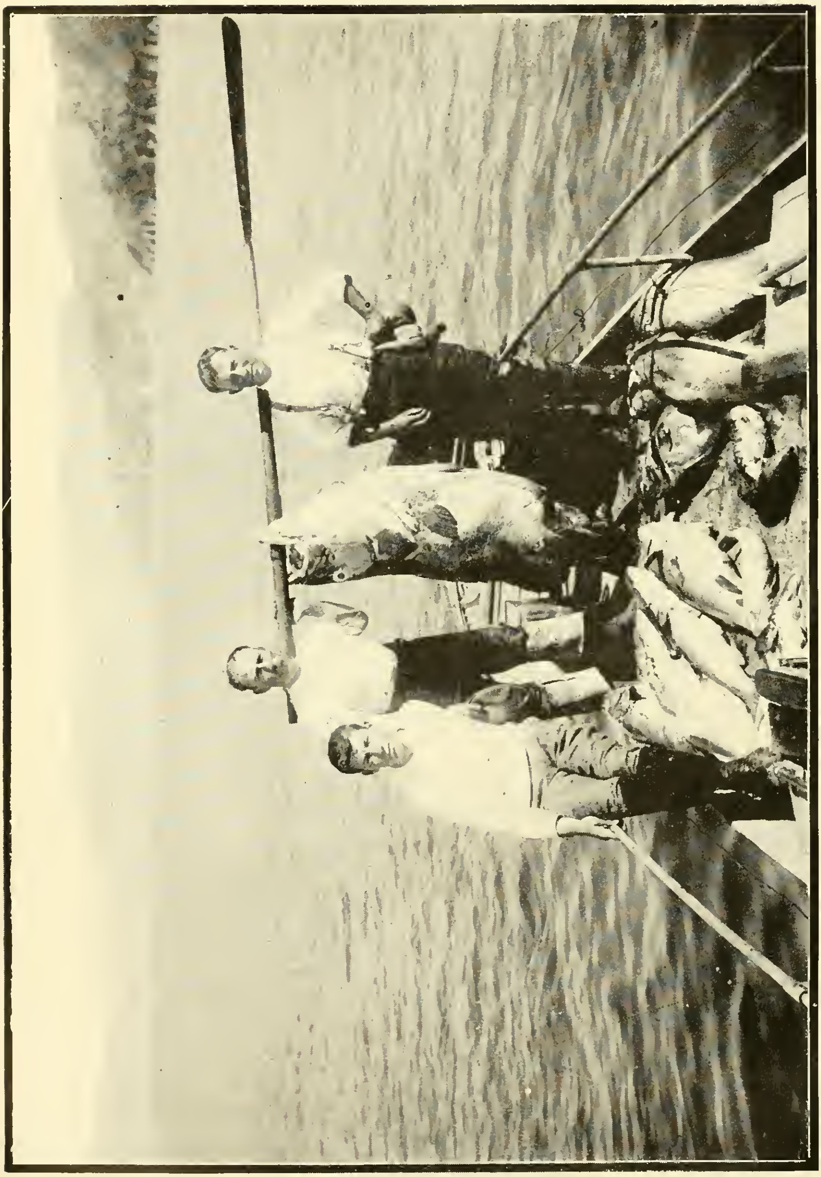
Teeth.—Broad bands of villiform teeth in the jaws, on the vomer and palatines; three patches on the tongue arranged in a triangle, the hinder patch large.

Fins.—The dorsal arises over the edge of the opercle; the first spine is small; the seventh and eleventh are equal and longest, slightly longer than the diameter of the eye, or 5·74 in the length of the head; the spines can be received into a sheath; the rays are much higher than the spines; the fourth and fifth are longest, and equal 3·4 in the head; the hinder rays



Polyprion americanus *Bloch and Schneider.*
One-seventh natural size.

Edgar R. Waite del.



W. Hahn, photo.] [Protected.

Polyprion americanus *Bloch and Schneider* (suspended)
Polyprion oxygeneios *Forster* (on deck).

are less than half this length, producing a rounded outline to the fin. The anal spines are short, the third longest; the fin is shorter than the soft dorsal, and terminates nearer the caudal; the rays of both fins have a deep scaly base. The pectoral is inserted in advance of the opercular margin; its fifth, or longest, ray extends to beneath the base of the seventh dorsal spine: the lower margin of the fin is rounded. The ventral is short, one-third the length of the head; its spine is inserted a little in front of the origin of the pectoral, being less than half the height of the first ray, to which it is closely adpressed. The caudal is slightly emarginate, and its peduncle is strongly compressed and deep, its height equal to its length behind the anal.

Scales.—The whole of the head, opercles, maxilla, and body covered with small scales, roughened on their free edges with minute denticles. The lateral line arises behind the opercle, has an extremely low curve over the pectoral, and follows the dorsal profile to beneath the termination of the fin, whence it attains the base of the caudal along the middle of the peduncle.

Colours. — The colour is almost uniform grey, slightly darker above; membrane of pectoral dark grey, of other fins dusky.

Length, 1,195 mm.; *weight*, disembowelled, 61 lb.

The sum of these characters leads me to associate the species with the Atlantic wreck-fish (*Polyprion americanus* Bloch and Schneider).* This fish is not uncommon in deep water off the coast of Europe, from Norway to the Mediterranean; it is also known from the Cape of Good Hope, and has been identified from Madeira and the Southern Indian Ocean. A single example has been recorded from North American waters, and New Zealand is now added to the known habitat. The fish has long been known here under the name of "bass," but Mr. L. F. Ayson, Chief Inspector of Fisheries for the Dominion, tells me that it was always regarded as a groper (*Polyprion oxygencios*) which attained to greater size in the deep waters. It has been taken 180 lb. in weight, and a specimen 172 lb. is illustrated on the accompanying plate, reproduced from a photograph secured by the kind offices of Mr. Ayson. It is interesting to find the name "bass" applied to the fish here, for stone-bass is one of the names current for the species in British waters. Young specimens are described as having the ridges of the head, the opercles, and the spines of the fins serrate, but the asperities are lost as the fish grows, those of the fin-spines being replaced by striae, and the latter condition is found in the specimen above described. The most obvious discrepancy between the characters of my fish and the descriptions consulted is to be found in the gill-rakers: they are described as being as long as the gill-fringes, whereas in the Kaikoura example the gill-rakers are replaced by low spinous bosses. Perhaps such are characters of the larger specimens.

The bass is caught off the New Zealand coast by the line fishermen when angling for groper or hapuka, and the catch is tolerably assured when the 100-fathom line is reached, though the fish may be hooked in 80 fathoms. The food does not appear to be known, for, as usual with fishes drawn from deep water, the stomach is everted through the mouth, and consequently emptied. To its near ally little comes amiss, the capacious mouth being capable of receiving almost anything in the way of food, and I have extracted a full-grown elephant-fish (*Callorhynchus milii*), containing two eggs

* Bloch and Schneider, Syst. Ichth., 1801, p. 205.

sheathed for extrusion, from the stomach of a groper. It is probable, therefore, that the bass is similarly voracious. The fishermen and salesmen tell me that the flesh of the bass is more flaky and delicate than that of the groper, and is generally preferred by those who may be acquainted with the difference. The bass is, however, always sold as groper, and as small specimens of the latter are preferred, on account of the more tender flesh, the merits of the bass may be said to be unknown outside professional fishing circles. The wholesale value of the specimen described was 10s.

Respecting the bass in the Wellington district, Mr. W. Lucena, of Picton, writes to me as follows: "They abound in Palliser Bay, Wellington, but only odd ones are caught in Cook Strait in deep water, and, as a rule, in the autumn. As far as our fishermen know, the bass are rare about Picton, but they say there is a shoal in the middle of the Strait where big fish are caught, but, being so far off, it has not been properly located. The habits seem to be similar to those of the hapuka, and their diet is also much the same."

I take this opportunity of gratefully acknowledging the kindness and assistance rendered to me by the following Kaikoura fishermen, namely: Messrs. Jensen Bros., Nelson Bros., H. Kelleher, C. Kingsnorth, and P. Petersen. I also desire to thank Mr. Hahn for permitting use of the protected photograph reproduced on Plate VI.

In the "Basic List of the Fishes of New Zealand" this species will stand as No. 110a.

12. Plagiogeneion rubiginosus Hutton.

Plate VII.

This species was originally described by Hutton* in 1876 from a mounted specimen in the Otago Museum under the provisional name *Therapon (?) rubiginosus*. In 1890 Forbes,† accepting Hutton's suggestion, instituted the genus *Plagiogeneion*, a fresh specimen taken near the mouth of the River Avon enabling him to supply certain deficiencies in the original account.

Another specimen, slightly smaller, is also in the Canterbury Museum collection, labelled "Canterbury." As Forbes does not mention this, it was evidently received after he wrote his paper.

It is to be noted that both Hutton and Forbes count 11 spines and 12 rays in the dorsal fin, whereas in both our examples, of which one is the specimen described by Forbes, the numbers are 12 spines and 11 rays.

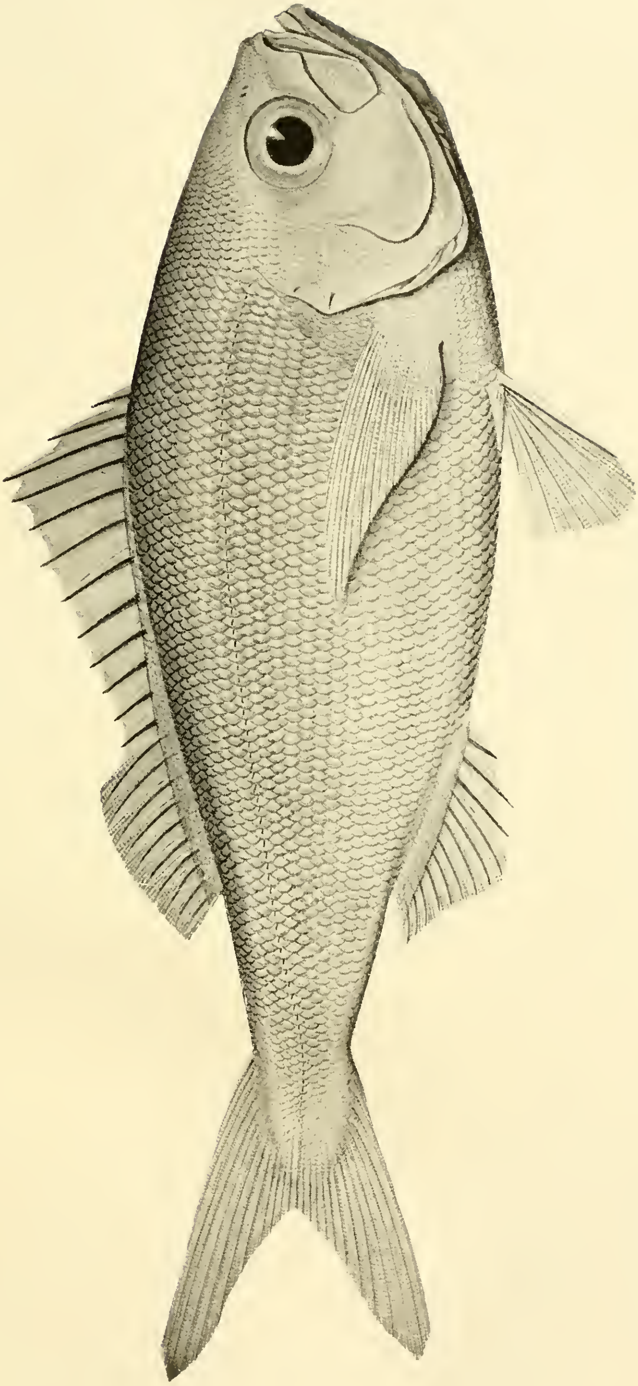
Owing to a more modern method of computation, the following description differs somewhat from the previous ones, and, as neither Hutton nor Forbes furnished a figure, the accompanying illustration is prepared from the example which I have reason to believe is the type of the genus.

D. xii, 11; A. iii, 10; V. i, 5; P. 21; C. 24+6. L. lat. 81; L. tr. 12+24.

Length of head, 3·59; height of body, 2·76; length of caudal, 7·0 in the length; diameter of eye, 3·36; interorbital space, 3·06; and length of snout, 4·0 in the head.

Head compressed, eyes lateral; snout notched in front to receive the premaxillary; the nostrils are small vertical orifices, each pair close together,

* Hutton, Trans. N.Z. Inst., vol. 8, 1876, p. 209.
† Forbes, *ib.*, vol. 22, 1890, p. 273.



Plagiogeneion rubiginosus *Hutton.*
Less than half natural size.

Edgar R. Waite del.

Face p. 218.

somewhat in advance of the upper anterior angle of the eye; interorbital broad and convex, the eye being considerably removed from the profile. Mouth subvertical, protractile; maxilla very broad, truncate distally; it extends to beneath the first fifth of the orbit, 1·6 in the eye. Gills 4, a slit behind the fourth; gill-rakers very long, 9 + 26 on the first arch; pseudobranchiae well developed.

Teeth.—Minute: in a single series in each jaw, a small patch on the head of the vomer, none on the palatines or tongue.

Fins.—The dorsal fin commences three-fourths of an eye-diameter behind the edge of the opercle; the third spine is the longest, nearly half the length of the head; the rays are shorter, their combined bases occupying half the corresponding measurement of the spines; the anal commences beneath the first dorsal ray, and is coterminal with the soft dorsal; both fins are receivable into a scaly base. The pectoral is falcate, and equals the head in length. The ventral is inserted slightly in advance of the first dorsal spine, and its spine is nearly as long as the third, or longest. The caudal is very deeply forked, and the least depth of the peduncle is a little more than the diameter of the eye.

Scales.—The whole of the head and body covered with ctenoid scales; the base of the pectoral, the large axillary scale, and the caudal rays are also scaly. The lateral line is very evident, and runs concurrently with the dorsal profile, along the middle of the caudal peduncle to the base of the rays.

Length.—To the middle caudal rays, 344 mm.

Colours.—After long preservation, uniform yellow, with a pink tinge in protected parts.

13. **Kyphosus sydneyanus** Günther.

Mr. T. F. Cheeseman, Curator of the Auckland Museum, recently sent to me the dried skin of a fish, the species of which he asked me to verify for him, and suggesting that it was the drummer (*Kyphosus sydneyanus*). The specimen is not suited for determinative purposes, but I have little doubt that it is thus correctly named, and I included it in my "Additions to the Basic List of the Fishes of New Zealand."* The species was originally described by Günther† under the name *Pimelepterus sydneyanus*, and outside the present record has, I believe, been recorded only from the coasts of New South Wales. The species has never been adequately figured, the only illustration with which I am acquainted being that published by Ogilby.‡ This is a mere sketch, and is incorrect in many ways, notably in being too deep and in the length of the pectoral. In Mr. Cheeseman's specimen of the species, if correctly determined, the pectoral is much shorter than figured, and does not extend to a point beyond the insertion of the dorsal. Regarding its distribution, Ogilby writes, "Either the range of the fish is extraordinarily limited or the local naturalists to the northward have failed to recognize this very distinct species; to the south no considerable extension of range is to be expected in a fish of this genus." The New Zealand specimen was taken at Great Barrier Island, and it may be noted that this island is very little south of the latitude of Sydney.

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* Waite, Rec. Cant. Mus., vol. 1, 1912, p. 319.
† Günther, Ann. Mag. Nat. Hist. (5), vol. 18, 1886, p. 368.
‡ Ogilby, "Edible Fishes New South Wales," 1893, p. 40, pl. xvi.

14. Gasterochisma melampus Richardson.

Plate VIII.

The adult fish was first described under the name *Lepidothynnus huttonii* by Günther* in 1889 from a specimen driven ashore in Lyttelton Harbour. Günther enriched his account with a sketch of the entire fish, made by Captain Hutton, an illustration of one of the scales, and of the skeleton, as mounted in the Canterbury Museum.

It has more recently been suggested that the specimen thus named is nothing more than the adult of *Gasterochisma melampus*, described by Richardson† forty-four years previously from a specimen obtained in Port Nicholson (Wellington Harbour). Günther was quite aware of the likeness of his *Lepidothynnus* to *Gasterochisma*, and if we accept the identity of the two we must still regard the differences produced by age as remarkable. Richardson's specimen was 8 in. in length, and we may especially notice the following points: The spinous portion of the dorsal fin is fully twice the height of the second portion; the pectoral is short, not half the length of the head; while the ventrals are one-third the maximum length of the specimen. Looking to the same features in *Lepidothynnus*, it is seen that the dorsal lobe is twice the height of the spines; the upper pectoral rays are but three-fourths the length of the head, and a falcate shape is produced; while, most remarkable of all, the ventrals, such a striking feature of the young, are quite insignificant, being but one-fourteenth the length of the fish as measured by Richardson. The disappearance of the full series of scales on the cheeks and on the top of the head is not an uncommon feature, but the presence of the small corselet is not at all foreshadowed by Richardson's figure.‡

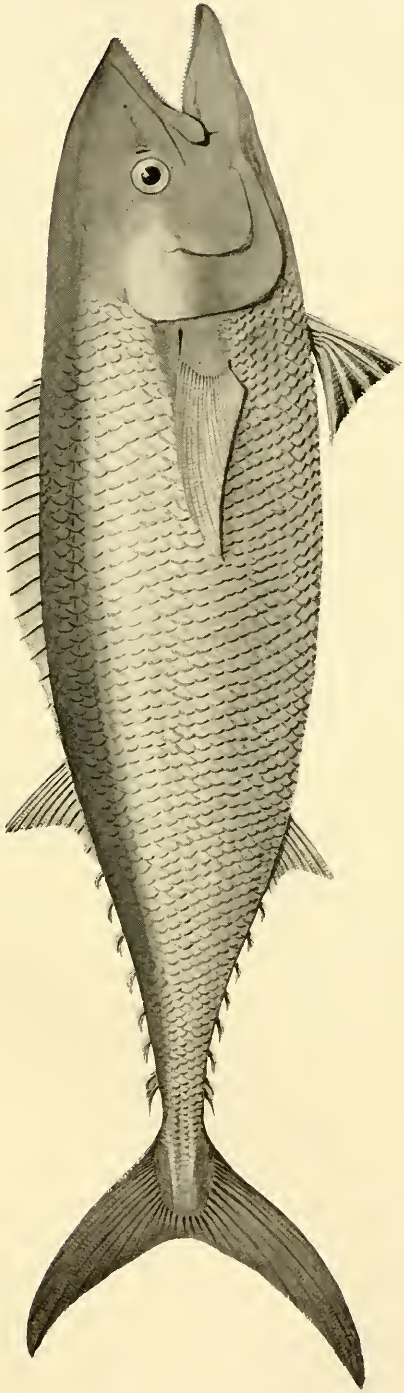
This author mentions that there is no vestige of a caudal keel. The adult shows 2 keels, or, rather, ridges, for they are not very prominent, while the lateral line is apparently reduced in extent, being traceable only under the spinous dorsal fin. In the young it is figured as terminating in advance of the hinder finlets, though described as passing through the tail. A comparison of Richardson's figure with the one now supplied shows that the general proportion and contour of the body is almost identical, the one noticeable difference being the profile of the caudal portion, represented as convex by Richardson, whereas in my specimen it is distinctly concave, as figured. It is further noteworthy that the groove developed in the young for the reception of the ventrals, and extending from their insertion to the anal fin, is retained for its entire length in the adult, notwithstanding the fact that the ventrals are but one-fourth the distance indicated. Some intermediate stages are clearly needed before the several peculiarities enumerated can be satisfactorily traced.

The illustration published by Günther is stated to be simply a sketch, and must not, therefore, be taken too seriously; but, as it formed the basis for portion of the description, its most discrepant features may be pointed out. It is evident that the dorsal fin is incorrectly shown, and may be due to a desire to conform to the skeleton, itself wrongly articulated. In this the dorsal spines are placed too far forward, making it appear that the fin arises over the opercle instead of some distance behind it; the gap between the spines and the lobe of the soft fin is therefore much too wide, both

* Gunther, Chall. Rep., xxxi, 1889, p. 15, pl. vi.

† Richardson, Ann. Mag. Nat. Hist., vol. 15, 1845, p. 346.

‡ Richardson, Voy. Ereb. and Terr., 1846, p. 60, pl. xxxvii.



Gasterochisma melampus *Richardson.*
One-tenth natural size.

Edgar R. Waite del.

Face p. 220.]

features being incorporated in the description. The general contour is wrong, the head and fore part of the body being represented as altogether too massive. The opercles as drawn bear no resemblance to the actual condition, while the area whereon the scales originate behind the head is not properly defined, and scales are not represented as present on the cheeks. Some of the features as portrayed are of positive value; the lateral line is shown as extending from the opercle to the caudal rays, and thus extends even farther than shown by Richardson's artist. Two keels are noted and illustrated at the base of the caudal, and the pectoral is described as being rather short, the fin thus agreeing better with *Gasterochisma* than with my specimen.

The specimen to which I have alluded is more fully described below, and illustrated on the accompanying plate. It was caught at Kaikoura in November, 1910, and presented to the Canterbury Museum by Messrs. Dennis Bros., of Christchurch, to whose kindness we owe many interesting fishes.

We have published records of four other specimens, all taken in Otago. Two obtained in June, 1873, were described by Hutton* under the name *Gasterochisma.* Unfortunately, their size was not given, but, judging from the accompanying figure and the fact that they were associated with Richardson's species, we may presume they were small. The figure appears to have been copied from Richardson, with slight modifications.

In 1898 Parker† recorded two examples—one from Otago Heads and the other from Blueskin Bay. The sizes were not recorded, but being associated with *Lepidothynnus*, and one of the specimens being stuffed, we may presume they were adult, or, at least, large individuals. [Since writing, I learn from Professor Benham, Curator of the Otago Museum, that the specimen is 59 in. (1,500 mm.) in length.]

The paper was read before the Otago Institute, but does not appear to have been published. "Particular attention was drawn to the great difference in size between the heart of the common tunny and that of this species."

By the kindness of Mr. A. Hamilton, Director of the Dominion Museum, Wellington, I hold his private copy of Hutton's "Catalogue of the Fishes of New Zealand," 1872, and against *Gasterochisma melampus* (p. 20) find the following interesting and significant note in pencil, the comparisons instituted being apparently with Richardson's figure: "Napier, May, 1888, from Dr. Spencer; length, 12 in.; pectorals more falcate, 20 scales below median line; head more rounded; position of median line wrong; ventrals not attached, as in *Nomeus*."

Since writing the foregoing paragraph as to the need of specimens of intermediate size, I have examined the description given by Johnston‡ of an example obtained in Tasmanian waters. This is of intermediate size, and indicates the assumption of adult characters, though the specimen was not fully grown, as thought by Johnston. The following are the most interesting features recorded: The specimen was captured in 1882 at the mouth of the estuary of the Derwent, and constituted the first record of the species in Tasmania. The total length was 39 in. (992 mm.), so that it may be regarded as an intermediate example.

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* Hutton, Trans. N.Z. Inst., vol. 6, 1874, p. 104, pl. xviii.
† Parker, Trans. N.Z. Inst., vol. 30, 1898, p. 575.
‡ Johnston, Rep. Roy. Soc. Tasm., 1883, p. 118.

The following proportions are deduced from Johnston's figures, though the basis for comparative length may not be quite the same as that now usually taken :—

B. vii ; D. xvii, i, 10, vi ; A. ii, 10, vi ; V. i, 5 ; P. 21. L. lat. 64 ; L. tr. 27.

Length of head, 4·0 ; height of body, 3·9 ; and length of caudal, 8·7 in the length ; diameter of eye, 10·0 ; length of snout, 2·1 ; length of pectoral, 1·68 ; and length of ventral (misprinted " anal "), 1·52 in the head.

Referring to the relative length of the dorsal spines and rays, Johnston writes : " In the figure in Dr. Günther's 'Study of Fishes,' p. 455 (after Richardson), the anterior dorsal spines exceed in length the first soft rays of the dorsal and anal. In the mature specimen above described the highest of the gently arched anterior dorsal spines are not so long as either the first longest soft ray of anal or dorsal, which are nearly equal." It will be seen that in those characters which suffer the greatest change with the growth of the fish—namely, the relative length of the dorsal spines and rays, the length of the pectoral and of the ventral—the Tasmanian specimen is intermediate, distinctly correlated with its intermediate size.

The following is a description of the Kaikoura example :—

B. v ; D. xviii, i, 9, viii ; A. i, 9, viii ; V. i, 5 ; P. 21 : C. 18 + 20 ; Sc. 70 ; Sc. tr. 7 + 19.

Length of head and height of body, 4·1, and length of caudal 10·5 in the length ; diameter of eye, 7·4 ; interorbital space and length of snout, 2·2 in the head.

Head compressed and ridged above, upper profile strongly arched. Eye small, deeper than long, placed very low in the middle of the length of the head but nearer the upper than the lower profile. The posterior nostril is a vertical slit close in front of the eye ; the anterior one is a round pore midway between the eye and the end of the snout ; the latter is pointed, and the cleft of the mouth is horizontal. The non-protractile maxilla is narrow, subacute behind, and reaches to beneath the front margin of the eye. The opercular bones are thin and flexible ; the opercle is deeply cleft forward above, its hinder edge is nearly straight with the angle rounded ; the preopercle has a notch in its upper portion. The gill-membranes are united very far forward ; no distinct rakers are developed, their place being taken by curved spines, irregularly disposed. Gills 4 in number, with a slit behind the fourth. Pseudobranchiae well developed.

Teeth.—The jaws are furnished with a single row of small conical teeth, about 30 in each ramus of maxilla and mandible ; there are also teeth on the fore part of the palatines, and a small patch on the vomer ; the tongue is smooth.

Fins.—The first dorsal fin arises behind the root of the pectoral, and extends to the lobe of the second fin, the distance of the last spine therefrom being not greater than that between two spines ; the spines are very low, the height of the third and eight or nine following being not more than one-fifth greater than the diameter of the eye ; the hinder spines decrease so that the last one is almost hidden in the groove into which the whole series can be depressed ; the base of this portion is equal to a third the length of the fish, exclusive of the caudal ; the base of the soft portion is slightly shorter. The second fin is formed of a lobe, more than twice the height of the longest spines, followed by finlets, of which 8 are free, the two last being close together, and connected with membrane. The anal fin is similar to the second dorsal, but is shorter, having a more posterior insertion. The pectoral is placed wholly in the lower half of the body, and extends to a point midway between the edge of the opercle and the origin of the anal fin; it is falcate and pointed, the fifth ray being the longest; its length is 1·24 in the head. The ventral arises below the edge of the opercle, in advance of the pectoral; the spine may readily be overlooked, being short and closely adpressed to the first ray, and incapable of being separated therefrom; all the rays have a broad, flat, bony front edge, which fold together like the rays of a fan; the first is two and a half times in the length of the head, and the following are successively longer, the fifth extending much farther than the first when the fin is folded; the inner rays of each fin are broadly united. The caudal is crescentic and deeply cleft, the lower lobe being the longer; the peduncle, behind the last finlets, is short, not more than its height, which equals a fifth more than the eye-diameter. There are two low ridges on each side of the tail, and a small pit above and below at the base of the caudal rays.

Scales.—The head is naked, with the exception of about 4 rows of scales on the cheeks. The scales commence behind the occiput, and clothe the whole of the body excepting a naked callous area in which lies the pectoral fin. The scales are large and cycloidal, as figured by Günther, while the lateral line is traceable only for a short distance under the middle of the first dorsal fin.

Colours.—The head is steel-blue; the body nearly black above and silvery beneath; the dorsal fin is hyaline, with brown spines, while the pectoral is silvery; the tail is black, and the eye metallic green and silver.

Length, 1,637 mm., or, exclusive of caudal fin, 1,473 mm.

Long after the foregoing had been passed in for publication I received a second example from Mr. Tom Bragg, of Half-moon Bay, Stewart Island. Under the date 12th February, 1913, Mr. Bragg writes, "The fish I sent you was got on the west coast. I was around there on a fishing cruise, and was anchored in Deas Cove, Thompson Sound, when this fish came into the cove, swimming at a tremendous speed round and round on the top of the water, as if something was chasing it; then all at once it changed its course and swam straight in towards the shore. It was going at a great rate when it struck a rock with its nose, and it was killed outright, for when I picked it up it was quite dead." This specimen is somewhat smaller than the Kaikoura example, being 1,395 mm. in length. It is otherwise so entirely similar, the proportional measurements being identical, that the figures for one will stand equally for the other.

15. Mola mola Linnaeus.

Plate IX.

So many illustrations of the sunfish have been published that to issue yet another may seem to be quite unnecessary. I venture to think, however, that the accompanying reproduction from an actual photograph will be distinctly interesting.

This picture shows an absolutely lateral view, the fish being photographed from above, so that lying on the ground there is no distortion as in many illustrations of sunfishes.

The fish was obtained at New Brighton, a marine suburb of Christchurch, on the 1st November, 1912. It had been washed up on to the beach, and was still alive when first seen, but in a very sickly condition, due apparently to the presence of a truly enormous quantity of both tape and round worms. The whole digestive tract of the unfortunate animal was distended to bursting-point, and when stranded it was observed that the worms protruded from both the mouth and vent of the fish. Specimens of the worms were forwarded to Professor Haswell, of Sydney, who handed them to Dr. S. J. Johnston for determination.

The presence of worms in stranded sunfishes, or those obtained in a dying condition, seems to be the rule rather than the exception. To mention New Zealand examples only, Archdeacon Williams* records an individual taken in December, 1889, which measured 9 ft. in length and $11\frac{1}{2}$ ft. in extreme depth—"As soon as the fish was dead, a long worm, many yards in length and like a narrow tape, began to come out of the mouth, and the end had not appeared when the fish was buried, two days afterwards." Writing on a still larger sunfish from Napier, the late Mr. S. H. Drew† mentions "vast quantities of internal parasites that infested the fish. The fishermen spoke of huge knots of tape-like worms as big as two fists, and masses matted together of round smooth worms of several kinds." Parker‡ described a large sunfish from Otago Harbour, and mentioned that the intestine contained immense numbers of a species of *Taenia* and a *Distoma*.

The New Brighton sunfish is a comparatively small one, and was cast for exhibition in the Canterbury Museum. Prior to this some notes were made on the proportions and coloration, and these are reproduced below. It should be remarked, however, that in consequence of the varying relative proportions which sunfishes undergo from early to adult life the figures supplied should be taken in conjunction with the size of the specimen. Mr. A. R. McCulloch § has recently published some very beautiful illustrations of young specimens (*Molacanthus*) showing the quaint forms of immature sunfishes.

The body of our example is covered, carapace-like, with a callous skin, studded with small prickles like that of some species of *Monacanthus*; this skin extends to the base of the caudal, but does not enclose the bases of the vertical fins, thus allowing them freedom of movement. The pectoral is similarly situated in a non-callous area, formed of a thinner prickless skin, which is the nature of the cuticle surrounding the dorsal, caudal, and anal fins. The marginal bony scutes on the tail are 12 in number, and are disposed along almost its entire edge.

The length of the head is 3·75; the depth of the body, 1·49 in the total; the diameter of the eye, 5·45; the length of the snout, 2·4; the interorbital space and the length of the caudal, 1·5 in the head.

Colours.—The coloration is blackish-brown above and silvery below, with darker vertical flecks above the pectoral, and with light blotches behind it. These alternate with the ground-colour, forming a wavy pattern on the hinder part of the carapace.

Some Dimensions.—Total length, 900 mm.; length of head, 240 mm.; depth of body, 605 mm.; height of dorsal fin, 410 mm.; height of anal fin, 425 mm.; length of pectoral fin, 120 mm.; length of caudal fin, 160 mm.

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* Williams, Trans. N.Z. Inst., vol. 25, 1893, p. 110.
† Drew, Trans. N.Z. Inst., vol. 29, 1897, p. 286.
‡ Parker, Trans. N.Z. Inst., vol. 29, 1897, p. 627.
§ McCulloch, P.L.S. N.S.W., xxxvii, 1913, pls. lviii and lix.

Edgar R. Waite del.

MOLA MOLA *Linnaeus.*
One-eighth natural size.

Face p. 224.]

Art. XXVII.—*The Natural History of Otago Harbour and the Adjacent Sea, together with a Record of the Researches carried on at the Portobello Marine Fish-hatchery: Part I.*

By G. M. Thomson, F.L.S.

[*Read before the Otago Institute, 14th November, 1912.*]

Plate X.

An examination of the coast-line in and near Otago Harbour shows that at a comparatively recent period there has been a considerable upward movement of the land-surface. It is quite evident that then Otago Peninsula was an island, separated from the mainland by a somewhat deep channel, and itself indented by three or four inlets. of which Tomahawk Lagoon, Hooper's Inlet, and Papanui Inlet are the relics. The last two are still subject to tidal influence, though nearly dry at low water; Tomahawk Lagoon is now cut off from the sea except at very high tides. Partly by elevation of the coast-line, partly by denudation of the adjacent land, and partly by blown sand, these various sheets of water gradually filled up. The main channel ultimately became completely blocked at its south-western end, forming the long narrow inlet now known as Otago Harbour. This is a shallow sheet of water about fifteen miles long, less than four miles broad at the widest point, and full of broad sand-banks which are partly exposed at low tide, and are separated by somewhat narrow channels. It is cut into two distinct basins by the projecting peninsulas of Port Chalmers and Portobello, and the two rocky islands. Quarantine Island and Goat Island. These two basins are united by three rock-bound passages, through which a strong tide pours backwards and forwards, keeping deep and well-scoured channels. I am informed by Mr. J. Blair Mason, Engineer to the Harbour Board, that the area of the whole harbour is 12,058 acres, and that during spring tides (with a rise of 6 ft.) 2,626,232,400 cubic feet of water flow in and out of the harbour each tide. while during neap tides (with a rise of 5 ft.) the volume is 2,100,985,920 cubic feet.

The amount of extraneous nitrogenous matter which finds its way into the harbour is now comparatively small, and is scarcely noticeable. Formerly, when all the drainage of Dunedin went into it, the amount was considerable, though it could barely be detected on the outflowing tide at the site of the Portobello Hatchery; but since this source of contamination was cut off it is a negligible quantity. A series of analyses were made for the Otago Institute some eleven or twelve years ago, but, unfortunately, I cannot lay my hands on them.

It is difficult to say how far the operations of the Harbour Board and the movements of steamers have affected the marine life of the harbour—probably much less than is popularly imagined. The results of tow-nettings at various periods of the year and at various times both of day and night, of hand-dredging in the channels, and of shore-collecting between tide-marks, seem to me to show that minute life is as abundant to-day as it was thirty years ago. Wherever this is the case the larger animals are sure to be found to a considerable extent, for food-supply appears to be the most potent factor in the distribution of organisms.

It was from a consideration of the large volume of constantly renewed sea-water passing and repassing between Quarantine Island and Portobello Peninsula, and of the strong flow passing round the peninsula into Big Bay or Lower Portobello Bay (as it is variously called), together with the accessibility of the spot and the possibility of acquiring a small and suitable area of land on easy terms, that the Otago Institute was induced some years ago to select the site for the present fish-hatchery and biological station. In some respects there are drawbacks to the position, but these are more than counterbalanced by the advantages referred to.

Outside the harbour the ocean-bottom slopes with an easy grade into deep water. Round the rocky portions of the peninsula the grade is steeper. Thus the 30-fathom line comes nearly within two miles of Cape Saunders, a slope of about 1 in 58; while off Taiaroa Head it is between six and seven miles distant, a slope of about 1 in 180. The 50-fathom line comes within about eight miles of the coast opposite the mouth of Papanui Inlet, and there would appear to be at that point a depression or slight valley on the ocean-floor running out seawards. The contour-lines on the map accompanying this paper* (kindly prepared by the Survey Department, Dunedin) can only be taken as approximately accurate, as no detailed survey of the sea-bottom has been made. According to the fishermen who work outside, and who go in for line fishing, there is quite a deep trough or valley about ten miles south-east of Cape Saunders, where the depth very quickly passes from 80 or 90 to 150 fathoms, and from there slopes out to very deep water. A similar sharp depression occurs between thirty and forty miles farther north. Though the exact location of these submarine valleys is not laid down on any map, they are well known to the fishermen, who in suitable conditions of wind and tide find these deeps very excellent fishing-grounds.

According to the Admiralty charts of this coast still in use, based on the surveys made by Captain J. L. Stokes in the "Acheron" (1849–51), a current sets up the coast in a north-easterly direction at the rate of from one to one and a quarter knots per hour. The "New Zealand Pilot" (8th edition) says, "On the east coast of the South Island the current usually sets northward with a rate of about one mile an hour." According to the fishermen, this current, especially at a distance of five to ten miles off the coast at Cape Saunders, frequently runs at the rate of four miles an hour. It is especially strong just before a south-west wind sets in, and when fishing under such conditions in from 90 to 150 fathoms it is sometimes almost impossible to let the lines down, even with heavy sinkers. On the other hand, just before north-east weather sets in, the current ceases entirely, and the lines go down nearly plumb from the boats. One effect of this nearly constant northerly current is the formation of an eddy into Blueskin Bay and round to the north of Taiaroa Head. This frequently causes the accumulation of large quantities of plankton and various pelagic organisms in that sheltered area, and, as a consequence, also the frequent accumulation of large quantities of fish. The general set up the coast of a north-easterly current is one argument in favour of the establishment of a marine hatchery in this part of Otago. Any swimming organisms liberated outside of Taiaroa Head, or even within the harbour on an ebb tide, tend to be carried along the coast northwards.

One physical phenomenon, which has been observed only since the station was started, is of considerable interest and importance. From the very first daily observations have been made of certain meteorological

* Map showing the coast-line between Taieri Mouth and Moeraki, with contour-lines showing the depth of the adjacent sea.

Submarine Contour Map of East Coast of Otago adjacent to Otago Harbour.
(Scale: Nearly six miles to an inch.)

facts—viz., the direction of the wind, the rainfall, and especially the temperature of the air, of the water of the bay, and of the hatching-ponds. These have been regularly recorded at 9 a.m. each day for more than seven years. At the same hour, through the courtesy of the engineers of Mr. F. J. Sullivan's trawling-steamers, the ocean temperature has been frequently (but only from time to time) recorded. None of these observations can be treated as strictly accurate, because the station is not provided with suitable instruments; therefore they can only be looked on as approximately correct. But, making this allowance, it may be affirmed generally that the temperature of the ocean-water at a distance of about two miles outside Taiaroa Head does not fall below 8·8° C. (48° Fahr.) in winter, nor does it rise above 12·2° C. (54° Fahr.) in summer. On the other hand, inside the harbour the variation, both seasonal and diurnal, is much greater, while in the hatchery-ponds it is greater still. In very cold winter weather the temperature of the water in the bay just outside the hatchery-ponds has fallen as low as 4·5° C. (40·1° Fahr.), while in the ponds on one occasion it went as low as 0° C. (32° Fahr.).

The effect of changes of temperature in the water on the animal-life which it contains has not yet been much studied, but it probably accounts for a good deal of the migration of organisms which seems to be such a conspicuous phenomenon in studying the natural history of the sea. It is probable that at the approach of winter many species of fish and other organisms leave shallow bays and estuaries, and move out into deeper water, where the temperature conditions are more uniform. Blue-cod, trumpeter, and some other species which are not uncommon in Otago Harbour in the summer months are conspicuous by their absence during winter.

Notes on Fishes.

In the "Transactions of the New Zealand Institute," vol. 38, p. 549, I gave a list of the principal fishes which have been recorded from Otago Harbour and the adjacent sea. Since the establishment of the Portobello Hatchery a good deal of valuable information on the subject has been accumulated by Mr. T. Anderton, the Curator, and this is now summarized up to date. In the following notes the numbers refer to the above list.

1. **Polyprion prognathus** Forster.

The hapuka, or groper, is caught in Otago throughout the whole year.

It appears to spawn about August, for the roes are sold in abundance in the Dunedin shops in July, while all big fish taken in September are "spent." But perfectly ripe fish have never been taken, for they cease to take bait some time before they spawn, and those which are taken in August are usually small and immature fish. The roe is estimated by Mr. Anderton to contain about 1,250,000 eggs. The most mature eggs which have been taken show no signs of oil-globules, and at once sink when placed in sea-water.

The hapuka is a gross feeder, and is most destructive to fish smaller than itself. Over 150 stomachs have been examined, and among the contents were red-cod, mackerel, warehou, soles, pig-fish, octopus, squid, whale-feed (*Munida*), swimming-crabs (*Nectocarcinus*), *Nyctiphanes*, and tests of *Salpidae*. Evidently all the food they take swimming, and they do not feed on the bottom on any stationary food.

1*a*. **Polyprion americanus** Bloch and Schneider.

This deep-water representative of the genus is now identified by Waite (*ante*, p. 215, Plates V and VI) with the wreck-fish of the Atlantic. It is occasionally taken outside Otago Heads, and is known by the local fishermen as "bass groper" or "black bass." It frequently weighs from 150 lb. to 180 lb.

1*b*. **Plagiogeneion rubiginosus** Hutton.

The type specimen of this rare species is in the Otago Museum. It is described by Forbes (Trans. N.Z. Inst., vol. 22, p. 273), and redescribed and figured by Waite (*ante*, p. 218, Plate VII).

2*a*. **Emmelichthys nitidus** Richardson.

A specimen of this taken on the coast near Dunedin is in the Otago Museum.

5. **Dactylosparus macropterus** Forster.

Tarakihi. The stomachs of the few which were examined contained mostly small *Crustaea*—viz., whale-feed, shrimps (*Mysidae*), and *Amphipoda*.
The species is well described and figured by E. R. Waite in "Records of the Canterbury Museum," vol. 1, No. 3, p. 220, pl. 45.

5*a*. **Mendosoma lineatum** Guichenot.

A specimen taken on the coast near Otago Heads is in the Otago Museum.

7. **Latris lineata** Forster.

Trumpeter. The stomachs of those examined contained *Halicarcinus planatus* and other small *Crustacea*.
This fish, as taken in Otago waters and sold in Dunedin fish-shops, is usually less than a foot long, but quite recently (August or September, 1912) very large specimens, nearly 3 ft. in length, have been taken from 90 to 150 fathoms in two localities off Cape Saunders and Taiaroa Head in large quantities.

7*a*. **Latris aerosa** Hutton.

The type specimen of this fish, in the Otago Museum, was caught off Taiaroa Head. It is called by Hutton "the copper moki."

8*a*. **Helicolenus percoides** Richardson.

The common sea-perch is omitted from the former list of fishes from Otago Harbour. The stomachs of those examined contained small crabs and shrimps (*Pontophilus*).
The ova are ripe in September, and the young fish are produced (viviparously) the same month.

10*a*. **Leptoscopus macropygus** Richardson.

This species, occasionally found off the east coast of Otago, must be added to my former list.

10*b*. **Crapatalus novae-zelandiae** Günther.

This fish, of which one specimen was taken "off Otago Heads" in the "Nora Niven" trawling expedition, must be added to our list. It is fully described by Waite (*l.c.*, No. 3, p. 239).

12*a*. **Kathetostoma giganteum** Haast.

Anderton records one specimen of this fish — the "flathead" — as taken about eight miles from Taiaroa Head, in 20 fathoms. Its stomach contained swimming-crabs and small bivalve shells. In the cruise of the "Nora Niven" this species was taken from the Canterbury Bight northwards to the Bay of Plenty. It is fully described by Waite (*l.c.*, No. 3, p. 241).

17. **Parapercis colias** Forster.

The stomachs of the blue-cod examined by Anderton contained the following: Red-cod, sea-perch (*Helicolenus*), kokopuru (*Tripterygion*), sea-horse, pipe-fish, octopus, small crabs (*Halicarcinus*, &c.), shrimps (*Pontophilus*), whale-feed, sea-anemones, and very frequently kelp and green algae.

17*a*. **Parapercis gilliesii** Hutton.

This species is omitted from my former list. The type specimen was taken near Dunedin, and was described by Hutton (Ann. Mag. Nat. Hist. (5), iii, 1879, p. 53). It has been more recently described by Waite (*l.c.*, No. 3, p. 244).

18. **Paratrachichthys traili** Hutton.

This has been made the type of a new genus, *Paratrachichthys*, by Waite (1899).

18*a*. **Trachichthys elongatus** Günther.

A specimen of this fish taken in the trawler off Otago Heads is in the Otago Museum.

20. **Thyrsites atun** Euphrasen.

The barracouta is a gregarious fish, swimming in considerable shoals, and it chiefly feeds on fishes and other animals which also swim in shoals. The most common food fish appears to be the sprat (*Amblygaster antipodus*), the stomachs sometimes being full of these. Red-cod, and occasionally hake (*Merluccius gayi*), were found in them, and on one occasion Anderton reports them as "quite full of small shrimps (*Nyctiphanes*)."

21. **Rexea furcifera** Waite.

The southern kingfish appears in the "Index Faunae Novae-Zealandiae" (p. 43) as *Promethichthys prometheus* Webb and Berthel, and by that name I have recorded it in the list of fishes found in Otago Harbour. Waite has, however, shown (*l.c.*, No. 3, p. 235) that it does not belong to that genus, so he has renamed it as above.

This fish is very common in the Dunedin shops, being taken nearly all the year round both by the trawlers and the line fishermen. Waite (*l.c.*) records it as chiefly feeding on squid. Anderton notes the following as the stomach-contents: Red-cod, young barracouta, silversides, sprats, leather-jacket (*Pseudomonacanthus*), garfish, squid, and small octopus.

27. **Seriolella brama** Günther.

The warehou is commonly sold in Dunedin as "trevally," but the latter name belongs to *Caranx platessa* Cuv. & Val.

The stomachs of those examined contained *Munida* and other small *Crustacea*, zoaeae of crabs, and large worms.

27*a*. **Gasterochisma melampus** Richardson.

The "butterfly-fish," as it is called when young, has been taken in Otago Harbour, and is now known to be the young of the scaled tunny, described as *Lepidothynnus huttoni* Günther. It is figured by Waite (*ante*, p. 220, Plate VIII). An adult taken in Otago Harbour in 1911 is in the Otago Museum.

29. **Chelidonichthys kumu** Lesson and Garnot.

The red gurnard is named *Trigla kumu* in the original list. The eggs and young fry were described and figured by Anderton in Trans. N.Z. Inst., vol. 39, p. 478, pls. 17, 18.

29*a*. **Lepidotrigla brachyoptera** Hutton.

This gurnard is not uncommon. It is described by Waite (*l.c.*, No. 3, p. 255).

29*b*. **Hemerocoetes acanthorhynchus** Forster.

This species must be added to the list of Otago fishes. It was taken off Waikouaiti during the cruise of the "Nora Niven," and also found in the stomachs of barracouta. It is described and figured by Waite (*l.c.*, No. 3, p. 245, pl. 54, fig. 1).

30. **Tripterygion tripenne** Forster.

The kokopu spawns in October and November. The young are very common in the harbour during the summer months, and furnish abundance of food for other species.

30*a*. **Tripterygion medium** Günther.
30*b*. **Tripterygion varium** Forster.

Both of these small species of kokopu occur in Otago Harbour.

31. **Agonostomus forsteri** Bloch and Schneider.

The stomachs of sea-mullet examined by Anderton in the month of March were found to be full of crab-zoaeae.

31*a*. **Centriscops humerosus** Richardson.

The bellows-fish was taken off Taiaroa Head during the cruise of the "Nora Niven." It is described by Waite (*l.c.*, No. 3, p. 169).

32*a*. **Trachelochismus pinnulatus** Forster.

Omitted from the previous list of Otago fishes. It has been taken near Dunedin.

32*b*. **Trachipterus altivelis** Kner.

Taken in Otago Harbour.

A specimen of an allied species labelled "*Trachypterus iris*" is in the Otago Museum. It was caught near Port Chalmers.

36. **Coridodax pullus** Forster.

The butter-fish, kelp-fish, or kelp-salmon, as it is variously called, is very common in Otago Harbour. It is wrongly identified in my previous list as *Odax vittatus* Solander.

Numbers of these kelp-fish have been kept for many months in the hatchery ponds and tanks, and they thrive very well in confinement. They were fed chiefly on kelp of various species. The only other food found in their stomach is *Munida*. The species is described and figured by Waite (*l.c.*, No. 3, p. 227, pl. 49).

37. **Pseudolabrus celidotus** Forster.

According to Waite (*l.c.*, p. 224), this is the correct name of the spotty, referred to in my former list as *P. botryocosmus* Richardson. This is a very common fish in Otago Harbour, and is frequently shown in the aquarium-tanks, as it is hardy and easily handled. It is a beautiful fish in the water, the ground-colour often varying from yellowish to a bright green, but the black blotch behind the pectoral fin is always a conspicuous mark, as are the bright-yellow ventral and anal fins.

38. **Pseudolabrus cinctus** Hutton.

The girdled parrot-fish is described and figured by Waite (*l.c.*, No. 3, p. 226, fig. 47).

All the parrot-fishes change colour very much when placed in altered surroundings. This species is characterized by a dark band surrounding the body, but when kept in a strongly lit aquarium-tank, this band sometimes becomes nearly white.

38*a*. **Pseudolabrus coccineus** Forster.

The scarlet parrot-fish was originally described from Dunedin by Hutton (Trans. N.Z. Inst., vol. 12, p. 455) as *Labrichthys roseipunctata*, and the type—evidently a young specimen—is in the Otago Museum. It is redescribed and figured by Waite (*l.c.*, No. 3, p. 224, pl. 46).

38*b*. **Pseudolabrus pittensis** Waite.

The banded parrot-fish is identified by Anderton as occurring not uncommonly in Otago Harbour. The stomachs of those examined were found to contain sea-horses, crabs, *Munida*, shrimps (*Pontophilus*), various molluscs (cockles, lamp-shells, and razor-shells), and kelp.

Flat Fishes.

In the list previously given by me (*l.c.*, p. 551) six species of flat fishes were recorded as occurring in Otago Harbour; but owing to the confusion which existed as to the identification of these species it is manifest that the list is of little value. This state of confusion has now been cleared up by Mr. Edgar R. Waite in the paper, so often quoted, in "Records of the Canterbury Museum," vol. 1, No. 3, where a full account of the nine best-known species is given (pp. 200–15), and a key is furnished to the characters of the seven genera represented. All these nine species occur in the waters of Otago Harbour or its neighbourhood.

39. **Caulopsetta scapha** Forster.

This species, referred to as "brill" in my former list, is a totally different fish. This specific name belongs to the megrim, or witch, a common form, not sold as a food fish on account of its lean, bony character. (Waite, *l.c.*, p. 200, pl. 34.)

The stomachs of those examined by Anderton contained only squid and worms. The egg is 0·68 mm. in diameter, and contains a single oil-globule.

40. **Ammotretis nudipinnis** Waite. (*Ammotretis rostratus* Hutton.)

This fine fish is named "New Zealand turbot" by Waite (*l.c.*, p. 209, pl. 39).

The eggs have been collected, and the development of the fry observed and figured by Anderton up to the eleventh day after hatching. The eggs are 1·5 mm. in diameter, and contain 21 to 28 oil-globules.

40*a*. **Ammotretis güntheri** Hutton.

This is the species sold as "brill" in the south. Along with those of the last-named, the eggs have been collected and large numbers of the fry reared at the hatchery. (See Waite, *l.c.*, p. 211, pl. 40.) The eggs are 1·7 mm. in diameter, and have numerous oil-globules evenly distributed throughout their substance.

41. **Rhombosolea plebeia** Richardson.

The common flounder, or sand-flounder, described and figured by Waite (*l.c.*, p. 203, pl. 35). The eggs are 0·65 mm. in diameter, and contain from 8 to 13 oil-globules.

42. **Rhombosolea millari** Waite. (*Rhombosolea flesoides* Hutton.)

The yellow-belly is the commonest flounder in the shallow lagoons and estuaries along the coast. Described and figured by Waite (*l.c.*, p. 205, pl. 37).

43. **Rhombosolea tapirina** Günther.

The greenback flounder is also found in all the inlets along the coast. It is described and figured by Waite (*l.c.*, p. 204, pl. 36). The eggs are 0·8 mm. in diameter, and contain a single oil-globule.

43*a*. **Rhombosolea retiaria** Hutton.

I am not aware whether the black flounder is met with in Otago Harbour or the open sea in its immediate vicinity; but it is found in brackish water, and goes up tidal rivers (such as the Taieri) into fresh water. Figured and described by Waite (*l.c.*, p. 207, pl. 38).

44. **Peltorhamphus novae-zeelandiae** Günther.

The so-called " English " or New Zealand sole is very abundant along the east coast.

During several seasons numbers of the eggs (over nine millions) have been hatched at Portobello, and the young fry turned out when a few days old. It is described and figured by Waite (*l.c.*, p. 213, pl. 42). The egg is the smallest of all of our flat fishes—only 0·5 mm. in diameter—and contains from 2 to 6 oil-globules.

44*a*. **Pelotretis flavilatus** Waite.

A common species, usually known as " lemon sole." Though not specifically named, this fish was well known and readily recognized. Nearly a million eggs have been hatched at Portobello, and the young fry liberated. It is figured and described by Waite (*l.c.*, p. 212, pl. 41). The egg is 0·8 mm. in diameter, and contains from 8 to 11 oil-globules.

45. **Physiculus bachus** Forster.

The red-cod in an immature condition is taken all the year round, often in enormous numbers. The mature fish is very large, between 2 ft. and 3 ft. long, but it is seldom caught. Males with ripe milt are frequently recorded, but the ripe ova have never been obtained. It is probable that, as is the case with many other species, the mature fish cease to bite on the approach of the spawning season.

The red-cod is an omnivorous feeder, and in the hundreds of stomachs examined and recorded by Anderton the following were found : Smaller red-cod, barracouta, kingfish, soles, sea-perch, sprats, lampreys, *Macrourus*, pipe-fish, sea-horse, pig-fish, squid, crabs (*Cancer*, *Cyclograpsus*, and *Halicarcinus*), *Munida* (sometimes the stomachs were quite full of these), *Lironeca*, and razor-shells. Specimens caught off Port Chalmers contained potatoes, turnip and potato peelings, and mutton-bones ; while one caught outside the Heads had swallowed the head of a rooster, probably thrown overboard by a passing steamer. Figured and described by Waite (*l.c.*, p. 183, pl. 31, fig. 1).

48. **Genypterus blacodes** Bloch and Schneider.

The following have been taken by Anderton from the stomachs of a large number of ling, mostly taken off Taiaroa Head : Red-cod, kingfish, soles, megrim, flathead (*Kathetostoma*), leather-jacket, pig-fish, small skate, squid, crabs (*Ommatocarcinus* and *Nectocarcinus*), great quantities of shrimps (*Nyctiphanes*), and (on one occasion) mutton-bones.

48*a*. **Coelorhynchus australis** Richardson.

This and the next two species must be added to the list of Otago fishes. They were taken during the cruise of the " Nora Niven " at various stations along the east coast. Described and figured by Waite (*l.c.*, p. 177, pl. 29, fig. 1).

48*b*. **Coelorhynchus aspercephalus** Waite.

Described and figured by Waite (*l.c.*, p. 178, pl. 29, fig. 2).

48*c*. Macruronus novae-zelandiae Hector.

Described and figured by Waite (*l.c.*, p. 180, pl. 30, fig. 1).

49. Hyporhamphus intermedius Cantor. (*Hemirhamphus intermedius* of former list.)

Garfish occur commonly in Otago Harbour during the summer months. The eggs are ripe in January. They are 2·5 mm. in diameter, contain a great number of minute oil-globules evenly interspersed throughout the superficial layer, and appear to be immersed in and loosely held together by numerous long transparent filaments.

The stomach of one examined in December was found to contain half-digested fragments of worms (?) mixed with green seaweed.

49*a*. Argentina elongata Hutton.

The silverside, which is omitted from the previous list, is common along the east coast, and was frequently taken in the trawl during the cruise of the "Nora Niven." It is described and figured by Waite (*l.c.*, p. 161, pl. 24).

51. Clupea neopilchardus Steindachner.

Recorded in previous list as *C. sagax* Arthur (not Jenyns). Fully described by Waite (*l.c.*, p. 158).

51*a*. Amblygaster antipodus Hector.

The sprat, which is very common on the east coast, especially during the summer months, is frequently mistaken for the preceding species. It is described by Waite (*l.c.*, p. 160).

55*a*. Syngnathus blainvillianus Eydoux and Gervais.

This pipe-fish is not uncommon in Otago Harbour. It is described and figured by Waite (*l.c.*, p. 174, pl. 27, fig. 2).

56*a*. Spheroides richei Fréminville. (*Amblyrhynchotus richei* Fréminville, Index Faunae Nov.-Zeal., p. 52.)

The little globe-fish is occasionally met with in Otago Harbour. It is common along the coast farther north, and is frequently brought ashore in great numbers in seine netting.

56*b*. Dicotylichthys jaculiferus Cuvier.

The porcupine-fish is occasionally met with in Otago Harbour.

60. Narcacion fairchildi Hutton.

Under this name Waite unites *Torpedo fairchildi* Hutton and *Torpedo fusca* Parker. The species is not uncommon in Otago coastal waters. It is fully described and figured by Waite (*l.c.*, p. 144, pl. 17).

61. Typhlonarke aysoni Hamilton.

Waite describes *Astrape aysoni* as the type of his new genus *Typhlonarke* (*l.c.*, p. 146, pl. 18).

Though this is a blind numbfish, Waite points out that it is found in comparatively shallow water (36–102 fathoms). It is not uncommon on the east coast of Otago.

63. **Mustelus antarcticus** Günther. (*Galeus antarcticus* Günther of previous list.)

The smooth hound is the smallest of the New Zealand sharks, varying from 18 in. to 3 ft. in length, but it is also the most abundant. It is common in the harbour and on the coast. Waite has described and figured it (*l.c.*, p. 140, pl. 14, fig. 2).

63*a*. **Galeus australis** Macleay.

The tope is common along the east coast of Otago. It varies from 3 ft. to 6 ft. in length. It is described and figured by Waite (*l.c.*, p. 139, pl. 15).

64*a*. **Carcharodon carcharias** Linnaeus.

The great white shark, the most formidable of all sharks, is an occasional visitant. An enormous specimen in the local Museum was taken in Otago Harbour.

65. **Cephaloscyllium isabella** Bonnaterre.

The carpet-shark, a species about 3 ft. or 4 ft. in length, is common in the harbour and along the coast. It is described and figured by Waite (*l.c.*, p. 136, pl. 14, fig. 1, and pl. 21, fig. 1).

65*a*. **Squalus fernandinus** Molina.

This is the species referred to as *Squalus acanthias* Linnaeus in the Index Faunae Nov.-Zeal., p. 54. This latter appears to be an Atlantic species.

The spiny dog-fish is from 2 ft. to 3 ft. in length; it is common in the harbour and along the coast. Waite has described and figured it.

65*b*. **Lamna nasus** Bonnaterre. (*Lamna cornubica* of the Index Faunae Nov.-Zeal., p. 54.)

The porbeagle shark. It has been occasionally taken in Otago Harbour.

65*c*. **Dalatias licha** Bonnaterre.

The brown shark has been taken in Otago Harbour, and a specimen is preserved in the local Museum.

66*a*. **Heptranchias indicus** Agassiz. (*Notorhynchus indicus* Cuvier, Index Faunae Nov.-Zeal., p. 54.)

A specimen of the perlon, captured in Otago Harbour, is in the local Museum.

66*b*. **Geotria australis** Gray.

The lamprey is usually described as a fresh-water fish, though it is only found in the rivers for a limited season, ascending them about October of each year, and returning to the sea in a couple of months. It is seldom met with as a marine species. Two large specimens were taken from a red-cod caught off Cape Saunders in July, 1909.

66c. **Eptatretus cirrhatus** Forster. (*Heptatrema cirrata* Forster, Index Faunae Nov.-Zeal., p. 55.)

The blind-eel, or hag, is common in the sea outside Otago Heads, and is greatly abhorred both by trawlers and line fishermen. It is described and figured by Waite (*l.c.*, p. 132, pl. 13).

Crustacea.

Brachyura.

None of the crabs found in New Zealand have any marketable value, and one of the achievements of the Portobello Marine Fish-hatchery has been the introduction of the edible crab of Britain—*Cancer pagurus*. Over twenty million fry of this species have been liberated in the waters of the harbour during the last few years, but no specimens have yet been met with. I do not know how long the zoaea stage of this crab lasts, but it is probably several weeks in duration, and, as the northerly current outside the Heads has already been referred to, it is probable that this has distributed the fry along the coast, and they may be found round Banks Peninsula quite as soon as in Otago Harbour.

Although the local species of crabs have no present commercial value, their zoaeae are enormously abundant during the summer months, and form no inconsiderable proportion of the fish-food during that season of the year. These zoaeae have not been worked out yet, and cannot, therefore, be recognized.

1. **Trichoplatus huttoni** A. Milne-Edwards. (*Halimus hectori* Miers, Cat. N.Z. Crust., p. 4.)

Occasionally met with in Otago Harbour and on the coast, especially after heavy north-easterly weather.

2. **Paramithrax peronii** Milne-Edwards.

Occasionally met with along the coast. It appears to be not uncommon from the Bluff to Cape Campbell.

All the species of *Paramithrax* are somewhat feebly provided with offensive or defensive weapons, and they therefore cover the carapace with sponges, sertularians, seaweeds, and other marine growths, so that when not moving about they readily escape recognition.

3. **Paramithrax latreilli** Miers. (*P. barbicornis* Miers.)

This is a very common crab along the coast, and is found at low water between tide-marks, where it usually hides among stones.

4. **Paramithrax longipes** G. M. Thomson.

Large numbers of this crab were taken by the trawlers in April, 1900, and they have since been met with along the coast at moderate depths. The carapace is usually more or less protected by "sponges, compound ascidians, serpulae, *Spirorbis*, and particularly with *Balanus decorus*," but owing to the length of the legs the animal is not nearly so fully protected as the preceding species, which has short limbs, which it is able to tuck completely in under the carapace.

Leptomithrax australis Jacquinot and Lucas.

Not uncommon on the coast. Occasionally taken on the sandbanks by the seine net.

6. Acanthophrys filholi A. Milne-Edwards.

Occasionally met with at moderate depths along the coast. All have the carapace more or less covered with sponges, &c.

7. Prionorhynchus edwardsii Jacquinot and Lucas.

This is the largest of the New Zealand crabs. It was originally found in the Auckland Islands, and was supposed to be peculiar to the group. Later it was taken on the Campbell Islands, and in August, 1900, the trawlers picked up great numbers of them outside of Otago Heads. On rare occasions since they have come across them again.

8. Eurynolambrus australis Milne-Edwards.

Very occasionally met with on the east coast.

9. Cancer novae-zealandiae Jacquinot and Lucas.

This is an extremely abundant crab in Otago Harbour and along the coast-line, from the tide-exposed sandbanks to 30 fathoms.

10. Nectocarcinus antarcticus Jacquinot and Lucas.

A common swimming-crab, both in Otago Harbour and in the adjacent sea. It is an extremely active and pugnacious species.

11. Ovalipes bipustulatus Milne-Edwards. (*Platyonichus bipustulatus.*)

This is another very common swimming-crab, often of considerable size, the carapace being 4 in. across and 3 in. deep. While moving about in the water, partly crawling and partly swimming, it carries its sharp and very powerful chelae in an elevated position ready for action. It buries itself in sand with great rapidity, front downwards at first, disappearing out of sight in five or six seconds, and then thrusts out its eye-peduncles, so as to be able to look around it.

12. Ommatocarcinus macgillivrayi White.

Occasionally taken in the trawlers, and found in the stomachs of fishes, from outside Otago Heads.

13. Macrophthalmus hirtipes Jacquinot and Lucas.

Very common on sandbanks in Otago Harbour and shallow bays along the coast. It is an active and most aggressive species.

14. Heterograpsus sexdentatus Milne-Edwards.

An extremely common shore-crab, occurring between tide-marks, usually under stones. The males have very powerful chelae, but they appear to use them only in self-defence, as they are not pugnacious. The ova hatch out in August and September.

15. **Heterograpsus crenulatus** Milne-Edwards.

Also found under stones between tide-marks, but not very common.

16. **Cyclograpsus lavauxi** Milne-Edwards.

Common under stones between tide-marks.

17. **Chasmagnathus subquadratus** Dana.

This is a very common crab, living on mud-flats in all the shallow bays and estuaries along the coast. It makes burrows not only between tide-marks, but also in situations completely out of reach of the water. Each individual occupies its own hole, those of the females being somewhat deeper than those of the males.

18. **Helice crassa** Dana.

Another species living in burrows on mud-flats in similar localities to the last.

19. **Sesarma pentagona** Hutton.

A specimen of this crab in the Otago Museum is labelled (in the late Captain Hutton's handwriting) as found in Dunedin. I have not come across the species elsewhere.

20. **Pinnotheres pisum** Linnaeus.

This little crab is found living commensally with mussels (*Mytilus* sp.); but it is only the females which live this confined life, the males being free-swimmers and rarely met with. This species spawns in December and January. The eggs are about 0·73 mm. in diameter. A specimen with a carapace 9·3 mm. in width carried about 1,400 eggs.

21. **Halicarcinus planatus** White.

An abundant crab in the harbour and near the coast. Moki taken in the channel just opposite the Portobello Hatchery have been found to have their stomachs crammed with this species.

22. **Hymenicus varius** Dana.
23. **Hymenicus pubescens** Dana.

I have referred small crabs taken by the dredge and the trawl-net and under stones in the neighbourhood of Otago Harbour to these species, but the whole group wants revision.

24. **Hymenosoma depressum** Jacquinot and Lucas.

Neighbourhood of Dunedin.

25. **Elamena producta** Kirk.

In rock-pools along the coast.

Anomura.

26. **Eupagurus novae-zealandiae** Dana. (G. M. Thomson, Trans. N.Z. Inst., vol. 31, p. 173, pl. 20, figs. 3–5.)

Common in Otago Harbour and along the coast.

27. **Eupagurus kirkii** Filhol. (G. M. Thomson, *l.c.*, p. 175, pl. 20, figs. 8–10.)

On the coast near Dunedin.

28. **Eupagurus cookii** Filhol. (G. M. Thomson, *l.c.*, p. 176, pl. 20, figs. 11–13.)

Taken in the trawl near Otago Heads.

29. **Eupagurus traversii** Filhol. (G. M. Thomson, *l.c.*, p. 179, pl. 16, figs. 1–3.)

On the coast near Otago Harbour.

30. **Eupagurus stewarti** Filhol. (G. M. Thomson, *l.c.*, p. 180; Chilton, Rec. Canterbury Mus., vol. 1, p. 298.)

Specimens taken off the coast to the south of Dunedin during the cruise of the "Nora Niven" are referred to this species by Chilton.

31. **Eupagurus rubricatus** Henderson. (G. M. Thomson, *l.c.*, p. 180; Chilton, *l.c.*, p. 297.)

Numerous specimens were picked up by the trawl at localities a little north of Otago Heads during the cruise of the "Nora Niven."

32. **Eupagurus norae** Chilton. (*Eupagurus edwardsii* Filhol: name preoccupied.) (G. M. Thomson, *l.c.*, p. 182, pl. 20, figs. 6 and 7: Chilton, *l.c.*, p. 299.)

Taken at various points near Dunedin, off Otago Heads, and near Moeraki.

33. **Eupagurus thomsoni** Filhol. (G. M. Thomson, *l.c.*, p. 183; Chilton, *l.c.*, p. 298.)

Taken in the trawl off Otago Heads in the cruise of the "Nora Niven" (in shells of *Turitella*).

34. **Paguristes barbatus** Heller. (Chilton, *l.c.*, p. 299.)

Two specimens from widely separated localities on the east coast of Otago were obtained during the cruise of the "Nora Niven."

35. **Petrolisthes elongatus** Milne-Edwards.

Extremely common under stones between tide-marks. The ova hatch out in November.

36. **Petrolisthes novae-zealandiae** Filhol.

Taken commonly in the trawl in Blueskin Bay. These little crabs are beautifully marbled with red and yellow markings.

37. **Petrocheles spinosus** Miers. (Chilton, *l.c.*, p. 296.)

Occurs sparingly along the east coast of Otago.

38. **Munida gregaria** Fabricius. (Chilton, *l.c.*, p. 301.)

This interesting crustacean is abundant in both its forms in Otago waters. In the bottom (or creeping) form it occasionally comes up the harbour in immense numbers. In September, 1898, the Upper Harbour seemed full of them, and they were seen creeping over the stones and piles of the jetties and among the rocks on the foreshore in countless thousands.

But it is in the swimming stage (formerly known as *Grimothea gregaria*) that they are so enormously abundant. They are found all the year round, but are particularly numerous in the summer months, when they move about in great bright-red shoals. They furnish one of the commonest articles of food, especially to fishes which swim near the surface, and they have been taken from the stomachs of the following: Red-cod, hapuka, kelp-fish, terakihi, blue-cod, spotty, parrot-fish, ling, leather-jacket, smooth hound, and spiny dog-fish.

At the hatchery Anderton has obtained the swimming stage carrying ova in the month of September; while during the same month numbers of those in the ponds in the *Grimothea* (swimming) stage gradually sank to the bottom and became quite indistinguishable from the *Munida* (ground or creeping form).

Macrura.

39. **Jasus edwardsii** Hutton.

The common crayfish is extremely abundant in Otago Harbour near the hatchery, and along the whole east coast of Otago.

The ova hatch out in November and December, and immense numbers of the fry have been liberated from the hatchery-ponds. A note on their development was published in Trans. N.Z. Inst., vol. 39, p. 484, pl. 20.

40. **Pontophilus australis** G. M. Thomson.

A very common shrimp in the harbour and on the coast.

41. **Betaeus aequimanus** Dana.

The jumping shrimp is found commonly under stones between tide-marks all along the east coast.

42. **Alope palpalis** White.

This is a fine large prawn, frequently met with in rock-pools along the coast.

43. **Hippolyte bifidirostris** Miers.

Common along the east coast, where it is frequently picked up by the trawlers.

44. **Palaemon affinis** Milne-Edwards.

Very common, and the only shrimp used as food by man to any extent.

45. **Brachycarpus audouini** Bate.

A slender little shrimp, quite common along the coast, and frequently picked up with trawled material.

Schizopoda.

46. **Nyctiphanes australis** G. O. Sars.

This is an extremely common species, and is a valuable food for fish. It is taken in the surface-nets at all seasons of the year, and large quantities have been found in the stomachs of various fish (chiefly hapuka, barracouta, and ling).

47. **Siriella denticulata** G. M. Thomson.

Found in the harbour and along the coast.

48. **Tenagomysis novae-zealandiae** G. M. Thomson.

Common along the coast-line in rock-pools and estuaries.

Stomatopoda.

49. **Squilla armata** Milne-Edwards. (Chilton, Trans. N.Z. Inst., vol. 43, p. 135.)

Dunedin.

50. **Lysiosquilla spinosa** Wood-Mason. (Chilton, *l.c.*, p. 139.)

Otago Harbour, but not common.

Cumacea.

51. **Diastylis neo-zealanica** G. M. Thomson.

In 1883–84 I got a few specimens of this shrimp when dredging in the Bay of Islands, and described the species from these (Journ. Linn. Soc., Zool., vol. 24, p. 268). I never met with it again, nor did any other collector find it, till 1906. In June of that year Mr. Anderton learned from the trawlers that great numbers of very large soles and flounders were being taken in Blueskin Bay. The fishermen thought they were spawning, and this shows how little dependence can be placed on the observational powers of the average fisherman, as they ought to know by this time that none of the flat fishes spawn till well on in August. On going out with the boats he found that the fish were following some food into the shallow water. On the trawl-net being hauled on board immense numbers of small shrimps were found on the deck, on the trawl-ropes and net, and the fish were gorged with them. They all proved to be *Diastylis neo-zealanica*. The species has not been met with again.

This case furnishes an example of the remarkable and gigantic migrations of organisms which take place in the ocean, of which we know neither the cause nor the location from which the animals come, but which all naturalists who have collected with the dredge or the trawl-net in these southern seas are not unfamiliar with. Fishermen sometimes affirm that some particular kind of fish which used to be common has been fished out, and has entirely disappeared or become rare. The first statement is obviously absurd, as all the fishermen in the country could not fish out any portion of the ocean-floor. But that species of fish and other organisms come and go in a way not capable of explanation in our present limited state of knowledge is an obvious fact, and shows the need of regular and continuous recording of observations such as are now being carried on at the Portobello Hatchery.

Amphipoda.

52. Vibilia propinqua Stebbing.

In Otago Harbour, and also taken by me washed up on the beach near Dunedin. The latter example was found in the test of a *Salpa*.

53. Phronima novae-zealandiae Powell.

Washed up in great numbers on the beaches, particularly in still weather. Always found in the test or "barrel" of a *Doliolum?*

54. Euthemisto thomsoni Stebbing.

Commonly washed up on the coast.

55. Platyscelus intermedius G. M. Thomson.

Occasionally found washed up on the coast.

56. Oxycephalus edwardsi G. M. Thomson.

Frequently washed up on the coast.

57. Nannonyx kidderi S. I. Smith. (*Nannoyx thomsoni* Stebbing; *Lysianassa kröyeri* G. M. Thomson.)

Very common in the harbour, and taken in the trawl along the coast in great numbers.

58. Ampelisca acinaces Stebbing.

Occasionally washed up on the beaches in great numbers.

59. Platyischnopus neozealanicus Chilton.

Taken in Otago Harbour.

60. Phoxocephalus bassi Stebbing.

Taken frequently in Otago Harbour.

61. Amphilochus squamosus G. M. Thomson.

Common in Otago Harbour.

62. Cyproidea otakensis Chilton.

Found in Otago Harbour.

63. Iphinotus typicus G. M. Thomson.

Occasionally found in Otago Harbour.

64. Panoploea spinosa G. M. Thomson.

Common in Otago Harbour.

65. Harpinia obtusifrons Stebbing.

"Numerous specimens taken in Otago Harbour": Chilton ("Sub-antarctic Islands of New Zealand," vol. 2, p. 619).

66. **Liljeborgia dubia** Haswell. (*Lilljeborgia haswelli* Stebbing.)

Common on the coast. Lives in pairs commensally with species of hermit-crabs (*Eupagurus*) in the upper whorls of the shells they inhabit.

67. **Leptamphopus novae-zealandiae** G. M. Thomson. (*Pherusa novae-zealandiae* G. M. Thomson.)

Common in Otago Harbour.

68. **Eusirus antarcticus** G. M. Thomson. (*Eusirus longipes* Stebbing; not Kröyer).

Not uncommon in Otago Harbour.

69. **Pontogeneia danai** G. M. Thomson.

Common in rock-pools along the coast.

70. **Paramoera austrina** Bate. (*Megamoera fasciculata* G. M. Thomson.)

Common in rock-pools along the coast.

71. **Melita inaequistylis** Dana. (*Melita tenuicornis* Dana.)

Common in rock-pools, and under stones between tide-marks.

72. **Elasmopus subcarinatus** Haswell.

Frequently taken along the coast in the trawl-nets.

73. **Paradexamine pacifica** G. M. Thomson.

Very common along the coast.

74. **Paradexamine laevis** G. M. Thomson. (*Amphithonotus laevis* G. M. Thomson.)

Occasionally met with in Otago Harbour.

No group of the *Amphipoda* has led to such divergence of opinion in regard to classification as the *Orchestidae*, or, as Stebbing styles it in his splendid monograph of the *Gammaridea* (in Das Tierreich), the *Talitridae*. This is due in part to the fact that the sexes of the same species differ very considerably, and that the males especially exhibit great structural changes in the course of their growth and development. Stebbing divides the group into thirteen genera, and in this he is followed by most carcinologists. With all deference to such a body of authority, working, however, as most of them do on material collected for them, I am inclined to dispute those distinctions which are based on such slight and such plastic characters as the development of the chelae of the gnathopods of the males. I have examined thousands of specimens collected by myself, have dissected, compared, and drawn hundreds of examples of New Zealand and Australian forms, and have compared these w th European and Australian types received from Messrs. Stebbing and Calman and Professor Haswell. As a result of my researches I am inclined to reduce *Talitrus*, *Talitroides*, *Orchestoidea*, *Talorchestia*, and *Parorchestia* to *Orchestia*, the first four being based almost exclusively on sexual characters, the last on the presence or absence of a claw on the apex of the 4th joint of the palp of the maxilliped. Similarly, I would include *Allorchestes* under *Hyale*, and I cannot follow Mr. A. O. Walker in his generic distinction.*

In my paper on the synonymy of the New Zealand *Orchestidae* (Trans. N.Z. Inst., vol. 31, p. 197) I gave a brief diagnosis of the New Zealand species as I limited and defined them. I hoped to work out these in detail and illustrate my contention fully, but pressure of parliamentary and other work has quite prevented me from doing so. So two or three years ago I handed over all my collections, dissections, notes, and drawings to my friend Dr. Chilton, in the hope that he would be able to clear up the confusion; but he, too, has had abundance of other work, so the matter has to remain unsolved for the present. Meanwhile the present identifications refer only to the species as defined in the paper referred to, the classification employed there having been adopted in the "Index Faunae Novae-Zealandiae," p. 257.†

75. **Orchestia gammarellus** Pallas.

"Usually found under wet stones, seaweed, &c., between tide-marks, occasionally swimming in rock-pools. Does not appear to burrow in sand." Common in and around Otago Harbour.

76. **Orchestia chiliensis** Milne-Edwards.

"Under stones, seaweed, &c., at or below high-water mark." Common about the harbour, where I have found great colonies under pieces of whalebone.

77. **Orchestia telluris** Bate.

"On sandy beaches, usually just above high-water mark." This is a burrowing species, and is not very common.

78. **Orchestia aucklandiae** Bate.

"At or below high-water mark, under stones, kelp &c.; a powerful species, hopping vigorously." Common along the beaches on the coast.

79. **Orchestia quoyana** Milne-Edwards.

"On sandy beaches, above high-water mark, usually under masses of old seaweed, below which it digs its shallow burrows." Very common.

80. **Orchestia tumida** G. M. Thomson.

"On sandy beaches and sandhills, usually at some distance from the sea." Common along the coast.

81. **Hyale prevostii** Milne-Edwards.

"In rock-pools between tide-marks." Common.

82. **Hyale pontica** Rathke.

"Between tide-marks." Not uncommon.

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* Ann. Mag. Nat. Hist. (8), vol. 2, p. 39.

† For another classification of this family see Stebbing, "Das Tierreich Amphipoda" (1906), pp. 523–85.—Eds.

83. **Hyale lubbockiana** Bate.

"One specimen in a rock-pool near Dunedin."

84. **Hyale chiltoni** G. M. Thomson.

Rock-pools near Dunedin.

85. **Aora typica** Kröyer.

Common in Otago Harbour and along the coast.

86. **Haplocheira barbimana** G. M. Thomson.

On the coast near Dunedin.

87. **Jassa pulchella** Leach. (*Podocerus validus* Dana.)

Often found in great numbers among the sutures of the carapace of the common crayfish (*Jasus edwardsii*).

88. **Paracorophium excavatum** G. M. Thomson.

On the coast near Dunedin.

89. **Corophium contractum** Stimpson.

Otago Harbour.

90. **Podocerus cristatus** G. M. Thomson.

Otago Harbour.

91. **Caprella aequilibra** Say.

Common in Otago Harbour; dredged among sertularians, &c.

92. **Caprellinopsis longicollis** Nicolet.

Common in Otago Harbour.

Isopoda.

93. **Tanais novae-zealandiae** G. M. Thomson.

Dredged in Otago Harbour.

94. **Heterotanais tenuis** G. M. Thomson. (*Paratanais tenuis* G. M. Thomson.)

Dredged in Otago Harbour.

95. **Paranthura nigropunctata** Lucas. (*Paranthura costana* Bate and Westwood.)

Washed up on the beach south of Dunedin.

96. **Haliacris neozelanica** Chilton. (*Munna neozelanica* Chilton.)

Otago Harbour.

97. **Meinertia imbricata** Fabricius.

Met with in Otago Harbour.

98. **Meinertia huttoni** Filhol.

Found in Otago Harbour.

99. **Aega novae-zealandiae** Dana.

Quite common on the coast.

100. **Aega maorum** Filhol.

"On the coast of Otago" (Filhol).

101. **Pseudaega punctata** G. M. Thomson.

Very common on the beaches, between tide-marks.

102. **Lironeca raynaudii** Milne-Edwards. (*Lironeca novae-zealandiae* Miers.)

A common fish-parasite, especially on flounders and ling.

I notice in recent works that the tendency is to call this genus *Livoneca*. The correct spelling, I believe, is *Lironeca*. I think I am correct in saying that Leach, in naming this and several other genera of *Isopoda*, played on the letters of his wife's name, Caroline—*e.g.*, *Cirolana*, *Nerocila*, *Lironeca*. No other spelling has any meaning.

103. **Nerocila macleayii** Leach.

A common parasite on various fishes.

104. **Cirolana rossii** Miers.

Very common in the harbour and along the coast. Traps put down for *Crustacea* are frequently found to contain them in great numbers.

Recently baited traps have been put down in localities where large numbers of young lobsters have been liberated, in the hope that examples of these very shy *Crustacea* might be met with. In every case numerous specimens of a small kokopu (*Tripterygion*) and of this Isopod have been caught, but no lobsters.

105. **Exosphaeroma gigas** Leach.

Not uncommon along the coast.

106. **Isocladus armatus** A. Milne-Edwards.

Common along the coast. I think that most of the forms which I formerly recorded as *Sphaeroma obtusa* Dana were only the females of this species.

107. **Isocladus spiniger** Dana.

Several specimens collected near Dunedin appear to belong to this species.

108. **Dynamella huttoni** G. M. Thomson. (*Cymodocea huttoni* G. M. Thomson.)

Very common along the coast.

109. **Cilicaea canaliculata** G. M. Thomson. (*Naesa* (= *Nesaea*) *canaliculata* G. M. Thomson.)

Commonly taken in the trawl off Otago Heads.

110. **Cassidina neo-zealanica** G. M. Thomson.

Very common on the coast; usually found creeping on seaweed.

111. **Amphoroidea falcifer** G. M. Thomson.

Occasionally met with in dredged or trawled material along the coast.

112. **Astacilla tuberculata** G. M. Thomson.

Dredged in Otago Harbour.

113. **Idotea lacustris** G. M. Thomson.

Found in the mouth of the Tomahawk Lagoon, at the mouth of a little stream coming into Otago Harbour at Sawyer's Bay, and also in the fresh-water streams themselves up to an elevation of nearly 2,000 ft.

The species appears to be undergoing transition from a salt-water to a fresh-water form. I have had specimens brought to me from a small stream on Swampy Hill, behind Dunedin (at a height of 1,800 ft.), which ran into the Silverstream, itself a tributary of the Taieri River.

114. **Idotea elongata** Miers.

Common along the coast.

115. **Idotea peronii** Milne-Edwards.

Common along the coast.

116. **Paridotea ungulata** Miers.

Fairly common in Otago Harbour and on the coast. Usually (? always) bright green in colour.

117. **Ligia novae-zealandiae** Dana.

The rock-slater is common under stones on rocky beaches.

118. **Actaecia euchroa** Dana. (Chilton, Trans. Linn. Soc., Zool., viii, p. 130.)

Dunedin.

Phyllocarida.

119. **Nebalia longicornis** G. M. Thomson.

Otago Harbour, and frequently taken outside the Heads in the trawl-nets.

Ostracoda.

120. **Cyprinotus flavescens** Brady.

Neighbourhood of Dunedin.

121. **Cythere atra** G. M. Thomson.

Among shore-algae, Otago Harbour.

122. Cythere innominata Brady. (*Cythere truncata* G. M. Thomson.)

Among shore-algae in Otago Harbour, and in rock-pools along the coast.

123. Loxoconcha punctata G. M. Thomson.

Among shore-algae in Otago Harbour, and in rock-pools along the coast. This species is very fully described and figured in "Pacifische Plankton-Crustaceen von G. O. Sars," p. 401, taf. 19, figs. 162–72.

124. Xestoleberis olivacea Brady.

Rock-pools along the coast.

125. Xestoleberis compressa Brady.

Rock-pools along the coast.

126. Philomedes agilis G. M. Thomson.

Common in rock-pools along the coast, and taken in the surface-net in the harbour and outside.

127. Philomedes sculpta Brady.

Surface-net, Otago Harbour.

128. Asterope australis Brady.

Taken abundantly in the surface-net, Otago Harbour.

Copepoda.

The free-swimming *Copepoda* form a large proportion of the plankton of these southern seas. They are enormously abundant at all seasons of the year, and are of the greatest importance as a source of food for several species of fish (*e.g.*, the *Clupeidae*) and for numbers of larvae of fish. In rearing young lobsters in the hatchery, in their very early swimming stages Anderton used formerly to use chopped-up livers of crabs (*Heterograpsus*, &c.) or finely chopped cockle. He now feeds them on *Copepoda*, using fine surface-nets, and removing large zoaeae, *Actiniae*, &c. The larval lobsters chase the minute *Copepoda* about, and feed freely on them.

129. Calanus helgolandicus Claus. (*Calanus finmarchicus* Brady, Giesbrecht, &c.; not Gunnerus.)

Surface-net; abundant.

130. Paracalanus parvus Claus.

Surface-net.

131. Clausocalanus arcuicornis Dana.

Surface-net, Otago Harbour.

132. Clausocalanus furcatus Brady.

Surface-net, Otago Harbour.

133. Centropages discaudatus Brady. (*Centropages typicus* Kröyer var. *aucklandicus* Kröyer.)

Surface-net, Otago Harbour.

134. Centropages pectinatus Brady.

Surface-net, Otago Harbour.

135. Temora tenuicauda Brady.

Surface-net, Otago Harbour.

136. Labidocera cervi Krämer.

Surface-net, Otago Harbour.

137. Acartia ensifera Brady.

Surface-net, Otago Harbour.

138. Oithona spinifrons Boeck.

Surface-net, Otago Harbour.

139. Thorellia brunnea Boeck var. antarctica G. M. Thomson.

Dredged in Otago Harbour.

140. Ectinosoma australe Brady.

Otago Harbour, between tide-marks.

141. Euterpe gracilis Claus.

Surface-net, Otago Harbour.

142. Amymome clausii G. M. Thomson.

Dredged in Otago Harbour.

143. Laophonte australasica G. M. Thomson.

Dredged in Otago Harbour.

144. Diarthrodes novae-zealandiae G. M. Thomson.

Dredged in Otago Harbour.

145. Merope hamata G. M. Thomson.

Dredged in Otago Harbour.

146. Dactylopusia neglecta G. O. Sars. (*Dactylopus tisboides* Claus.)

Between tide-marks, Otago Harbour.

147. Xouthous novae-zealandiae G. M. Thomson.

Dredged in Otago Harbour.

148. Phroso gracilis Brady.
Surface-net, Otago Harbour.

149. Microthalestris forficula Claus. (*Thalestris forficula* Claus.)
Between tide-marks, Otago Harbour.

150. Thalestris australis Brady.
Between tide-marks, Otago Harbour.

151. Harpacticus chelifer Müller.
Very common in harbour and along the coast.

152. Harpacticus glaber Brady.
Surface-net, Otago Harbour.

153. Zaus contractus G. M. Thomson.
Dredged in Otago Harbour.

154. Peltidium novae-zealandiae Brady.
Surface-net, Otago Harbour.

155. Porcellidium fulvum G. M. Thomson.
Dredged in Otago Harbour.

156. Porcellidium interruptum G. M. Thomson.
Dredged in Otago Harbour.

157. Psamathe longicauda Philippi. (*Scutellidium tisboides* Claus.)
Otago Harbour and in rock-pools along the coast.

158. Scutellidium plumosum Brady.
Surface-net, Otago Harbour.

159. Idya furcata Baird.
Common in shore-kelp and rock-pools near Dunedin.

160. Corycaeus robusta Dana (?).
Surface-net, Otago Harbour.

161. Paurocope robusta Brady.
Surface-net, Otago Harbour.

162. Centromma thomsoni Brady.
Surface-net, Otago Harbour.

163. Conostoma elliptica G. M. Thomson.
Dredged in Otago Harbour.

164. Artotrogus boeckii Brady.
Dredged in Otago Harbour.

165. **Artotrogus ovatus** G. M. Thomson.
Dredged and taken in surface-net in Otago Harbour.

166. **Acantiophorus scutatus** Brady and Robertson.
Dredged in Otago Harbour.

The *Caligidae* are not noted here, as all are parasites on fish. Neither have the *Balanidae* nor the *Pantopoda* been included in this list.

Art. XXVIII.—*Some Hitherto-unrecorded Plant-habitats* (VIII).

By L. Cockayne, Ph.D., F.L.S., F.R.S.

[*Read before the Philosophical Institute of Canterbury, 4th December, 1912.*]

This paper is divided into three sections. The first contains the usual general plant-habitats; the second an enumeration of the species collected for me by Miss B. E. Baughan on the Westland slopes of the Copeland Pass and in the Copeland Valley; and the third a list of species from the Upper Clinton Valley, supplementary to those already published by Petrie (Trans. N.Z. Inst., vol. 28, pp. 540–90), and by Cheeseman in his Manual and in Trans. N.Z. Inst., vol. 42, pp. 200–8. Miss Baughan's collection is of importance, since it is the first record of the flora of any part of alpine Westland south of the Franz Josef Glacier and its vicinity. The Clinton plants were collected or noted by Mr. J. Crosby Smith, F.L.S., or myself during a brief visit paid to that highly interesting locality in March, 1912. Unfortunately, the weather, except on one day, was very wet, while our work on the actual pass was conducted, in part, during a heavy snowstorm, otherwise the list might have been much longer. As it is, the recorded plants are only increased from 64 to 176, and that cannot nearly represent the total florula. With regard to the species in the first section, those from Marlborough and western Nelson were collected by Mr. C. E. Foweraker and myself, our collection from the Awatere Valley and its surrounding mountains numbering 303, but only a few are published here. The plants from Mount Oxford, never before enumerated, are being collected with great assiduity by the Rev. J. E. Holloway, M.Sc., and those of Hanmer by Mr. C. Christensen, who is examining the plant-life of that district in a most thorough manner, and has already made discoveries, both floristic and ecological, of considerable importance. The Takitimu plants were collected by myself, but I only reached an altitude of 1,000 m. at most; only the more important are recorded, my total collection numbering 124 species. Let me, in concluding these introductory remarks, take this opportunity of thanking most heartily all those mentioned above, together with others cited below, who have so generously and willingly contributed specimens and information.

I. Species from various Localities.

Acaena Buchanani Hook. f. subsp. **longe filamentosa** Bitter.

South Island: Southland — (1.) Riverton Flats; J. Crosby Smith. (2.) Dunes, Riverton; L. C.

Aciphylla Dobsoni Hook. f.

South Island: Otago—Mount Jones, near Lake Hawea, on rock at summit. B. Seth-Smith!

Agrostis muscosa T. Kirk.

South Island: (1.) Marlborough—Awatere Valley; Foweraker and L. C. (2.) Nelson—Steppe of Tarndale Moraine; Foweraker and L. C.

Alsophila Colensoi Hook. f.

South Island: Southland—Takitimu Mountains. L. C.

Anisotome carnosula (Hook. f.) Cockayne and Laing.

South Island: Marlborough — Shingly Range, Awatere, at 1,200 m. altitude. Foweraker and L. C.

Astelia montana (T. Kirk) Cockayne.

South Island: Southland—Common in lowland *Danthonia Raoulii* steppe. L. C.

Carex Muelleri Petrie.

South Island: Marlborough—Awatere Valley. Foweraker and L. C.

Celmisia coriacea Hook. f. var. **stricta** Cockayne var. nov.

Caules multiramosi, folia typo rigidiora supra valde argentea basim versus sensim angustata.

South Island: Southland—Forming at and above 900 m. altitude continuous silvery masses on the hill-sides, which extend as far as the eye can see, and give a distinctive colour to the slopes even at a considerable distance. Takitimu Mountains. L. C.

This variety branches more than the type, so that one plant may consist of more than thirteen rosettes, each 62 cm. high, and the whole 1·9 m. in diameter. The leaves are narrower and more rigid than those of the type, extremely silvery on the upper surface, the margins strongly recurved, and the lamina gradually tapers above in a long acute apex and below into the comparatively narrow petiole. The silvery pellicle of the upper leaf-surface of *C. coriacea* decreases considerably in plants grown under lowland-garden conditions, but, so far as plants in cultivation with me go, those of this variety still remain much more silvery than those from the Hanmer mountains, both being planted at about the same time. The typical form of *C. coriacea* is present in the wetter mountains to the west of the Takitimus, so the distribution of the two forms is analogous with that of *Gaya ribifolia* and *G. Lyallii* (Trans. N.Z. Inst., vol. 44, p. 38; 1912).

Celmisia Haastii Hook. f.

South Island: (1.) Canterbury—Fellfield near summit of Mount Oxford; J. E. Holloway! (2.) Otago—Summit of Mount Jones, near Lake Hawea; B. Seth-Smith!

Celmisia lanceolata Cockayne.

South Island: Southland—Near summit of the Hump. J. Crosby Smith!

Celmisia Lyallii Hook. f.

South Island: Canterbury—Fellfield of Mount Oxford. J. E. Holloway!

Celmisia Mackaui Raoul.

South Island: Canterbury—Hills at the back of Akaroa, on rocks at or near summits; also on rock at 210 m. altitude, and on cliff at Fisherman's Bay at sea-level. A. Gray!

These habitats are given not because they are new, strictly speaking, but because the species had not been noted for many years, nor was any published account available of its life-conditions. Mr. A. Gray, B.A., to whom I am much indebted for the trouble he has taken, writes me as follows: "It is seldom met with except in places quite inaccessible to stock. The only exception I have noticed is when it was growing in a very wet place amongst flax, &c., at the head of Stone Bay. In the swamp it was a much bigger plant than when found in the crevices of the rocks."

Celmisia mollis Cockayne.

This plant was noted in my plant-habitat paper No. VII as collected by Mr. W. Willcox on "mountains near Hanmer." This year I found several specimens in the same district on Mount Charon, and growing in company with *C. spectabilis* and *C. Traversii*. I have already (Trans. N.Z. Inst., vol. 44, p. 31) suggested a hybrid origin for the plant, and the above occurrence is very suggestive in this regard. The type plant from Arthur's Pass would, however, be of different, though ecologically similar, parentage —viz., *C. spectabilis* × *C. petiolata*. The Mount Charon plant is growing well in my garden.

Celmisia Monroi Hook. f.

South Island: (1.) Marlborough—On rock, Upper Awatere Valley; Foweraker and L. C. (2.) Nelson—Tarndale Mountain and St. Arnaud Mountains; Foweraker and L. C.

This species has much narrower and somewhat thinner leaves than *C. coriacea*, but they vary considerably in breadth, the narrowest noted being 10 mm. broad by 22·5 cm. long. Perhaps 18 mm. would be the average breadth. On Mount Fyffe I noted what may be the same species, but the leaves were extremely thin. I am of opinion that the Mount Cook plants included in his description of the species by Cheeseman (Manual, p. 313) and recently described by Petrie under the name *C. Boweana* (Trans. N.Z. Inst., vol. 44, p. 182) do not belong to *C. Monroi*.

Celmisia spectabilis Hook. f.

South Island: Canterbury—Mount Oxford. J. E. Holloway!

Clematis afoliata Buchanan.

South Island: Marlborough — Awatere Valley, in montane belt. Foweraker and L. C.

Clematis marata J. B. Armstrong.

South Island: Marlborough—Robinson Creek, Inland Kaikoura Mountains, at 1,000 m. altitude. Foweraker and L. C.

Convolvulus fracto-saxosa Petrie sp. nov.

South Island: Marlborough—Shingle-slip on Inland Kaikoura Mountains. Foweraker and L. C.

Coprosma Banksii Petrie.

South Island: Southland — *Nothofagus Menziesii* forest, Takitimu Mountains. L. C.

Coprosma Colensoi Hook. f.

South Island: Southland—*Nothofagus Menziesii* forest, Takitimu Mountains. L. C.

Coprosma microcarpa Hook. f.

South Island: Marlborough—*Nothofagus cliffortioides* forest, Awatere Valley. Foweraker and L. C.

Coprosma rugosa Cheesem.

South Island: Southland—Subalpine scrub, Takitimu Mountains. L. C.

The scrub occurs only in patches. The chief species are: *Coprosma rugosa*, *C. parviflora*, *C. ciliata*, *C. cuneata*, *Aristotelia fruticosa*, *Nothopanax Colensoi*, *Cassinia Vauvilliersii*, *Phormium Cookianum*, *Aciphylla Colensoi* (a form approaching *A. maxima*), and *Polystichum vestitum*.

Cotula (filiformis Hook. f.) ?

South Island: Nelson—Dry ground amongst *Leptospermum scoparium*, vicinity of Hanmer Plains. C. Christensen !

C. filiformis has not been recorded, except in Armstrong's list of Canterbury plants, since its original discovery some fifty years ago. I am not at all sure of my identification, but am sending a specimen to Kew.

Cotula maniototo Petrie.

South Island: Canterbury—River-bed of Waimakariri, in wet muddy ground, at only a few metres above sea-level. H. Firman and L. C.

Cheeseman (Manual, p. 354), gives only seven localities for this species, but he remarks that it is probably common throughout the South Island.

Danthonia australis Buchanan.

South Island: Nelson—Mount Charon (Hanmer), near summit. L. C.

The distribution of this remarkable grass is in harmony with the climate, it being a dominant plant on mountains within the range of the western rainfall, but quite wanting to the east. The above habitat shows its reduction almost to vanishing-point.

Dracophyllum uniflorum Hook. f.

South Island: Southland—Takitimu Mountains. L. C.

Drapetes villosa Berggren var. **multicaulis** Cheesem.

South Island: Canterbury—Mount Oxford. J. E. Holloway !

Epilobium brevipes Hook. f.

South Island: Nelson—On rock-faces in Wairau Valley, above the gorge, and at 1,200 m. elevation, St. Arnaud Mountains. Foweraker and L. C.

Epilobium rostratum Cheesem. var. **pubens** Petrie var. nov.

South Island: Marlborough—On dry ground, Upper Awatere Valley. Foweraker and L. C.

Exocarpus Bidwillii Hook. f.

South Island: Canterbury—Mount Oxford. J. E. Holloway !

Gaultheria depressa Hook. f.

South Island: Southland—Lowland *Danthonia Raoulii* steppe. L. C.

Gaya Lyallii (Hook. f.) J. E. Baker.

South Island: Southland—Takitimu Mountains. L. C.

Gaya ribifolia (F. v. Muell.) Cockayne.

South Island: (1.) Marlborough — Shingly Range, the Inland Kaikouras, &c.; Foweraker and L. C. (2.) Nelson—Tarndale; Foweraker and L. C.

The epharmonic distribution of the two species of *Gaya* is admirably illustrated in the Wairau Valley. Proceeding from Tarndale to the Rainbow, at first, and for a considerable distance, there is only *G. ribifolia*, but quite suddenly, as the wetter district is gained, *G. Lyallii* is alone encountered.

Gnaphalium paludosum Petrie.

South Island: Marlborough—Bogs and wet ground, Upper Awatere Valley. Foweraker and L. C.

Gypsophila tubulosa Boiss.

South Island: Nelson — Neighbourhood of Hanmer Plain, on bare ground of *Leptospermum* heath. C. Christensen!

This species has generally been considered indigenous, but I cannot help thinking it is an introduced plant, since *it has never been found in really virgin country*, but always in places where sheep graze. Cheeseman, however (Manual, p. 62), considers it truly indigenous, and his opinion must carry great weight.

Helichrysum coralloides (Hook. f.) Benth. & Hook. f.

South Island: (1.) Marlborough—Shingly Range, Awatere, at 1,500 m. altitude; Foweraker and L. C. (2.) Nelson—Tarndale Mountain and Wairau Gorge; Foweraker and L. C.

H. coralloides is a much more common plant than was imagined. It probably occurs on all the higher dry mountains of Marlborough. *H. Selago* is much more closely related to this species than it is to *H. microphyllum*, a plant with quite slender branches, and which blooms at a different season of the year. The latter also grows upon the ground as well as upon rocks, in which case, as in subalpine scrub on Shingly Range, it forms an erect shrub 80 cm. tall.

Helichrysum depressum (Hook. f.) Benth. & Hook. f.

South Island: Marlborough—Seaward Kaikoura Mountains. L. C.

Helichrysum Selago (Hook. f.) Benth. & Hook. f.

South Island: Southland — On rock-face, Takitimu Mountains, at about 900 m. altitude. L. C.

If the name *H. microphyllum* (see plate 35A in the "Flora Novae-Zelandiae") is to be kept for the slender-stemmed late-blooming plant, then the stouter-stemmed plant mentioned by Hooker, and included by him (Handbook, p. 146) and by Cheeseman also (Manual, pp. 342–43) in their descriptions of *H. microphyllum*, must be removed to *H. Selago*, which will need splitting up into varieties, if not species. For instance, the Wairau Gorge plant has the leaves so hidden by white wool as to be mere shining tubercles, as in *H. coralloides*. But in the case of a plant common on the Hanmer Mountains the wool is hardly visible with the naked eye, the leaves are in more series, and more closely imbricating than in *H. Selago* as described; also, they are acute, and without the keel on the outer (under) surface. Another Hanmer plant has the wool as usual, but the leaves are strongly acute, almost apiculate, not obtuse or subacute as in Cheeseman's description. Mr. Christensen first called my attention to these two plants as distinct, and I am in hopes that he will bring evidence as to their constancy, or the contrary. Again, the plant from near Cape Saunders (Otago) has stems, &c., of an equal diameter to those of *H. coralloides*. *H. microphyllum* as I limit it, and as Hooker first described it from Bidwill's specimens from one locality, is a common Marlborough plant; the leaves are much smaller than those of *H. Selago*, keeled, obtuse to almost subacute, and embedded in white wool; the flower-heads also are much smaller.

Helichrysum Sinclairii Hook. f.

South Island: Marlborough—Base of Shingly Range. Foweraker and L. C.

This had not been seen since the original discovery by Sinclair more than fifty years ago. Dr. Stapf, F.R.S., kindly compared our specimens with the type at Kew, and reported that they matched in all essentials. The plant, however, is much taller and more striking than the height given by Hooker (2–4 in.) would lead one to suppose. In fact, it is a suffruticose dense bush some 56 cm. tall and 58 cm. through. The stems are woody and decumbent at first, but are finally erect and suffruticose. The erect stems are straight, leafy, and put forth short lateral branches. The leaves are soft, and covered with white tomentum on both surfaces. When in flower the plant is distinctly handsome, and it should be easy of cultivation and excellent for the rock-garden.

Hymenanthera dentata R. Br. var. **alpina** T. Kirk.

South Island: Southland—On rock, at 900 m., Takitimu Mountains. L. C.

Petrie is of opinion that the examples of the above from Central Otago, &c., are merely epharmonic forms of the coastal *H. crassifolia* Hook f., and there is much in favour of this view. Culture experiments could easily solve the point, especially raising both from seed under the same conditions.

Hymenanthera dentata R. Br. var. **angustifolia**.

South Island: Southland—Bank of Makarewa River, Southland Plain. Crosby Smith and L. C.

Leptocarpus simplex A. Rich.

South Island: Southland—Gravelly shores of Lakes Manapouri and Te Anau. Crosby Smith and L. C.

This is a remarkable station for a coastal halophyte.

Leucogenes grandiceps (Hook. f.) Beauverd.

South Island: Canterbury—Summit of Mount Oxford. J. E. Holloway!

Linum monogynum Forst. f.

South Island: Marlborough—In company with *Olearia insignis*, *Veronica Hulkeana*, *Angelica Gingidium*, *Phormium Cookianum*, and *Discaria toumatou*, on dry cliff-faces, Awatere Valley, up to 600 m. altitude. Foweraker and L. C.

Lobelia Roughii Hook. f.

South Island: Marlborough—Shingle-slips of Shingly Range. Foweraker and L. C.

Although this has not been recorded from many localities, it is almost certain to be found on all dry mountains where there are extensive shingle-slips.

Mazus radicans (Hook. f.) Cheesem.

South Island: Southland—Riverton flats, near the sea. J. Crosby Smith!

Generally a mountain plant, but descends to sea-level in Westland.

Muehlenbeckia ephedroides Hook. f.

South Island: Marlborough—Awatere Valley. Foweraker and L. C.

Myoporum laetum Forst. f.

South Island: Marlborough—Awatere Valley, at 26 km. from the sea. Foweraker and L. C.

Myosotis Cockayniana Petrie sp. nov. For description see p. 269 in this volume.

South Island: Marlborough—On shingle-slip, Shingly Range, Awatere. Foweraker and L. C.

Nothopanax Colensoi (Hook. f.) Seem.

South Island: Canterbury—Subalpine scrub of Mount Sinclair, Banks Peninsula. R. M. Laing; L. C.

Olearia coriacea T. Kirk.

South Island: Nelson—Side of creek near bridle-track to Jack's Pass. C. Christensen!

The leaves are flat, and not curved like a saddle, as described by me previously (Trans. N.Z. Inst., vol. 38, p. 370). I collected a similar form this year at about 600 m. altitude on Mount Fyffe. It was affected with a gall.

Olearia ilicifolia Hook. f.

South Island: Canterbury—Subalpine scrub of Mount Sinclair, Banks Peninsula. R. M. Laing; L. C.

Olearia moschata Hook. f.

South Island: Southland—Takitimu Mountains, at 900 m. altitude. L. C.

Oreobolus pectinatus Hook. f.

South Island: Southland—Lowland *Danthonia Raoulii* steppe near Waimahaka. L. C.

Oreostylidium subulatum (Hook. f.) Berggren.

South Island: Southland—Common in bogs in the Aparima and Mararoa Valleys. Crosby Smith and L. C.

Ourisia macrophylla Hook.

South Island: Marlborough — Mount Fyffe, Seaward Kaikoura Mountains, at 600 m. altitude. L. C.

This quite matches the North Island plant.

Pimelea sericeo-villosa Hook. f.

South Island: Marlborough—Shingly Range, and near Molesworth, Awatere Valley. Foweraker and L. C.

Podocarpus Hallii T. Kirk.

South Island: Canterbury—Subalpine forest of Mount Sinclair, Banks Peninsula. L. C.

Probably originally comprising most of the high forest of that district.

Ranunculus Cheesemanii T. Kirk.

South Island: Marlborough—Common in shallow streams, Upper Awatere Valley. Foweraker and L. C.

This seems to me a quite well-marked species. It is everywhere in slowly running water in the Acheron Valley, &c., and apparently is most invariable in its characters. (For contrary opinion see Laing, Trans. N.Z. Inst., vol. 44, p. 70, 1912.)

Ranunculus chordorhizos Hook. f.

South Island: Marlborough—Shingle-slip on Shingly Range. Foweraker and L. C.

Previously recorded only from five localities. If my identification is correct, this extends the range very considerably to the north.

Ranunculus Enysii T. Kirk.

South Island: Canterbury—Mount Oxford. J. A. Holloway!

Ranunculus Godleyanus Hook. f.

South Island: Westland—Mount Moltke, south of Franz Josef Glacier. B. E. Baughan.

Raoulia cinerea Petrie sp. nov. For description see p. 269 in this volume.

South Island: Marlborough Shingly Range, on shingle-slip. Foweraker and L. C.

Raoulia glabra Hook. f.

South Island: Southland—Lowland *Danthonia Raoulii* steppe near Waimahaka. L. C.

Raoulia grandiflora Hook. f.

South Island: Canterbury—Mount Oxford, near summit. J. E. Holloway!

Raoulia Haastii Hook. f.

South Island: Southland—Mararoa River bed. Crosby Smith and L. C.

Schizeilema nitens (Petrie) Domin.

South Island: Marlborough—Shallow streams in Upper Awatere Valley. Foweraker and L. C.

Senecio sciadophilus Raoul.

South Island: Canterbury—(*a*) Remains of forest near Waimate; C. Foweraker! (*b*) Extremely abundant where forest still remains on Banks Peninsula.

Stackhousia minima Hook. f.

South Island: Nelson—On the Tarndale Moraine. Foweraker and L. C.

The flowers are exceedingly sweet-scented, and fill the air with fragrance long before they are noticed.

Styphelia empetrifolia (Hook. f.) Diels.

South Island: Southland—Lowland *Danthonia Raoulii* steppe near Waimahaka. L. C.

Suttonia nummularia Hook. f.

South Island: Canterbury—Mount Oxford. J. E. Holloway!

Teucridium parvifolium Hook. f.

South Island: Marlborough—Lower Awatere Valley. Foweraker and L. C.

Veronica cupressoides Hook. f.

South Island: Marlborough—Bank of Robinson Creek, Inland Kaikoura Mountains, at 1,000 m. altitude. Foweraker and L. C.

Veronica epacridea Hook. f.

South Island: Marlborough—Shingle-slip on Shingly Range, at 1,200 m. altitude. Foweraker and L. C.

Veronica Hectori Hook. f.

South Island: Otago—Mount Jones, near Lake Hawea. B. Seth-Smith!

Veronica lycopodioides Hook. f.

South Island: Canterbury—Mount Oxford. J. E. Holloway!

Veronica Raoulii Hook. f.

South Island: Marlborough—Common on rocks in the Awatere Valley. Foweraker and L. C.

Veronica rupicola Cheesem.

South Island: (1.) Marlborough — Mount Fyffe, Seaward Kaikoura Mountains, at 600 m. altitude, on rock-face; L. C. (2.) Nelson—(*a*) Mount Tarndale, at 950 m. altitude, or more; Foweraker and L. C.: (*b*) creek off Hanmer River; C. Christensen!

Wahlenbergia cartilaginea Hook. f.

South Island: Marlborough—Shingle-slip on Shingly Range, at 1,200 m. altitude. Foweraker and L. C.

The leaves are stiff, and rather like those of a crusty saxifrage. They form dull-green rosettes, which rise just above the stones. The rhizome is long, far-creeping, rather fleshy, and tortuous; it puts forth erect slender pale stems, which bear the leaves.

II. Species collected by Miss B. E. Baughan on the Westland Side of the Copeland Pass and in the Copeland Valley.

Aciphylla Monroi *Hook. f.*
Anisotome Haastii (*F. v. Muell.*) *Cockayne and Laing.*
—— pilifera (*Hook. f.*) *Cockayne and Laing.*
Archeria Traversii *Hook. f.*
Aristotelia fruticosa *Hook. f.*
—— racemosa (*Linn. f.*) *Hook. f.*
Astelia Petriei *Cockayne.*
Calamagrostis pilosa (*A. Rich.*) *Cockayne.*
Carmichaelia grandiflora *Hook. f.*
Cassinia Vauvilliersii (*Homb. & Jacq.*) *Hook. f.*
Celmisia coriacea (*Forst. f.*) *Hook. f.*
—— discolor *Hook. f.*
—— petiolata *Hook. f.*
—— Sinclairii *Hook. f.*
—— Walkeri *Hook. f.*
Coprosma Banksii *Petrie.*
—— ciliata *Hook. f.*
—— cuneata *Hook. f.*
—— foetidissima *Forst. f.*
—— lucida *Forst.*
—— serrulata *Hook. f.*
Coriaria ruscifolia *L. f.*
—— thymifolia *Humb. & Bonpl.*
Dacrydium cupressinum *Sol.*
Danthonia flavescens *Hook. f.*
Dracophyllum Kirkii *Berggren.*
—— longifolium (*Forst. f.*) *R. Br.*
—— montanum (*Cheesem.*) *Cockayne sp. nov.* = D. Urvilleanum *A. Rich. var.* montanum *Cheesem.* (*Man. N.Z. Flora, p. 424; 1906*).
—— Traversii *Hook. f.*
Drimys colorata *Raoul.*
Epilobium glabellum *Forst.*
Forstera sedifolia *L. f.*
Fuchsia excorticata (*Forst.*) *L. f.*
Gaultheria rupestris *R. Br.*
Gaya Lyallii (*Hook. f.*) *J. E. Baker.*
Geum parviflorum *Sm.*
Griselinia littoralis *Raoul.*
Helichrysum bellidioides (*Forst. f.*) *Willd.*
Hemitelia Smithii *Hook.*
Leucogenes grandiceps (*Hook. f.*) *Beauverd.*
Libocedrus Bidwillii *Hook f.*
Lycopodium varium *R. Br.*
Metrosideros hypericifolia *A. Cunn.*
—— lucida (*Forst. f.*) *A. Rich.*
Muehlenbeckia axillaris (*Hook. f.*) *Walp.*
Nothopanax Colensoi (*Hook. f.*) *Seem.*
Ourisia (Colensoi *Hook. f.*) ?
Olearia avicenniaefolia *Hook. f.*
—— cymbifolia *Hook. f.*

Olearia ilicifolia *Hook. f.*
—— moschata *Hook. f.*
—— nummularifolia *Hook. f.*
Pentachondra pumila *R. Br.*
Phormium Cookianum *Le Jolis.*
Phyllachne Colensoi (*Hook. f.*) *Berggren.*
Pittosporum Colensoi *Hook. f.*
Podocarpus ferrugineus *Don.*
—— Hallii *T. Kirk.*
—— nivalis *Hook. f.*
Pseudopanax lineare (*Hook. f.*) *C. Koch.*
Ranunculus Lyallii *Hook. f.*
—— sericophyllus *Hook. f.*
Raoulia grandiflora *Hook. f.*
Rubus australis *Forst. f.*
Schefflera digitata *Forst.*
Senecio elaeagnifolius *Hook. f.*
—— scorzoneroides *Hook. f.*
Veronica Bidwilli *Hook. f.*
—— Gilliesiana *T. Kirk.*
—— Lyallii *Hook. f.*
—— macrantha *Hook. f.*
—— salicifolia *Forst. f.*
—— subalpina *Cockayne.*
Weinmannia racemosa *L. f.*

III. SPECIES NOT HITHERTO PUBLISHED FROM FIRST HUT IN CLINTON VALLEY TO SUMMIT OF MCKINNON'S PASS. (NOTED OR COLLECTED BY J. CROSBY SMITH AND THE AUTHOR.)

Acaena Sanguisorbae *Vahl. var.*
Aciphylla Lyallii *Hook. f.*
Agrostis Dyeri *Petrie.*
Angelica Gingidium (*Forst.*) *Hook. f.*
Anisotome Haastii (*F. v. Muell.*) *Cockayne and Laing.*
Asplenium flaccidum *Forst. f.*
—— Richardi *Hook. f.*
Astelia montana (*T. Kirk*) *Cockayne.*
—— Petriei *Cockayne.*
Blechnum capense *Schlecht.*
Calamagrostis pilosa (*A. Rich.*) *Cockayne.*
—— setifolia (*Hook. f.*) *Cockayne.*
Caltha novae-zelandiae *Hook. f.*
Carex Cockayniana *Kükenthal.*
—— diandra *Schrank.*
—— Gaudichaudiana *Kunth.*
—— ternaria *Forst. f.*
Cassinia Vauvilliersii (*Homb. & Jacq.*) *Hook. f.*
Celmisia argentea *T. Kirk.*
—— coriacea (*Forst. f.*) *Hook. f.*
—— glandulosa *Hook. f.*
—— laricifolia *Hook. f.*
—— Sinclairii *Hook. f.*

Celmisia verbascifolia *Hook. f.*

This is *C. Brownii* Chapman. The eastern plant referred to *C. verbascifolia* by Kirk and others is an unnamed species.

Chrysobactron Hookeri *Colenso.*
Claytonia australasica *Hook. f.*
Coprosma ciliata *Hook. f.*
—— cuneata *Hook. f.*
—— foetidissima *Forst. f.*
—— parviflora *Hook. f.*
—— ramulosa *Petrie.*
—— repens *Hook. f.*
—— serrulata *Hook. f.*
Coriaria angustissima *Hook. f.*
—— thymifolia *Humb. & Bonp.*
—— ruscifolia *L.*
Cotula squalida *Hook. f.*
Craspedia robusta (*Hook. f.*) *Cockayne sp. nov.* = C. uniflora *Forst. f. var.* robusta *Hook. f. as defined in Man. N.Z. Flora, p. 348.*

Unfortunately, I did not secure a specimen, but merely noted it as above, so am not certain as to identification.

Danthonia crassiuscula *T. Kirk.*
—— Cunninghamii *Hook. f.*
—— semiannularis *R. Br.*
Donatia novae-zelandiae *Hook. f.*
Dracophyllum longifolium (*Forst. f.*) *R. Br.*
—— *sp.*

Apparently related to *D. Pearsoni* T. Kirk.

Drimys colorata *Raoul.*
Drosera arcturi *Hook.*
—— stenopetala *Hook. f.*
Epilobium arcuatum *Petrie sp. nov.*

For description see p. 265 in this volume. Cultivated plants bloomed in my garden by end of November when in sun and by 15th December in shade. Seeds are ripe about three weeks after flowering.

—— chloraefolium *Hausskn.*
—— glabellum *Forst. f.*
—— insulare *Hausskn.*
—— pedunculare *A. Cunn.*
Erechtites glabrescens *T. Kirk.*
Forstera sedifolia *L. f. var.* oculata *Cheesem.*
—— tenella *Hook. f.*
Fuchsia excorticata *Forst. f.*
Gaultheria depressa *Hook. f.*
Gaya Lyallii (*Hook. f.*) *J. E. Baker.*
Geranium microphyllum *Hook. f.*
Geum parviflorum *Sm.*
Griselinia littoralis *Raoul.*
Gunnera albocarpa (*T. Kirk*) *Cockayne.*
Helichrysum bellidioides *Hook. f.*
Hierochloe redolens *R. Br.*
Hymenanthera dentata *R. Br. var.* alpina *T. Kirk.*
Hymenophyllum multifidum *Swz.*

Juncus novae-zelandiae *Hook. f.*
Lagenophora Barkeri *T. Kirk.*
—— petiolata *Hook. f.*
Lycopodium fastigiatum *R. Br.*
Mentha Cunninghamii (*A. Cunn.*) *Benth.*
Montia fontana *L.*
Muehlenbeckia australis (*Forst. f.*) *Meissn.*
—— axillaris *Hook. f.*
Myosotis antarctica *Hook. f.*
—— macrantha (*Hook. f.*) *Benth. & Hook. f.*
Nothofagus Menziesii (*Hook. f.*) *Oerst.*
Nothopanax Colensoi (*Hook. f.*) *Seem.*
—— simplex (*Forst. f.*) *Seem.*
Nertera dichondraefolia *Hook. f.*
Olearia arborescens (*Forst. f.*) *Cockayne and Laing.*
—— ilicifolia *Hook. f.*
—— macrodonta *Baker.*
Ourisia caespitosa *Hook. f.*
Oxalis magellanica *Forst.*
Pentachondra pumila *R. Br.*
Phormium Cookianum *Le Jolis.*
Pittosporum divaricatum *Cockayne sp. ined.*
Podocarpus Hallii *T. Kirk.*
Polystichum vestitum *Presl.*
Pratia macrodon *Hook. f.*
Ranunculus Baughani *Petrie sp. nov.*
For description see p. 265 in this volume
—— foliosus *T. Kirk.*
—— Lyallii *Hook. f.*
Rumex flexuosus *Sol.*
Schoenus pauciflorus *Hook. f.*
Senecio elaeagnifolius *Hook. f.*
—— Lyallii *Hook. f.*
—— scorzoneroides *Hook. f.*
Styphelia empetrifolia (*Hook. f.*)
Suttonia nummularia *Hook. f.*
Taraxacum magellanicum *Comm.*
Trisetum antarcticum *Trin.*
Uncinia uncinata (*L. f.*) *Kukenth.*
Veronica buxifolia *Benth.*
—— Lyallii *Hook. f.*
—— macrantha *Hook. f.*
—— salicifolia *Forst. f*
—— subalpina *Cockayne.*
Viola Cunninghamii *Hook. f.*
—— filicaulis *Hook. f.*

Art. XXIX.—*On the Occurrence of* Poa litorosa *Cheeseman on Herekopere Island.*

By D. Petrie, M.A., Ph.D.

[*Read before the Auckland Institute, 11th December, 1912.*]

In the early summer of last year Mr. H. Guthrie-Smith, of Tutira (Hawke's Bay), kindly sent me some live tufts of native grasses from Herekopere Island (off Stewart Island). Among these was a piece that, on flowering this season, has proved to be *Poa litorosa* Cheeseman, a grass that was thought to be confined to the subantarctic islands of New Zealand. Along with this came a piece of *Poa foliosa* Hk. f., which the late Mr. Kirk collected on the same island a good many years ago, as well as pieces of two other grasses, one of which is a new species and is described in another paper contributed to this volume.

This extension of the range of Cheeseman's species is of considerable interest, as it adds an additional link to the already well-known connection between the floras of New Zealand proper and of the subantarctic islands. The grass is likely to occur at the Snares. The flora of this isolated group is still very imperfectly known, and a careful exploration of its botany is urgently needed.

Art. XXX.—*Note on the Pollination of* Rhabdothamnus Solandri *A. Cunn.*

By D. Petrie, M.A., Ph.D.

[*Read before the Auckland Institute, 11th December, 1912.*]

In a short paper in vol. 35 of the Transactions I described the mode of pollination in this species, and came to the conclusion that the flowers are pollinated by the agency of birds, though no direct evidence of this was at the time available. It is with much satisfaction that I can now submit such evidence. Mr. M. Fraser, of New Plymouth, who spent his boyhood in the Upper Waipu district of Auckland Peninsula, writes me that in the early days of settlement this shrub grew in great abundance on the loamy river-flats of the Waipu district. He again and again observed the tui visit its flowers to feed on the abundant nectar secreted by them. His attention was specially attracted by the patient and dexterous efforts of the bird to maintain its foothold on the slender naked branches, and its cleverness in swinging its body and twisting and stretching its neck and fluttering its wings till it succeeded in inserting its bill into the flower. The struggle that led to the sucking of the nectar amply explains the occasional rupture of the corolla, to which I appealed as evidence that the flowers are pollinated by birds. Since the original paper was written I have never lost an opportunity of examining the flowers of this interesting plant, and have seen nothing to conflict with the account there given of the remarkable mechanism that makes auto-pollination impossible. It is one of the most beautiful adaptations to prevent auto-pollination that I am acquainted with.

Art. XXXI.—*Descriptions of New Species and Varieties of Native Phanerogams.*

By D. Petrie, M.A., Ph.D.

[*Read before the Auckland Institute, 11th December, 1912.*]

1. **Ranunculus Baughani** sp. nov.

Planta tota pilis flavido-albidis appressis molliter villosa.

Folia radicalia pauca (?), petiolata, 4–5 cm. longa; petiolus crassiusculus, ± 2 cm. longus; lamina late ovato-deltoidea, 2 cm. longa, 2½ cm. lata, tripinnatisecta; segmenta ultima brevia, angusta, acuta v. subacuta; caulina pauca, congesta, bracteis similia, subsessilia, radicalibus minora minusque secta.

Scapus crassitudine mediocri, circa 8 cm. altus, apicem versus ad tres ramos 1-floriferos edens.

Flores breviter pedicellati, 1½–2 cm. in diam., laete flavi.

Sepala 5, petalis fere aequilonga, lata, obtusa, tenuia, pallida, plurinervata, extra parce villosa.

Petala 10, apice rotundata, basim versus cuneato-angustata, plurinervata.

Stamina et pistilla plurima.

Achenia matura haud visa.

The whole plant villous with soft yellowish-white appressed hairs.

Radical leaves apparently few, petiolate, 4–5 cm. long; petiole rather stout, ± 2 cm. long; blade broadly ovate-deltoid, 2 cm. long, 2½ cm. broad, trifoliolately divided, the primary divisions once or twice pinnatisect; ultimate segments short, narrow, acute or subacute.

Cauline leaves few, bract-like, sessile or nearly so, approximate, smaller and less divided than the radical.

Scape moderately stout, about 8 cm. high, divided near the top into 3 or fewer branches, each bearing a single flower.

Flowers peduncled, 1½–2 cm. across, large for the size of the plant.

Sepals nearly as long as the petals, broad, obtuse, thin, pale, many-nerved, sparsely villous on the outside.

Petals 10, bright yellow, rounded at the top and cuneately narrowed to the base, many-nerved; nectaries basal (apparently 3).

Stamens and pistils very numerous.

Ripe achenes not seen.

Hab.—Mount Balloon (Te Anau – Milford Track).

This species is named in honour of Miss B. E. Baughan, by whom it was collected as above. The material for its description, which was very scanty, was lent me by Mr. R. M. Laing, B.Sc., of Christchurch. The plant has its nearest ally in *R. sericophyllus* Hook. f., in which, however, the scapes are always 1-flowered.

2. **Epilobium rostratum** Cheesm. var. **pubens** var. nov.

Planta typo humilior magisque diffusa, caulibus foliis capsulisque valde pubescentibus.

More depressed and spreading than the type, with the stems, leaves, and capsules strongly pubescent.

Hab.—Dry ground in Awatere Valley (Marlborough), and bed of Robinson River, in same district.

Collected by Dr. L. Cockayne, F.R.S., F.L.S., 11th January, 1912, who has supplied me with specimens.

3. **Epilobium arcuatum** sp. nov.

Caules pauci v. plures a basi duro emissi, erecti v. a parte inferiore decumbentes, ad 16 cm. alti, purpurascentes, parce bifariam pubescentes, cetera glabri.

Folia in paribus oppositis subconnatis arcte disposita, elliptica, 2–2½ cm. longa, 1–1¼ cm. lata, subacuta, rubescentia, in petiolos breves latiusculos angustata, integra v. obscure repanda, tenuia, glabra ; venis utrinque valde conspicuis et a costa oblique excurrentibus.

Flores 4–7, in axillis foliorum superiorum plerumque conferte dispositi : pedunculi foliis subtendentibus aequilongi, glabri, rubri.

Calycis lobi lanceolati, acuti, corollam pallide puniceam fere aequantes.

Capsula 2–2½ cm. longa, crassiuscula, glabra ; seminibus papillosis.

Stems few or several from a hard base, rarely branched and then only from the base, erect or at first decumbent, rather stout, purplish, slightly bifariously pubescent, otherwise glabrous, leafy throughout, lowermost leaves larger and broader.

Leaves in opposite subconnate pairs, elliptic, 2–2½ cm. long, 1–1¼ cm. broad, subacute, reddish-green, rather thin, narrowed into short broad petioles, entire or slightly repand, glabrous ; veins prominent on both surfaces and running out obliquely from the midrib.

Flowers as many as 7 in the axils of the higher leaves, generally crowded near the tops of the stems ; peduncles as long as their subtending leaves, reddish, glabrous.

Calyx-lobes lanceolate, acute, nearly as long as the pink corolla.

Capsule 2–2½ cm. long, rather stout, glabrous, reddish ; seeds papillose.

Hab.—Clinton Valley (Te Anau – Milford Track). Dr. L. Cockayne, F.R.S., F.L.S. ! and D. P. ; McKinnon's Pass, H. J. Matthews !

The present species seems intermediate between *E. glabellum* Forst. f. and *E. chloraefolium* Haussk.

4. **Olearia Willcoxii** sp. nov.

Suffrutex humilis, parce ramosus.

Rami graciles, ascendentes v. subdivaricantes, subteretes, ± striati, molli densaque pubescentia incani, veteres fere glabri.

Folia alterna, subdistantia, anguste elliptica, circa 3 cm. longa, 1 cm. lata, integra, breviter petiolata, subacuta, parce coriacea, superne glabra ac fusco-viridia, infra tomento cinereo-albo arcte appresso vestita, imo petiolo foliis jam delapsis prominente ac decurrente..

Capitula pauca, pauciflora (floribus 5–8), 4 mm. longa, in ramulis brevibus lateralibus aliquantum infra summos ramulos subracemose disposita ; bracteae breves, lineares.

Involucri squamae 3–4 seriatae, lanceolatae v. lineari-lanceolatae, subacutae, castaneae, paene glabrae, haud viscidae, inferoribus gradatim minoribus.

Radii ligulae paucae, parum conspicuae.

Achenia pubescentia.

A rather low sparingly branched undershrub.

Branches slender, ascending and more or less divaricating, subterete, striate, hoary with soft dense pubescence, in age almost glabrous.

Leaves alternate, rather distant, narrow-elliptic, 3 cm. long, 1 cm. broad, subacute, slightly coriaceous, shortly petiolate; above dull green glabrous and with evident midrib and areolate veining; below densely clothed with appressed greyish-white tomentum, venation very obscure; a prominent scar with decurrent ridges standing out from the branches after leaf-fall.

Heads few, few-flowered (5–8 flowers in each), 4 mm. long, rather crowded, subracemosely arranged on short lateral branchlets placed some distance below the tops of the main branches; bracts short, linear.

Involucre more or less turbinate; bracts in 3–4 series, lanceolate or linear-lanceolate, subacute, dark brown, nearly glabrous, not viscid; the upper gradually longer than the lower.

Rays few, little conspicuous.

Achenes pubescent.

Hab.—Queenstown Hill, Lake County.

This species, which I am pleased to name after its discoverer, was collected by Mr. William Willcox, Director of the Queenstown Park. It is somewhat closely allied to *O. oleifolia* T. Kirk. Dr. L. Cockayne, F.R.S., F.L.S., of Christchurch, kindly lent me the material for this description. As it was very scanty, allowance must be made for possible inaccuracies, especially in my account of the habit of the plant, which is still but little known.

5. **Celmisia intermedia** sp. nov.

Caules a basi ± ramosi, primo plerumque prostrati demum erecti v. ascendentes, in aetate reliquiis vaginarum foliorumque demortuorum persistentibus vestiti, graciles.

Folia conferta, imbricata, anguste obovato- v. elliptico-spathulata, ± 1½ cm. longa, 6–10 mm. lata, subacuta, tenuia, in partem petiolarem perangustam contracta, denique in vaginam latam amplectentem striatam glabram ampliata, infra (costa excepta) tomento candido arcte appresso vestita, supra glabra viscidaque v. tenui pubescentiae subtomentosae argenteae pellicula praedita, a marginibus apiceque minute et subremote dentata, venis haud distinctis.

Scape in ramulis singulis plerumque 1 (rarius 2), axillares, prope summos ramulos inserti, 7–15 cm. longi, gracillimi, parce laxeque tomentosi; bracteae subdistantes, lineari-subulatae.

Capitula 1–1½ cm. lata; involucri squamae lineari-subulatae delicate glanduloso-pubescentes, interioribus longioribus.

Achenia linearia, parce pubescentia, pappo paulo breviora.

Stems more or less branched below, at first usually prostrate, then erect or ascending, in age clothed with the persistent remains of sheaths and decayed leaves, slender, forming considerable low patches.

Leaves crowded, imbricating, narrow obovate- or elliptic-spathulate, ± 1½ cm. long, 6–10 mm. broad, subacute, thin, contracted below into a very narrow petiolar part and then suddenly expanded into a long broad striate glabrous sheath; densely clothed below with glossy closely appressed whitish tomentum except on the midrib; above viscid and almost glabrous, or covered with a delicate pellicle of silvery subtomentose pubescence; minutely and rather distantly toothed along the edges and at the tip; veins indistinct.

Scapes usually solitary on the branchlets, springing from the axils of the subterminal leaves, 7–15 cm. long, very slender, sparingly and loosely tomentose; bracts rather distant, linear-subulate.

Heads 1–1½ cm. across; involucral bracts linear-subulate, delicately glandular-pubescent, the inner longer.

Achenes linear, sparsely pubescent, a little shorter than the pappus.

Hab.—Mount Frederic, 3,400 ft. (P. G. Morgan)! Arthur's Pass, 3,000 ft., D. P.; mountains near Westport (Townson)! Mount Greenland, Westland (Dr. L. Cockayne)!

In his "Manual of the New Zealand Flora" Mr. Cheeseman has included this plant in var. *petiolata* T. Kirk of Hooker's *C. incana.* It is doubtless connected with that species by forms more or less intermediate, but it possesses a number of distinctive characters that remain constant over wide areas on the western side of the South Island, and it therefore appears to me best to recognize it as a distinct species, a course that Dr. Cockayne has already suggested. Mr. Kirk's variety, the type of which was collected by myself, is closer to typical *C. incana* than is the widely spread form described above. The species forms a transition between Hooker's species *C. incana* and *C. discolor.*

6. **Helichrysum (Leucogenes) Grahami** sp. nov.

Caules numerosi a radice longo crasso ligneo emissi, simplices v. parce divisi, subgraciles (cum foliis 3–4 mm. lati), molles, flexiles, 10–15 cm. alti.

Folia dense pluriseriatim imbricata, lato basi sessilia, breviter lanceolata, ± 5 mm. longa, subacuta, tomento laxo albido dense vestita; superiora ampliata capitulum tamen haud excedentia.

Capitula 2–5-fasciculata, terminalia, sessilia, ± 2 mm. lata; involucri squamae 3-seriatae, pallidae, scariosae, nitidae, lineari-oblongae, subacutae vix radiatae, exterioribus apice parce tomentosis.

Flores numerosi, feminei 1-seriati; corolla perangusta, basi subito tumida, apicem versus leviter expansa; pappi setae paucae, barbellatae, apicem versus leviter incrassatae.

Achenium parce pilosum.

Stems numerous, from the top of a long stout woody root, simple or sparingly branched, slender (with the leaves on, 3–4 mm. across), soft and pliant, 10–15 cm. high.

Leaves closely imbricating in several series, appressed or slightly spreading at the tips, sessile by a broad base, shortly lanceolate, ± 5 mm. long, subacute, everywhere densely clothed with loose greyish-white cottony tomentum, a few of he uppermost longer and broader, but not exceeding the heads.

Heads in capitate fascicles of 2–5, terminal, sessile, each ± 2 mm. across; involucral bracts in 3 series, very pale, shining, scarious, linear-oblong, subacute, scarcely radiating, the outer sparingly tomentose on the backs.

Florets numerous, female in 1 series; corolla abruptly swollen at the base, very narrow, slightly dilated above; pappus hairs few, slender, barbellate, slightly thickened above.

Achene sparsely papillose.

Hab.—In clefts of rocks on Sebastopol Ridge, Sealey Range, Hooker Valley, Mount Cook. Flowers in February and March.

This interesting addition to the chasmophytic plants of our rocky mountain-slopes was discovered by Mr. Peter Graham, Chief Guide at the Mount Cook Hermitage. I am deeply indebted to him for a fine specimen, and am pleased to associate his name with so remarkable a plant. In some respects it is intermediate between *Helichrysum* Vaill. and *Leucogenes* Beauverd. Fuller material is needed to settle its exact position.

7. **Raoulia cinerea** sp. nov.

Caules ramosi, serpentes, a latere inferiore complures longos radices emittentes, crassiusculi ; rami breves prostrati v. ascendentes.

Folia dense pluriseriatim imbricata, suberecta, apicibus ± incurvata, integerrima, lineari-subulata, acuminata, 4–6 mm. longa, ± ½ mm. lata, undique tomento cinereo laxo vestita.

Capitula ramos terminantia, inter folia ultima immersa, circa 5 mm. lata.

Involucri squamae 2–3 seriatae, folia suprema haud excedentes, scariosae, subflavidae, acutae, dorso parce tomentosae, interiores glabrae haud radiatae.

Flores in capitulo utroque circa 15.

Pappi setae graciles, nec barbellatae nec apice incrassatae.

Achenium lineari-oblongum, glabrum.

Stems branched, forming dead-looking patches, creeping and sending down numerous long slender roots from the underside, with the leaves rather stout ; branches short, prostrate or ascending.

Leaves densely imbricating in several series, forming small close grey rosettes, suberect and more or less incurved at the tips, entire, linear-subulate, acuminate, 4–6 mm. long, ± ½ mm. broad, everywhere densely clothed with pale-grey loose tomentum.

Heads terminating the branches and sunk among the uppermost leaves, about 5 mm. across ; involucral bracts in 2 or 3 series, not exceeding the uppermost leaves, scarious, yellowish, acute, sparingly tomentose on the backs, the innermost glabrous not radiating.

Florets about 15 in each head.

Pappus hairs few, slender, not barbellate or thickened at the tips.

Achene linear-oblong, glabrous.

Hab.—Shingle Peak, Upper Awatere (Marlborough), 5,000 ft.

This most distinct species was collected by Dr. L. Cockayne, F.R.S., F.L.S., and Mr. S. G. Mowat, in January and February, 1912, to whom I am greatly indebted for specimens.

8. **Myosotis Cockayniana** sp. nov.

Perennis, a basi ramosa ; ramis pilosis, foliosis, subgracilibus, erectis v. ascendentibus, ± 8 cm. longis.

Folia radicalia pauca, lineari-oblonga, a parte inferiore ± angustata, ad 4 cm. longa, 5–6 mm. lata, obtusa, vix recurvata, superne dense piloso-hispida, infra pilis subfirmis plerumque reflexis minus dense pilosa ; caulina sessilia, subconferta, a summis caulibus condensata, radicalibus similia sed breviora angustioraque, circa 2 cm. longa, 4 mm. lata.

Racemi inter folia summa immersi, brevissimi, dense molliterque pilosi ; floribus densissime congestis.

Calyx ± turbinatus, alte 5-lobatus, lobis subulato-oblongis.

Corolla purpurascens, longitudine calycem vix aequans; tubo lato, ad tertiam partem in 5 lobos rotundatos secta, squamulis perobscuris (v. nullis ?).

Stamina 5 longa, subsessilia, ad corollae faucem pertinentia.

Stylus gracillimus, staminibus aequilongus, subcapitatus.

Perennial, branched from the base; branches pilose, leafy, rather slender, erect or ascending, ± 8 cm. high.

Radical leaves few, linear-oblong, slightly narrowed below, 4 cm. long, 5–6 mm. broad, obtuse, slightly recurved when dry, above densely clothed with rather long stiff whitish hairs that project beyond the edge all round, below less densely pilose with stiff hairs commonly reflexed; cauline sessile, close-set, crowded at the tops of the stems, similar to the radical but flatter shorter and narrower, about 2 cm. long and 4 mm. broad.

Racemes sunk among the uppermost leaves, very short, densely and delicately pilose, the flowers strongly congested.

Calyx more or less turbinate, clothed with long delicate straight and hooked bristle-like hairs, 5-lobed to below the middle, lobes subulate-oblong.

Corolla purplish (when dried), barely equalling the calyx, with a wide tube cut for one-third its length into 5 rounded lobes; scales very obscure (or absent ?).

Stamens 5, almost sessile, rather long, reaching to the mouth of the corolla-tube but not beyond.

Style very slender, as long as the stamens, subcapitate.

Hab.—Shingle Range, Upper Awatere (Marlborough), 5,000 ft. Flowers December and January.

This well-marked species was collected by Dr. L. Cockayne, F.R.S., F.L.S., to whom I am indebted for specimens. The flowers examined are perhaps not fully developed, and may elongate somewhat when more mature. The anthers are, however, fully formed.

9. **Gentiana tenuifolia** sp. nov.

Caules 30–40 cm. alti, 2–3 mm. in diam., subteretes.

Folia radicalia numerosa, conferta, majuscula, anguste obovato-spathulata, 8–14 cm. longa, 2–3½ cm. lata, tenuia, obtusa v. subacuta, nervis 3–5 arcuatis venisque reticulatis manifestis. Folia caulina in paribus oppositis paucis longeque distantibus disposita, sessilia, anguste triangularia, subacuta, semi-amplexicaulia, superiora gradatim minora.

Flores vix numerosi, in umbellis bracteatis caulem pedunculosque laterales terminantibus.

Calyx ± 1 cm. longus, in lobos 4 lineari-subulatos ad tres partes divisus.

Corolla alba, alte secta, lobis acutis.

Stamina pistillo crasso dimidio breviora.

Stems 30–40 cm. long, 2–3 mm. in diameter, simple, glabrous, subterete, marked by two closely placed parallel ridges running down either side from the leaf-bases.

Radical leaves numerous, crowded, large, narrow obovate-spathulate, 8–14 cm. long, 2–3½ cm. broad (the petiolar part nearly as long as the blade), obtuse or subacute, thin, entire, glabrous, with 3–5 arcuate nerves and evident reticular venation; cauline leaves in few widely distant opposite pairs, sessile, narrow-triangular, subacute, semi-amplexicaul, diminishing upwards.

Flowers rather few, in bracteate umbels terminating the main axis and the lateral peduncles (12 cm. long or less), ultimate pedicels 4–5 mm. long.

Calyx about 1 cm. long, cut for three-fourths its length into 4 linear-subulate 1-nerved lobes.

Corolla (in the specimens examined not fully expanded) white, somewhat longer than the calyx, deeply divided into 5 acute lobes.

Stamens half as long as the stout pistil.

Hab.—Lyell Creek, 1,000 ft., and Boundary Peak, near edge of scrub (south-west Nelson), 4,000 ft.

Mr. William Townson has kindly lent me his specimens of this plant, which he collected in the two localities mentioned above. He did not succeed in finding plants with the flowers expanded, but the stamens in the partially closed corolla have already shed their pollen. The leaves are unusually large and thin, and the intervals between the cauline leaves remarkably long. I have what may be the same plant from Mount Blairich, collected by the late Henry J. Matthews, but the specimens are too immature to warrant a decided opinion.

10. **Convolvulus fracto-saxosa** sp. nov.

Perennis, ubique pubescentia cinerea copiose vestita.

Rhizoma gracile radices tenues ramosos subhorizontales edens.

Caules simplices v. a basi divisi, procumbentes.

Folia longe petiolata, trimorpha, forma ac magnitudine variabilia; in forma ultima ac simul multo frequentissima laminae longae (ad 3 cm.), angustae, subhastate tripartita, lobo terminali lineari obtuso v. subacuto supra ± canaliculato (costa obscura), lobis lateralibus a laminae basi emissis subtriangularibus a parte exteriore dilatatis ac plerumque alte divisis.

Flores axillares, solitarii, longe pedunculati.

Sepala inaequalia, late obovata, ± crenata.

Corolla alba, 2 cm. in diam.

Perennial, everywhere densely clothed with copious rather long slate-grey pubescence.

Rootstock rather slender, fleshy, sending off thin branching nearly horizontal roots.

Stems slender, simple or branched from the base, prostrate or trailing, leafy, 8–16 cm. long.

Leaves petiolate, thin, trimorphic, variable in size and shape; *primary* (earliest) shortly petiolate with small semicircular or broadly ovate or ovate-cordate entire or sinuate blades about $\frac{1}{2}$ cm. long and 1 cm. broad; *intermediate* with longer petioles and blades $1\frac{1}{4}$ cm. long, $\frac{3}{4}$ cm. broad, divided into 3 oblong obtuse entire or slightly sinuate lobes (the terminal lobe at right angles to and longer than the two lateral lobes); the *ordinary* form on longer petioles (3–$4\frac{1}{2}$ cm.) with subhastately tripartite blades 2–3 cm. long and 1–$1\frac{3}{4}$ cm. broad (at the base), the terminal division long narrow obtuse or subacute, more or less chanelled above, with obscure midrib, the basal divisions subtriangular narrow at the point of origin and widening outwards, sometimes entire, but usually deeply cut in front into 2 widely diverging subacute lobes.

Flowers axillary, solitary; peduncles as long as the petioles, thickened above and with 2 linear short bracts a little way below the flower.

Sepals 5, the outer 3 larger, broadly obovate and more or less crenate, 5 mm. long.

Corolla white, 2 cm. in diameter.

Hab.—Inland Kaikouras, Awatere Basin, on shingle-slip.

Collected by Dr. L. Cockayne, F.R.S., F.L.S., who has supplied the material for this description. The species is no doubt closely related to *C. erubescens* Sims, but the remarkable form and constant general character of the *ordinary* leaves, and the conspicuous grey pubescence, mark it off clearly enough.

11. Veronica Willcoxii sp. nov.

Frutex erectus, ramosus, glaber, ad 8 dcm. altus; ramis strictis.

Folia decussata, imbricata, basi connata, anguste obovata, 10–12 mm. longa, 4–6 mm. lata, subacuta, in basim sessilem latiusculum gradatim angustata, rigida, coriacea; supra concava, valde vernicosa nitidaque; subtus glaucescentia ac puncticulata, carinata, costa media fere excurrente.

Racemi 2–4, in axillis foliorum superiorum dispositi, 2–3 cm. longi, densiflori; floribus breviter pedunculatis.

Bracteae tenues, lanceolatae, ad basim calycis pertinentes.

Capsula late elliptica, obtusa, calycis lobis duplo longior, 5 mm. longa, $3\frac{1}{2}$ mm. lata.

A compact erect much branched shrub, 8 dcm. high or less.

Branches rather stout, strict, leafy, glabrous or sparsely bifariously pilose towards the tips, below closely ringed by the scars of fallen leaves, dark brown.

Leaves decussate, imbricating, connate at the base except in age, narrow, obovate, 10–12 mm. long, 4–6 mm. broad, subacute, rigid, coriaceous, entire, glabrous; above dark green, concave, shining, and strongly varnished; below glaucescent and finely and closely puncticulate, keeled by the prominent almost excurrent midrib, otherwise veinless; edges slightly recurved when dried.

Racemes 2–4 in the axils of the uppermost leaves, 2–3 cm. long, dense-flowered; rhachis glabrous or slightly puberulous, dark brown, the lower part naked.

Bracts thin, lanceolate or lanceolate-subulate, reaching to the base of the calyx.

Flowers shortly peduncled, apparently white. Calyx deeply cut into 4 thin obovate scarious lobes ciliate at the margin, about half as long as the corolla-tube. Tube of corolla rather short and wide, limb broadly 4-lobed.

Stamens and style long exserted.

Capsule broadly elliptic, twice as long as the calyx or more, compressed above, less so below, 5 mm. long. $3\frac{1}{2}$ mm. broad.

Hab.—Routeburn Valley, near Lake Harris, 3,000 ft. W. Willcox! and D. P.

I take this to be a very distinct species, more closely related to *V. decumbens* Cheesm. than to any other. It has been in cultivation for a number of years, but its wild habitat was unknown till early in 1911. I have not seen wild specimens in flower, but the cultivated plant is certainly identical with that found sparingly in the Upper Routeburn Valley.

12. **Veronica Armstrongii** T. Kirk var. **annulata** var. nov.

Folia opposita, connata, quam in typo breviora, annulos angustos cupuliformes erectos ramis appressos formantia; foliorum apicibus mere truncatis, parce ciliolatis; calycis segmentis integerrimis.

Planta valde depressa, ramulis quam in typo paucioribus brevioribusque instructa.

Leaves opposite, connate, shorter than in the type, forming narrow cup-like erect rings appressed but not adnate to the branches, the tips quite truncate, with a slight depression at the junction of the connate leaves.

Calyx-segments entire. The whole plant depressed and with fewer and shorter branchlets than in the type.

Hab.—Rock face of northern slope of Takitimu Mountains, Southland, at 2,950 ft. altitude.

Collected by Dr. L. Cockayne, F.R.S., F.L.S., 13th March, 1912, who has supplied me with material for the above description.

In *V. Armstrongii* the connate leaves form a slightly dilated cup round the branchlets, while the leaves present a small median cusp. Its most southerly known habitat is the north-east face of the Kurow Mountains (Waitaki County). Mr. Cheeseman's herbarium contains several specimens collected there by myself. Dr. Cockayne would rather regard the plant as a distinct species.

13. **Veronica Grahami** sp. nov.

Caules graciles, prostrati tandem erecti, parce ramosi, ramis erectis 15–20 cm. longis, cicatricibus foliorum delapsorum subdistantibus notati, a parte foliacea pubescentes v. pilosiusculi, alibi glabri.

Folia in paribus oppositis disposita, ± conferta, plerumque imbricata, basi lato sessilia, coriacea, ovato-cuneata, 7 mm. longa, 5 mm. lata, apice rotundata ac in lobos 5 breves obtusos crenatim secta, lobo medio permulto latiore, nervis obscuris, passim parce albo-pubescentia, in siccitate brunnea.

Flores solitarii, in axillis foliorum superiorum dispositi.

Calyx 4-partitus, lobis erectis linearibus parce pubescentibus.

Corolla et stamina haud visa.

Capsula calycis lobis aequilonga, valde compressa, late obcordata, glabra, 5 mm. lata altaque.

A depressed, tufted, sparingly branched herb.

Stems slender, at first prostrate, then erect, as are the branches, 15–20 cm. long, when young more or less pubescent-pilose, in age glabrous and marked by rather distant scars of fallen leaves.

Leaves in opposite pairs, close-set and usually overlapping, sessile by a broad base, coriaceous, ovate-cuneate, 7 mm. long by 5 mm. broad, at the top rounded and cut in crenate fashion into 5 short obtuse lobes, the middle one much the widest, everywhere sparsely pubescent with very short stiff moderately appressed whitish hairs, reddish-brown when dried, nerves obscure.

Flowers solitary, in the axils of the upper leaves.

Calyx 4-partite; lobes erect, linear, thin, sparsely pubescent-pilose.

Corolla and stamens not seen.

Capsule as long as the calyx-lobes, 5 mm. broad and high, much compressed, broadly obcordate, glabrous.

Hab.—Cracks of rocks near Copeland Pass, Mount Cook, 7,000 ft.

This very distinct species was forwarded to me by Mr. Peter Graham. Chief Guide at the Mount Cook Hermitage. Its nearest ally is probably *V. Muelleri* Buchanan, a species that is not well known. It is to be hoped that its discoverer may soon be able to secure flowering specimens of this interesting find.

14. **Danthonia oreophila** Petrie var. **elata** var. nov.

Planta typo permulto altior crassiorque, valde densos caespites formans.

Culmi 35–55 cm. alti, crassiusculi, subrubentes.

Folia 20–30 cm. longa, vaginis latis coriaceisque.

Paniculi rami longi ; spiculae rubello-flavidae, quam in typo majores.

A much taller, stouter, and more tufted plant than the type.

Culms 35–55 cm. high, rather stout, reddish.

Leaves 25–30 cm. long, with broad coriaceous sheaths.

Panicle larger and with longer branches ; spikelets larger and reddish-yellow while young.

Hab.—Sealey Range, Tasman Valley ; abundant from 4,000 ft. to 5,000 ft.

The typical form occurs in fair quantity on the same slopes. The reddish tint is very conspicuous, and is to some extent shared by the leaves. Flowers late January and early February.

15. **Poa Cockayniana** sp. nov.

Species *Poae dipsaceae* (mihi) subsimilis ; folia angustiora, firmiora. complicata ; paniculi rami rhachisque scabridi ; spiculae minores, magis compressae, obovato-cuneatae ; glumae vacuae spiculas 2–3 florigeras paene aequantes ; glumae floriferae tenuiter scaberulae ; folia juniora supra plerumque ± pubescentia.

Perennial, culms tufted, more or less branched at the base, rather stiff. slender, erect, terete, smooth, glabrous, 35–50 cm. long, generally 2–3-noded. the nodes narrow and the topmost a little more than half-way up the culm.

Leaves 30–40 cm. long, shorter than the culms ; sheaths loose, thin, complicate, strongly striate or fluted, forming about $\frac{1}{3}$ the entire length of the leaves ; blades rather stiff, complicate (rarely flattened), narrow, gradually tapering to fine tips, glabrous or finely pubescent (when young). delicately striate above and more strongly below ; midrib prominent ; ligule a very short broad band more or less coarsely jagged.

Panicle ovate, 10–15 cm. long, 6–7 cm. broad, few-flowered ; rhachis and branches scabrid ; branches capillary, 2- rarely 3-nate, sparingly subdivided, the lower half naked, the upper with few rather distant pedicellate spikelets.

Spikelets 6 mm. long, compressed, narrow obovate-cuneate, 2–3-flowered ; empty glumes nearly equal, only a little shorter than the spikelets (the upper glume almost equalling the flower it encloses), lanceolate, acute, membranous, 3-nerved, the upper part of the keel ciliate-scabrid ; flowering-glumes oblong-lanceolate, obtuse and irregularly erose (rarely subacute and nearly entire), distinctly 5-nerved, the nerves vanishing below the top. delicately scaberulous, membranous, scarious at the edges and tip and with long cobwebby hairs at the base and reaching nearly half-way up the back ; palea $\frac{1}{4}$ shorter than the flowering-glume, nerves ciliate.

Hab.—Banks of Rolleston River, Westland.

The specimens, kindly sent me for identification, were collected by Dr. L. Cockayne, F.R.S., F.L.S., late in the season, and are all considerably past flower. He mentions that the grass has a somewhat wide distribution in the higher valleys of the western side of the South Island. For years past Dr. Cockayne has collected native grasses with unwearied zeal and great discrimination, and well deserves to have his name associated with this discovery.

16. **Poa Guthrie-Smithiana** sp. nov.

Culmi dense caespitosi, infra serpentes v. prostrati, tenuissimi, plurinodosi, a nodis ramos confertos ascendentes flaccidos intravaginales foliosos floriferosque 15-30 cm. longos edentes.

Folia culmis paulo breviora, anguste linearia, complicata, levia, glabra, 12–20 cm. longa; vaginae latae, tenues, striatae; ligula brevis, acuta, lamina multo latior.

Panicula perangusta, erecta, viridis, 5–10 cm. longa; rami 3–5 verticillati, erecti, graciles, delicate scabridi, infra nudi, 3–5 spiculas pedicellatas gerentes.

Spiculae 6 mm. longae, ovatae, 2–4 floreae.

Glumae vacuae inaequales, spicula parte tertia breviores. Gluma florifera lanceolata, acuta, glabra, carinata, 3-nervata, nervo medio paulum excurrente, nervis lateralibus supra evanidis. Palea gluma florigera paulo brevior, 2-nervata; nervis delicate ciliatis.

Stamina palea circa partem tertiam breviora.

Culms densely tufted, below prostrate or creeping, very slender, many-noded, giving off from the nodes closely placed slender flaccid intravaginal leafy and flower-bearing branches 15–30 cm. long.

Leaves rather shorter than the culms, narrow-linear, complicate, smooth, glabrous, obsoletely nerved, 12–20 cm. long; sheaths broad, open, thin, striate, about $\frac{1}{3}$ as long as the blades; ligule thin, short, acute, much broader than the blade.

Panicle very narrow, erect, green, 5–10 cm. long; rhachis slender, smooth, striate; branches 3–5 verticillate, short, slender, erect, delicately scabrid, naked below, bearing 3–5 pedicellate spikelets.

Spikelets green, ovate, 6 mm. long, 2–4-flowered.

Empty glumes unequal, about $\frac{1}{3}$ as long as the spikelet, lanceolate, acute, glabrous, the lower 1- the upper faintly 3-nerved; flowering-glumes lanceolate, acute, keeled, green with white scarious edges, smooth, glabrous, 3-nerved (the median nerve slightly excurrent, the lateral vanishing below the top), with a few rather long hairs on the callus and at the back; palea green, nearly as long as the flowering-glume, 2-nerved, nerves delicately ciliate.

Stamens slender, about $\frac{1}{3}$ as long as the palea.

Hab.—Herekopere Island, off Stewart Island.

Mr. Guthrie-Smith, of Tutira, kindly sent me some live tufts of this grass in the early summer of last year. The plants have grown well in my garden, and have lately come into flower. It is from these cultivated specimens that the above description has been drawn up. The species is allied to *Poa ramosissima* Hook. f. both in the habit of growth and in the form of the panicle. It appears to have economic possibilities of some value, but at present these cannot be accurately estimated.

Art. XXXII.—*On some Additions to the Flora of the Mangonui County.*

By H. Carse.

[*Read before the Auckland Institute, 11th December, 1912.*]

Since my paper "On the Flora of the Mangonui County" was published (Trans. N.Z. Inst., vol. 43, 1911), a few botanical discoveries worthy of note have been made.

Hypericum japonicum Thunb.

Owing to a clerical error, I omitted this species from the catalogue of plants. It is not uncommon in damp places.

Corokia Cheesemanii Carse sp. nov.

Corokia pps. sp. nov. Carse, Trans. N.Z. Inst., vol. 43, p. 201, 1911.

In my paper I referred to this, mentioning that it was probably similar to one found by Mr. Cheeseman in the North Cape district. I had not then seen specimens of Mr. Cheeseman's plant, nor flowering specimens of the Tauroa plant. I have recently been able to compare the two and am convinced that they are identical, and also that they are markedly different from the already acknowledged species. I have much pleasure, therefore, in dedicating the new species to Mr. Cheeseman, its original discoverer. The specific description is as follows:—

Frutex erectus, ramosus, 1·5–3·5 m. altus. Rami graciles, foliosi, non tortuosi nec intertexti; ramulis, foliis subtus, et inflorescentiâ argenteo-tomentosis. Folia alterna, 3–5 cm. longa, elliptico-oblonga vel oblongo-lanceolata, petiolis brevissimis. Flores fasciculati vel in paniculas terminales paucifloras dispositi, circa 10 mm. diam., petalis oblongo-lanceolatis. Drupae oblongae, 7 mm. diam., 10 mm. longae, rubrae.

Hab.—North Island: Spirits Bay, North Cape district: T. F. C.! Tauroa, in woods; H. B. Matthews! H. C.

Flowers: October–November.

A slender shrub, 1·5–3·5 m. high. Branches spreading, not tortuous nor interlacing as in *C. cotoneaster*. Young shoots, under-surface of leaves, and inflorescence densely clothed with silvery-white tomentum. Leaves alternate, 3–5·5 cm. long, elliptic-oblong to oblong-lanceolate. Petioles very short, or lengthened and flattened, as in *C. cotoneaster*. Flowers similar to those of *C. cotoneaster*, but narrower in the petals, in fascicles of 2–4 in the axils of the leaves or of small branches, or in terminal panicles. Drupe obovoid-oblong or oblong, 7 mm. in diameter, 10 mm. long.

This description applies to the type specimens, but the plant appears to pass by regular gradations into *C. cotoneaster* on the one hand, and into *C. buddleoides* on the other, with a tendency in one form to a broadening of the leaves, bringing the species very close to the Chatham Island *C. macrocarpa*. At present I have not seen the fruit of the last-mentioned form.

The typical form is very distinct. From *C. buddleoides* it differs in its smaller size, smaller and proportionally broader leaves, which are usually more obtuse, in the fewer-flowered and less-leafy panicles. From *C. cotoneaster* it is distinguished by the absence of tortuous and interlacing branches, those of *C. Cheesemanii* standing out straight at an angle of 45°, by the larger, oblong, and usually apiculate leaves, by the usually paniculate inflorescence, and by the oblong drupe.

Coprosma crassifolia Col.

A few plants only found in woods at Tauroa. Hokianga is the northern limit given in the Manual.

Sonchus asper Hill var. littoralis Kirk.

Occurs plentifully on damp sea-cliffs. This looks very distinct from the common prickly sowthistle, and is, I think, worthy of specific rank.

Thelymitra Matthewsii Cheeseman sp. nov.

A dainty and apparently rare species, known only from a very restricted area between Lake Tangonge and the west coast. The small size and the curious spiral twist of the leaf distinguish it from its congeners. It was named in honour of the late Mr. R. H. Matthews, to whose painstaking investigation we owe so much of our increased knowledge of the orchids of the far north.

Thelymitra imberbis Hook. f.

Mr. H. B. Matthews, who is following in his late father's footsteps as an orchidologist, has recently discovered a variety of this orchid with pale cream-coloured flowers.

Caladenia minor Hook. f.

Mr. Matthews has also dropped on a *Caladenia* with greenish-yellow flowers, pink being the usual colour.

Corysanthes Carsei Cheeseman sp. nov.

This is a very tiny plant, $\frac{1}{2}$–$\frac{3}{4}$ in. high, rather difficult to find. It occurs in wet peat associated with *Lycopodium Drummondii*, *Drosera spathulata*, *Utricularia delicatula*, &c. It was discovered by Mr. H. B. Matthews and myself in a morass adjoining Lake Tangonge.

Scirpus sulcatus Thouars var. distigmatosus C. B. Clarke.

Occurs in maritime marshes. So far I have not seen it inland in this district.*

Uncinia pedicellata Kükenthal.

This appears on my list as "*Uncinia* sp. pps. intermediate between *U. australis* and *U. riparia*." Specimens which I obtained at Kaitaia were identified as above by Oberpfarrer Kükenthal, the great European authority on the *Cyperaceae*.

Carex vacillans Sol.

So far in the far north I have seen only a very few poor specimens of this usually common plant.

* Since the above was written this sedge was found by Mr. H. B. Matthews in swampy land adjoining Lake Tangonge.

Art. XXXIII.—*Notes of the Botany of the Ruggedy Mountains and the Upper Fresh-water Valley, Stewart Island.*

By D. L. Poppelwell.

[*Read before the Otago Institute, 3rd December, 1912.*]

Plate XI.

General.

During the Christmas holidays of 1911, in company with a party of four others, I spent the time from the 28th December, 1911, to the 2nd January, 1912, under canvas near the mouth of the Ruggedy River, in the north-west of Stewart Island, with a view to examining the flora of that region, which had not, so far as I can ascertain, until then been botanically explored. Subsequently, in company with Mr. R. Fisher and Mr. J. Bragg, I walked from the head of Paterson's Inlet to the northern portion of the Ruggedy Mountains and back again, noting the botany of the upper portion of the Fresh-water Valley. This latter journey occupied two days—namely, the 4th and 5th January. Several botanical expeditions have been made to the lower portion of the valley referred to, but I do not think the upper portion had been examined prior to our visit. During our stay at Ruggedy we climbed some of the heights, including Red Head Peak, and, although for reasons stated later we did not attain the top of the latter, we got far enough up to be able to state with tolerable certainty the nature of the plant-life of this range. When the short time at our disposal and the difficulty of the country examined is considered, it will be obvious that this report is far from exhaustive, but it may serve in a small way to enlighten those interested as to the plant covering of this little-visited part of Stewart Island.

I do not intend dealing at any length with introduced plants in this paper, although a considerable number of them are to be found on the ground visited, especially that part near the Ruggedy River. Comparatively recently this country was held under grazing lease. A good deal of it has been burnt, and apparently surface-sown with English grasses, and there has also been introduced many of the usual weeds of cultivation, which have been spread a good deal by cattle.

The following is the list of the introduced plants noted : *Holcus lanatus* (L.), *Dactylis glomerata* (L.), *Poa pratensis* (L.), *Festuca rubra* (L.), *Rumex acetosella* (L.), *Stellaria media* (L.), *Trifolium repens* (L.), *T. hybridum*, *Prunella vulgaris* (L.), *Cnicus lanceolatus* (Willd.), *Taraxacum officinale* (Wigg), and *Medicago denticulata* (Willd.).

Physiography.

The nature of the country examined was very varied. It included mountains, forest, dunes, bogs, and rocks. The western side is subject to perhaps as stormy conditions as are to be met with in any part of the world. The Ruggedy Mountains in their westerly aspect are as wild and weather-worn as can be conceived, although on account of the high rainfall every crevice and nook which can give any shelter to a plant is filled with a close array of wind-shorn foliage.

North of the high Ruggedy Range there is strong physical evidence that, like the strait which apparently once ran from Mason's Bay to Paterson's Inlet, another strait ran from the Ruggedy River through the Freshwater Valley to Paterson's Inlet, and probably another opening to the sea existed between the latter strait and the West Ruggedy beach, the southern boundary of which would be slightly north of Red Head. Evidence of this is furnished by the low country (not more than 150 ft.) lying between the various points mentioned, and by the fact that such low country consists almost entirely of ancient dunes. Stewart Island, apparently, therefore, once consisted of at least five islands — namely, (1) Mount Anglem Island; (2) that portion now constituting the high land at the Rugged Islands; (3) Ruggedy Range Island; (4) Mount Rakiahua; and (5) the high southern part of the island. (On this subject, see also Cockayne's Stewart Island report, p. 7.*)

Speaking generally, the rocks of Stewart Island are granitic. The Rugged Islands and the Ruggedy Mountains are apparently composed of a harder substance than most of the other parts, as they stand up in great cliffs and jagged peaks of weather-worn rock, serrated on the top, and capped here and there with weird-looking minarets and towers.

Dr. Marshall, in one of his papers, says that at Ruggedy Point there is "a large instrusive mass of granophyre whose resistant nature causes it to form outstanding rugged pinnacles and cliffs."†

What is true of Ruggedy Point is also true of the whole of the Ruggedy Range, which is not only identical in structure with the Ruggedy Islands, but is also worn in the same extraordinary manner. Here and there running through the granite are seams of quartz, and the rise and dip of the grain of the rocks shows great movement in parts, whatever may have been the determining cause.

General Ecology.

As this has béen fully dealt with by Dr. Cockayne in his Stewart Island report, I only mention it here to say that his remarks on the subject apply equally to the portions visited by me as to the other parts of the island. The principal factor regulating the plant-life is that of wind, although, of course, soil-conditions have their due effect.

The Plant-life.

In order to make these notes more intelligible, I propose to treat the plant-life under the various heads of—(1) Rocks and cliffs, (2) dunes, (3) mountain meadow, (4) forest, (5) bogs and swamps.

(1.) Rocks and Cliffs.

In dealing with the rock and cliff vegetation it is necessary to distinguish between (*a*) coastal rocks and cliffs—*i.e.*, those swept with the sea-spray—and (*b*) rocks situated at a higher elevation or at a distance from the coast.

(a.) *Coastal Rocks and Cliffs.*

Practically the whole coast of Stewart Island is rocky, although here and there long stretches of sandy beach are found. The north-west coast

* "Report on a Botanical Survey of Stewart Island," Parliamentary paper C–12, 1909.

† "Geological Notes on South-west of Otago," Trans. N.Z. Inst., vol. 39, 1907, p. 498.

is no exception. The headland facing the Rugged Islands consists of weather-worn and jagged rocks about 300 ft. high, on one side subject to the full blast of the south-westerly gales and seas, and on the other to the more gentle northerly breezes and the direct sunlight. The flora answers to the conditions of exposure. The more exposed parts are bare, while those situations which afford any shelter at all are clothed with a mantle of weather-beaten plants. Next the sea there is an almost pure association of *Olearia angustifolia* with *Anisotome intermedia** occupying the rock-crevices, and *Veronica elliptica* where the peat is deeper. In proportion to the shelter, there will also be found *Olearia Colensoi*, *Senecio rotundifolius*, and *Phormium Cookianum*. What marks the physiognomy most, however, is the *Olearia angustifolia*, which is pressed close to the rocks, and roots in many places right into the rock itself. Its rounded tops and close foliage attest its struggle against the elements. On the north side of the Ruggedy Islands it is so abundant as to render the whole cliff-side conspicuously white at a distance, with its numerous beautiful daisy flowers, looking almost too delicate for so exposed a situation. Growing also in damper situations on the rocks there is an abundance of *Crassula moschata*, with here and there *Sonchus littoralis*, *Myosotis albida*, *Brachycome Thomsoni*, *Poa Astoni*, *Gnaphalium luteo-album*, *Apium prostratum*, *Gentiana saxosa*, *Samolus repens*, *Luzula campestris*, *Asplenium lucidum*, *Senecio lautus*, *Dracophyllum longifolium*, *Scirpus aucklandicus*, and *Hierochloe redolens*. A similar association of plants, with the addition of *Nothopanax Colensoi*, *Olearia nitida*, and *Veronica elliptica*, was noted on the north side of Ruggedy River. This association fairly represents that of the coastal rocks, but in a more sheltered nook, farther from the sea, the rock association included the following additional plants, namely: *Celmisia rigida*, *Gentiana saxosa*, *Apium prostratum*, *Olearia nitida*, *Pratia angulata*, *Epilobium nerterioides*, *Blechnum capense*, *Pteridium esculentum*, with *Arundo conspicua*, *Astelia nervosa*, *Carex ternaria*, and *Blechnum fluviatile* (near creek), and, in shade of *Olearia* scrub, *Stilbocarpa Lyallii*.

(b.) *Higher Rocks.*

On the top of the Ruggedy headland, where there was an exposed saddle, a specially marked wind-swept association was noted, consisting of *Leptospermum scoparium* as a very low mat hardly 2 in. high and covered with flowers; *Senecio bellidioides*, with thick bristly leaves, pressed to the ground in close rosettes; *Olearia Colensoi*, only a few inches high; *Celmisia rigida* (very plentiful); stunted *Phormium Cookianum; Dracophyllum prostratum;* and *Anisotome intermedia* (?). Higher still, on the south side, the same association, with the exception of the *Leptospermum* and *Senecio bellidioides*, was dominant, with the following added plants: *Gentiana saxosa*, *Microtis unifolia*, *Thelymitra uniflora*, *Poa Astoni*, *Luzula campestris*, *Pratia angulata*, *Veronica buxifolia*, and *Styphelia acerosa*. The cliffs at Red Head differ but little from the above. Where not too much exposed, they are covered with *Anisotome intermedia* (?), *Apium prostratum*, with *Olearia angustifolia* in patches, interspersed with specimens of *Olearia Colensoi* and *Senecio rotundifolius*—these latter according to situation, the *Olearia angustifolia* being nearest the sea. At an elevation of about 1,200 ft. on the west side of Red Head Peak of the Ruggedy Mountains,

* This plant is not typical, and may be *A. Lyallii*, of which I have seen no authentic specimen.

where the full blast of the westerly wind sweeps the mountain-slope, the weather-worn rocks were clothed with a stunted heath association, of which the following were the principal constituents: *Leptospermum scoparium* (plentiful and almost prostrate), *Olearia Colensoi*, *Dracophyllum longifolium*, small *Celmisia rigida*, *Gaultheria erecta* (stunted), *Metrosideros lucida*, *Phormium Cookianum*, *Styphelia acerosa*, *S. empetrifolia*, *Poa Astoni*, *Pentachondra pumila*, *Dacrydium biforme*, *Forstera sedifolia*, *Senecio Lyallii*, *Oreobolus strictus*, *Drapetes Dieffenbachii*, *Weinmannia racemosa*, and *Thelymitra longifolia*.

This is the highest altitude we were able to attain, and to get so high involved most strenuous climbing up almost precipitous rock-faces, clothed, where plants could get a hold, with the above association, the different plants varying according to shade and shelter, but all showing evidence of much stress from wind and weather. At the height of 1,200 ft. we came out on a rocky top, behind which a deep perpendicular-sided ravine divided us from the ultimate peak, perhaps 400 ft. above us. The stunted forest climbed up to the highest peak in the crevices, and great gaunt rocks stood up round us on every side. We had climbed direct from Red Head, from which point the top is practically unattainable, although from the east side I do not think there would be any insurmountable difficulty in gaining the summit. There is, however, no open ground at the top, and I am satisfied the above association is typical of the range.

(2.) DUNES.

In dealing with the dunes, the only division necessary appears to be that of (*a*) present dunes and (*b*) ancient dunes. The distinction here drawn is one merely of stability. The present dunes are more or less in an unstable condition except in parts, and are only found on the coast; while the ancient dunes extent some distance inland, and are for the most part clothed with low forest or a definite heath association

(a.) *Present Dunes.*

A considerable area of dunes is found at Ruggedy River, and also along the back of the beach at West Ruggedy. For the most part, these are unstable towards the sea, and show evidence of considerable alteration from time to time according as the wind bids them travel. At the highest, they probably reach only about 100 ft. The association is very similar to that noted by me in my paper relating to the botany of Codfish Island,* although the greater area has resulted in the "dune complex" of Cockayne's report, and a much greater variety of plants is found in the wetter and more stable situations. The fore-dune is, as usual, covered with the yellow-brown *Scirpus frondosus*, mixed with *Euphorbia glauca*, while the tops are crowned with *Festuca littoralis*. In the wetter places *Scirpus nodsus* is found, while here and there are patches of *Carex pumila*, *Sonchus littoralis*, *Selliera radicans*, *Crassula moschata*, and *Apium prostratum*. On the more stable dunes there is a considerable quantity of *Linum monogynum*, *Poa caespitosa*, and *Hierochloe redolens*. *Coprosma acerosa*, *Pimelia Lyallii*, and *Calystegia Soldanella* spread over the surface and take the mat form. In damper places *Scirpus nodosus* is plentiful. A few plants of *Geranium*

* "Notes on the Plant Covering of Codfish Island and the Rugged Islands," Trans. N.Z. Inst., vol. 44, p. 77.

sessiliflorum of small size are dotted about, with numerous specimens of *Craspedia uniflora* var. *robusta.* Gradually the dunes become more stable as they recede from the coast, and ultimately become covered with forest. It is difficult to draw the line between ancient and modern dunes, the transition from one to the other being so gradual.

(b.) *Ancient Dunes.*

In dealing with the ancient dunes it will be necessary to treat the plant covering under two heads—namely, dune heath and dune forest.

* *Dune Heath.*

There is a considerable dune heath at Ruggedy lying between the frontage dunes and the dune forest. The dunes vary much in their water-content, and their plant covering differs accordingly. The common association of the drier parts consists of *Leptospermum scoparium* (much of it dwarfed, but on the edge of the forest nearly 30 ft. tall, with trunks in some cases 15 in. in diameter), *Pteridium esculentum, Blechnum capense, B. discolor, Styphelia acerosa,* stunted *Weinmannia racemosa, Coprosma foetidissima, Veronica salicifolia,* stunted *Griselinia littoralis, Gaultheria erecta, Olearia Colensoi, Aristotelia racemosa, Coprosma Colensoi, Phormium Cookianum,* and *Astelia nervosa.* In the more open parts *Coprosma acerosa, Lagenophora pumila, Libertia ixioides* (in full bloom), *Polypodium diversifolium, Coriaria ruscifolia, Wahlenbergia saxicola, Styphelia Fraseri, Linum monogynum, Calystegia Soldanella, Geranium sessiliflorum, Gaultheria perplexa, Coriaria angustissima* (?), with stunted *Carpodetus serratus* and a juvenile plant or two of *Rubus schmidelioides.* I also noted two plants of *Celmisia rigida.* In the damper parts the association changed somewhat, and included *Arundo conspicua, Juncus planifolius, Hydrocotyle asiatica, Scirpus nodosus,* and, as actual bog was approached, *Utricularia monanthos,* and in places *Leptocarpus simplex.* In the pools *Potamogeton Cheesemani* was also seen.

The upper portion of the Fresh-water Valley consists almost entirely of ancient dunes alternating with bogs and swamps. On the drier hills there is an abundance of *Leptospermum scoparium,* with *Styphelia Fraseri, Pentachondra pumila, Thelymitra uniflora, Celmisia longifolia, Cassinia Vauvilliersii, Olearia nitida, Nothopanax Colensoi, Acaena novae-zealandiae, Phormium Cookianum, Lycopodium ramulosum, Veronica salicifolia, Rubus australis, Lagenophora petiolata, Pteridium esculentum, Gaultheria erecta, Coprosma acerosa.* Here and there patches of *Danthonia Raoulii* meadow are found, the tussocks fairly close together, but in the spaces between them *Helichrysum filicaule, Thelymitra uniflora, Microtis porrifolia, Celmisia longifolia* (very plentiful), and *Herpolirion novae-zealandiae.* In an open space among the *Leptospermum scoparium,* at an elevation of about 100 ft. above sea-level, I found a solitary specimen of *Celmisia Sinclairii* (?),* and also several plants of *Caladenia Lyallii* and *C. bifolia.* Specimens of *Prasophyllum Colensoi* were also abundant. *Pseudopanax crassifolium,* with occasional plants of *Nothopanax Colensoi,* is also frequently seen in the mixed dry heath. Near our camp, among very tall *Leptospermum scoparium,* there was a mixed patch of plants, consisting of *Rubus australis, Pittosporum Colensoi, Coprosma foetidissima, Blechnum capense, Polystichum vestitum, Astelia nervosa, Lycopodium volubile, Styphelia*

* Perhaps a new species.

acerosa, *Griselinia littoralis*, *Gaultheria perplexa*, *Coprosma acerosa*, with *Gnaphalium trinerve* and *G. luteo-album*, and a patch of the alpine fern *Lindsayi linearis*.

** *Dune Forest.*

Between Ruggedy River, Fresh-water Valley, and West Ruggedy (on the sheltered side) there is a forest on the ancient dunes. It is of the "Rimu-Kamahi" order, but is for the most part low. There is a considerable thickness of humus on the floor of the forest, and in places it is somewhat boggy. The plants noted by me were *Dacrydium cupressinum*, *Podocarpus ferrugineus*, *Weinmannia racemosa* (whose predominance gives a character to the association), *Dracophyllum longifolium*, *Coprosma foetidissima*, *C. propinqua*, *Northopanax Edgerleyi*, *Northopanax Colensoi*, *Griselinia littoralis*, and *Metrosideros lucida*, with occasional plants of *Olearia Colensoi*, *Senecio rotundifolia*, and *Coprosma lucida*. The floor-covering consisted principally of *Blechnum discolor* and *B. capense*. *Dicksonia squarrosa* is common. On the trunks of trees and logs I also noted *Tmesipteris tannensis*, *Lycopodium Billardieri*, *Polypodium diversifolium*, and *Hymenophyllum dilatatum* and *H. sanguinolentum*. Occasional specimens of *Pseudopanax crassifolium*, *Styphelia acerosa*, *Veronica salicifolia*, and *Coprosma Colensoi* were also seen. Among epiphytes *Dendrobium Cunninghamii* and *Earina mucronata*, both in full bloom, were noted. Next the beach at Ruggedy West there was a low scrub consisting principally of *Olearia Colensoi* and *Senecio rotundifolius*, but near its edge I saw an occasional plant of *Phormium tenax*.

(3.) MOUNTAIN MEADOW.

The only elevated open meadow examined by me was on the hills just adjoining the headland near Rugged Island. There is a considerable area of open land, ascending to a height of about 900 ft. On the east side of the hills there is an almost continuous forest, which will be dealt with under its proper heading. The open side lies exposed to the west, and its plant association is accordingly much affected by wind.

Commencing above the wind-swept Ruggedy headland, at a height of about 200 ft., in a boggy place, I noted *Gnaphalium trinerve*, *Pratia angulata*, *Gnaphalium luteo-album*, *Ranunculus rivularis*, *Carex ternaria*, *Phormium Cookianum*, *Anisotome intermedia* (?), *Blechnum capense*, *Scirpus nodosus*, *Selliera radicans*, *Scirpus aucklandicus*, and *Epilobium nerterioides*. At a height of 350 ft. great patches of *Libertia ixioides* in full bloom appeared, the brownish leaves of the plants giving a marked physiognomy to the hillside. Dotted all over were the rosettes of *Celmisia rigida*, decorated with their handsome flowers. In exposed situations the leaves of this *Celmisia* had a brownish-green colour, and were only 2 in. or 3 in. long. Where the plant was growing in the shelter the leaves were 9 in. or 10 in. long, and of a much brighter green on the upper side. Here and there were specimens of *Coprosma propinqua*, with *Styphelia acerosa* and *Dracophyllum longifolium* shorn almost to the cushion form. Some rounded cushions of *Oreobolus pectinatus* also dotted the hillside, with occasional stunted plants of *Veronica buxifolia*. In parts the hillside appeared to have been burnt, so that the present association is not necessarily original, although, judging from the dry sticks lying about, apparently the original large plants were much the same as at present. The carpet plants were *Gentiana saxosa*, *Senecio bellidioides*, *Gaultheria perplexa*, and *Anisotome* *intermedia*, the latter with very short leaves. On the hilltop, at 800 ft., *Celmisia rigida* was still the most abundant plant, but *Olearia nitida*, *Blechnum capense*, *Styphelia acerosa*, *Veronica buxifolia*, and *Danthonia Raoulii* played an important part.

Here and there *Apium prostratum* was seen, along with *Hierochloe redolens*, *Suttonia rigida*, *Acaena Sanguisorbae*, *Pratia angulata*, *Gnaphalium trinerve*, *Epilobium nerterioides*, *Geranium microphyllum*, and *Thelymitra longifolia*. Proceeding along the ridge, we entered a bit of a forest on a low saddle, and emerged again at a height of about 700 ft. in a great wind-funnel, where the alpine scrub showed very marked modification, from the changed ecological conditions. The principal plants were *Leptospermum scoparium* (shorn to a low close mat), *Metrosideros lucida* (a much-branched low-growing bush), *Olearia Colensoi*, *Styphelia acerosa*, *Veronica buxifolia*, *Dracophyllum longifolium*, *Nothopanax Colensoi*, *Coprosma foetidissima*, *Olearia nitida*, *Coprosma lucida*, *Griselinia littoralis*, and *Phormium Cookianum*. All these plants were cut off closely by the wind to a height of only a foot or two, until, as the hilltop was reached, they grew to about 4 ft. as they merged into the forest, which, climbing up the sheltered side, met the rounded top of the heath plants. On the bare patches among the aforesaid plants were numerous small specimens of *Celmisia rigida* and *Anisotome intermedia* (?). The only other high open part inspected by me was that of the higher portion of Red Head Peak, which has already been dealt with under the heading of "Rocks and Cliffs."

(4.) FOREST.

It is hard to draw the line between the coastal scrub on the west side and the forest. The high winds seem to considerably affect the association. The only parts which seem to properly come under the head of "forest" are those in sheltered situations—namely, on the eastern slopes—although, as the coast is receded from and the frontage belt of *Olearia angustifolia*, *O. Colensoi*, and *Senecio rotundifolia* begins to afford its shelter, the usual "Rimu-Kamahi" association obtains a hold. On the eastern slope of the bare hill to the south of Ruggedy Point, for instance, the following association was noted: *Weinmannia racemosa*, *Dracophyllum longifolium*, *Coprosma foetidissima*, *C. lucida*, *Nothopanax Edgerleyi*, *N. Colensoi*, *Coprosma propinqua*, *Griselinia littoralis*, *Dacrydium cupressinum*, *Metrosideros lucida*, with an undergrowth of *Blechnum discolor*, *B. capense*, *Astelia nervosa*, and *Carex ternaria*. On the tree-trunks were fringes of *Luzuriaga marginata*, *Polypodium diversifolium*, *Asplenium flaccidium*, and the filmy ferns. Here and there also were groups of the tree-fern *Dicksonia squarrosa*. The general aspect of the forest was brownish-green, from the abundance of *Dacrydium cupressinum* trees standing out above their fellows, with darker patches where the rounded heads of the *Metrosideros lucida* appeared, and intermediate splashes of a lighter colour where the *Weinmannia racemosa* predominated. In the gullies were observed *Rhipogonum scandens*, *Rapanea Urvillei*, *Hemitelia Smithii*, the floor-covering being *Blechnum discolor* and *B. capense*, while the damp logs were covered with *Hymenophyllum dilatatum*, *H. sanguinolentum*, *Polypodium diversifolium*, and *P. australe*. Near the edge of the forest *Muehlenbeckia complexa*, *Pseudopanax crassifolium*, *Tmesipteris tannensis*, and *Lycopodium volubile* were noted, with occasional specimens of *Veronica elliptica*. Throughout this forest, but not plentiful, specimens of *Olearia Colensoi* and *Senecio rotundifolius* also grew, seemingly somewhat out of their station.

The forest traversed in the endeavour to scale Red Head Peak consists in the foreground principally of "Olearia-Senecio" scrub association. It is, of course, exposed to the westerly gales, which apparently preclude the usual mixed forest from getting a hold until the protecting fringe of scrub is passed. The forest proper is, however, the usual "Rimu-Kamahi," but here contained a few species not noted elsewhere in this report. The floor-covering consisted of *Blechnum lanceolatum, B. capense,* and *Asplenium lucidum,* while the damp logs were covered with *Nertera depressa* and *Polypodium diversifolium.* Here and there in boggy places *Carex ternaria* and a smaller species were plentiful. Isolated plants of *Anisotome intermedia* (?) and *Veronica elliptica* were dotted about. Then followed a mixed association of *Dracophyllum longifolium, Coprosma Colensoi, Nothopanax Colensoi, Rapanea Urvillei, Leptospermum scoparium, Coprosma lucidum, Rubus schmidelioides, Pteridium esculentum,* and *Blechnum discolor, Weinmannia racemosa, Coprosma foetidissima, Carpodetus serratus, Griselinia littoralis, Dicksonia squarrosa, Olearia nitida, Astelia nervosa, Muehlenbeckia complexa, Rhipogonum scandens, Thelymitra longifolia,* and *Aristotelia racemosa.* One specimen each of *Drimys colorata* and *Cordyline australis* were also seen. The outside appearance of the roof of this forest was markedly flat for its association, the plants presenting a close array of wind-shorn foliage of a dull grey-green colour, here and there tinged with brown where *Dracophyllum* pushed up its head. This smooth appearance continued right up the mountain-side, except where some giant rock thrust itself through the mantle of plants. Beyond 300 ft. a change was noted, and *Metrosideros lucida, Asplenium flaccidum, Lycopodium Billardieri, Hemitelia Smithii,* and the orchids *Corysanthes triloba, Thelymitra longifolia, Microtis unifolia, Dendrobium Cunninghamii,* and *Pterostylis australis* crept into the association. At 530 ft. *Melicytus lanceolatus, Fuchsia excorticata, Aristotelia racemosa, Veronica buxifolia, Pittosporum Colensoi, Libertia ixioides* were added. At 700 ft. the first precipitous rocks were met with, and a close mantle of *Dracophyllum longifolium, Olearia Colensoi, O. angustifolia* (in full bloom), *Griselinia littoralis. Leptospermum scoparium, Phormium Cookianum, Styphelia acerosa, Rapanea Urvillei,* and *Nothopanax Colensoi* surrounded them, while *Anisotome intermedia* (?) filled the cracks and crannies. I also noted *Claytonia australasica* as growing in a peaty crevice of these rocks. Just beyond these exposed rocks there was an almost level piece of forest, in which the association was *Metrosideros lucida, Griselinia littoralis, Senecio rotundifolius, Dracophyllum longifolium, Coprosma foetidissima,* with occasional specimens of *Dacrydium cupressinum* and *Weinmannia racemosa,* the trees being covered with weird festoons of *Polypodium diversifolium* and the filmy ferns. The forest-floor was covered with the usual *Blechnum discolor* and *B. capense,* with an occasional *Asplenium obtusatum.* In this spot I also saw a few specimens of *Styphelia empetrifolia, Nothopanax Edgerleyi, Luzuriaga marginata, Tmesipteris tannensis,* and a tall *Gahnia procera.* From this upwards the climb was a decidedly rocky one, which is dealt with under the head of "Cliffs and Rocks." From the top an extensive view of the forest-roof was obtained both east and west, the most characteristic aspects being the closely compressed smooth roof of the western slopes, broken, immediately the watershed was passed, by the usual up-and-down appearance of the "Rimu-Kamahi" association.

On the north of the Ruggedy River there is a large area of forest extending right round the coast. On the sea frontages there is the usual

"Senecio-Olearia" belt, but the forest is somewhat more mixed than that noted farther south. This forest contained the following species, which list is not, of course, exhaustive: *Veronica elliptica*, *Anisotome intermedia* (?), *Olearia angustifolia*, *O. Colensoi*, *O. nitida* (the latter in many cases with a trunk 2 ft. in diameter, although generally prostrate at the base), *Coprosma areolata*, *Senecio rotundifolius*, *Rubus australis*, *Aristotelia racemosa*, *Acaena Sanguisorbae*, *Juncus planifolius*, *Coprosma propinqua*, *Rubus schmidelioides*, *Rapanea Urvillei*, *Coprosma foetidissima*, *Blechnum discolor*, *Polypodium diversifolium*. As the scrub became denser I noted *Gunnera prorepens*. *Nertera depressa*, *Coprosma lucida*, *Ranunculus hirtus*, *Blechnum capense*. *Fuchsia excorticata*, *Carex ternaria*, *C. dissita*, *Griselinia littoralis*, *Leptospermum scoparium*, *Gnaphalium luteo-album*, *Metrosideros lucida*, *Dracophyllum longifolium*, *Carpodetus serratus*, *Weinmannia racemosa*, *Dacrydium cupressinum*, *Muehlenbeckia complexa*, *Rhipogonum scandens*, *Pittosporum Colensoi*, *Asplenium flaccidum*, *Astelia nervosa*, *Pratia angulata*, *Schefflera digitata*, *Polypodium grammitidis*, *Pseudopanax crassifolium*, *Earina mucronata*, *Polystichum vestitum*, *Erechtites prenanthoides*, and *Asplenium lucidium*.

(5.) BOGS AND SWAMPS.

Under this heading I propose to deal with the plants growing in the wet and boggy land in Fresh-water Valley. Strictly speaking, it is hard to draw the line in many cases between heath and bog, as these two are so closely united. The Fresh-water Valley consists practically of wet and boggy land all through, although here and there are scrub islands, and in many cases extensive dry sandy ridges. On the other hand, there are numerous creeks and several large lagoons, some of them about a quarter of a mile in length by half that width. The principal bogs are covered with stretches of *Hypolaena lateriflora* and *Gleichenia alpina*, with here and there in the wetter places great cushions of *Sphagnum*. There also are colonies of *Utricularia monanthos*, and carpets of the pretty blue flowers of *Herpolirion novae-zealandiae*. Here and there are smaller cushions of *Oreostylidium subulatum*, and in the drier places vast quantities of *Celmisia longifolia*. In parts there are many stunted specimens of *Cassinia Vauvilliersii* and *Phormium Cookianum* and the ixia-like orchid *Thelymitra uniflorum* (in full bloom). Much of the ground is covered by *Pentachondra pumila* and *Styphelia empetrifolia*; and occasional plants of *Styphelia acerosa*, *Blechnum capense* var. *minor*, and *Lycopodium ramulosum* are common, as also is *Dracophyllum longifolium*. In the places where there is an abundance of standing water is found an almost pure association of *Leptocarpus simplex*, while on the "heath islands" will be found *Olearia nitida*, *Nothopanax Colensoi*, *Astelia nervosa*, *Acaena novae-zealandiae*, *Lycopodium fastigiatum*, *Phormium Cookianum*, *Veronica salicifolia*, *Rubus australis*, *Lagenophora petiolata*, and *Pteridium esculentum*. In many parts the ground is red with broad patches of *Drosera binata* and the small round mats of *D. spathulata*. Less common, but still tolerably plentiful, will be found *Gaultheria perplexa*, *G. erecta*, *Coprosma acerosa*, and *Caladenia Lyallii*. Here and there are stretches of drier ground covered with *Danthonia Raoulii*, the tussocks fairly tall, and the ground between them filled up with *Pratia angulata*, *Thelymitra longifolia*, and *Microtis unifolia*, with occasional specimens of *Prasophyllum Colensoi*. For long stretches near some of the lagoons there will be nothing but the red stems of *Leptocarpus simplex*, or in some places the green stems of *Scirpus nodosus*. In boggy creeks I noted

Fig. 1.—Wind-funnel, Ruggedy Head.
Celmisia rigida plentiful, with *Phormium Cookianum*.

Fig. 2.—Typical Coastal Rock Association.
Olearia angustifolia and *Anisotome intermedia* in foreground, with *Veronica elliptica*, *O. Colensoi*, and *Phormium Cookianum* in background.

Potamogeton Cheesemani. Farther up the valley the general appearance of the country is brownish-green splashed with yellow and green. The first is caused by the abundance of *Leptospermum* and the latter by *Danthonia Raoulii* and *Phormium Cookianum.* In parts there are great stretches of reddish-brown *Leptocarpus simplex* in the water, with *Scirpus nodosus* on the lagoon-banks. In the very wet places with standing water *Cladium Vauthiera* is also common. Here and there in the boggy places *Gaimardia* cushions are common, with a few specimens of *Oreobolus pectinatus* and an abundance of *Carpha alpina.* Farther up the valley the *Droserae* become very abundant, and larger than the specimens seen farther down.

Growing under manuka in a fairly dry spot I noted some specimens of *Schizaea fistulosa* var. *australis* and *Caladenia Lyallii*, also *Erechtites scaberula* and *Agropyron scabrum.* Near the head of the valley and just abreast of the Ruggedy Mountains the swamp flora consisted of *Carex ternaria*, *Hypolaena lateriflora*, stunted *Veronica buxifolia* and *Cassinia Vauvilliersii*, *Thelymitra longifolia* (abundant); and *T. uniflora* and *Scirpus nodosus* were also plentiful in patches. In this association *Caladenia*, *Erechtites*, and *Pratia* were also plentiful. Near the bank of one of the lagoons mentioned the following plants were growing, namely: *Gunnera prorepens*, *Scirpus nodosus*, *Ranunculus rivularis*, *Arundo conspicua*, *Viola Cunninghamii*, *Lagenophora petiolata*, *Helichrysum filicaule*, with the usual *Hypolaena* and *Drosera* and *Celmisia longifolia.*

The most interesting facts collected on the trip are:—

1. Those relating to the distribution of plants, thus—

    Celmisia rigida is a plentiful plant both near the coast and in sub-alpine regions on the high hills both at Ruggedy and on Red Head Peak. Dr. Cockayne mentions it as "evidently rare," and "confined to coastal cliffs at south end of Mason's Bay," and as "not subalpine."

    Celmisia Sinclairii (?).*—Hitherto reported from Mount Anglem only, in Stewart Island, but collected by me in Fresh-water Valley at practically sea-level.

    Cordyline australis.—According to Cockayne, supposed to be only in Fresh-water Valley, in the open. Not seen by me there, but noted on the west side of Red Head Peak, in forest.

    Coriaria angustissima.—Not hitherto reported from Stewart Island.

    Asplenium bulbiferum.—A common plant generally in Stewart Island, but not seen by me on the west coast.

2. The mixed taxad forest on the ancient dunes.

3. The importance of the wind factor in determining the distribution of the species.

4. The marvellous plasticity of many genera in accommodating themselves to their environment, especially *Leptospermum*, *Celmisia*, *Coprosma*, *Nothopanax*, &c.

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* This plant differs materially from type, and may be a new species. Dr. Petrie considers it such, and has taken my specimens for critical examination.

Art. XXXIV.—*Notes of a Botanical Excursion to Northern Portion of the Eyre Mountains.*

By D. L. Poppelwell.

[*Read before the Otago Institute, 3rd December, 1912.*]

General.

In the company of Mr. James Speden, of Gore, I spent two days on the mountain west of Lake Wakatipu during the Easter holidays of 1912. We left Queenstown by oil-launch at 8 a.m. on the 8th April, arriving at Table Bay about 9 a.m. We journeyed thence about eight or nine miles up the valley to a hut, at about 2,800 ft. elevation, belonging to the proprietor of the Walter Peak Station. This we made our headquarters, and made excursions to the mountain-tops round us, reaching a height of about 5,600 ft. on the southern side of Mount Walter, returning to Queenstown across the lake on the evening of the 9th.

As no list of the plants of this locality has, so far as I am aware, been hitherto published, a note of those collected by us may be of interest. Among the plants noted was *Aciphylla Spedeni* Cheeseman n. sp. (*ante*, p. 93), which is now shown to extend from the Symmetry Peaks, where the writer found it in 1910, to Cecil Peak, where Mr. Speden found it a few months ago, and to Walter Peak.

I append a list of the plants observed, which totalled 177 species, spread over ninety-two genera and forty-one orders.

Pteridophyta.

Hymenophyllaceae.

Hymenophyllum tunbridgense (L.) Smith. Subalpine rocks.

Polypodiaceae.

Polystichun vestitum (Forst. f.) Presl. Lowland and mountain meadow.
—— *cystostegia* Hook. f. Alpine meadow and among rocks.
Blechnum penna marina (Porr.) Kuhn. Lowland and alpine meadow.
—— *capense* (L.) Schlecht. Lowland meadow and rocks.
—— *fluviatile* (R. Br.) Lowe. Lowland meadow.
Hypolepis tenuifolia (Forst. f.) Bernh. Lowland meadow.
Pteridium esculentum (Forst. f.) Cockayne. Lowland meadow, abundant.
Polypodium Billardieri (Willd.) C. Chr. Epiphytic on rocks at 3,500 ft.
Cheilanthes Sieberi Kunze. Lowland sunny faces, lake-side.

Lycopodiaceae.

Lycopodium Selago L. Alpine rocks.
—— *fastigiatum* R. Br. Mountain meadow.
—— *volubile* Forst. Among scrub.
—— *scariosum* Forst. Subalpine heath.

Spermophyta.

Taxaceae.

Podocarpus nivalis Hook. Alpine scrub up to 3,000 ft.

Gramineae.

Danthonia Cunninghami Hook. f. Cliffs.
—— *Raoulii* Steud. Lowland meadow.
—— *flavescens* Hook. f. Mountain meadow.
—— *crassiuscula* Kirk. Mountain meadow.
Arundo conspicua Forst. f. Damp ground.
Poa caespitosa Forst. f. Common, lowland meadow.
—— *Colensoi* Hook. f. Common, subalpine meadow.
Festuca rubra L. var. *novae-zealandiae.* Subalpine meadow.
Agropyron scabrum Beauv. Alpine meadow.

Cyperaceae.

Carpha alpina R. Br. Alpine swamp.
Oreobolus pectinatus Hook. f. Mountain meadow.
Carex ternaria Forst. f. Swampy places.

Juncaceae.

Juncus novae-zealandiae Hook. f. Alpine swamp.
Luzula campestris D. C. Subalpine meadow.

Liliaceae.

Bulbinella Hookeri Benth. & Hook. Lowland swamp.
Cordyline australis (Forst. f.) Hook. f. Heath, plentiful.
Phormium Cookianum Le Jolis. Heath, plentiful.
Astelia nervosa Banks & Sol. Creek-bank, in scrub.
Astelia montana (Kirk) Cockayne. Open places.

Orchidaceae.

Pterostylis Banksii R. Br. In beech forest.

Cupuliferae.

Nothofagus fusca Oerst. Beech forest.
—— *Solandri* Oerst. Beech forest.
—— *cliffortioides* Oerst. Beech forest.

Polygoniaceae.

Muehlenbeckia complexa (A. Cunn.) Meissn. Subalpine scrub.
—— *axillaris* Walp. Subalpine meadow.

Portulaceae.

Claytonia australasica Hook. f. Subalpine meadow.
Hectorella caespitosa Hook. f. Subalpine meadow.

Caryophyllaceae.

Colobanthus brevisepalus Kirk. Mountain meadow.

Ranunculaceae.

Clematis foetida Raoul. Subalpine heath and rocks.
Ranunculus lappaceus Smith. Common.
—— *tenuicaulis* Cheeseman. Creek-banks.
—— *Haastii* Hook. f. Shingle-slips.
—— *Buchanani* Hook. f. On rocks at 5,000 ft.
Caltha novae-zealandiae Hook. f. Alpine meadow.

Cruciferae.

Cardamine fastigiata Hook. f. Subalpine rocks.

Malvaceae.

Gaya Lyallii J. E. Baker. Creek-bank.

Saxifragaceae.

Carpodetus serratus Forst. Creek-bank, 2,000 ft.

Pittosporaceae.

Pittosporum Buchanani Hook. f. Lowland scrub.

Rosaceae.

Rubus australis Forst. Creek-bank, 2,000 ft.
—— *cissoides* A. Cunn. Creek-bank, 2,000 ft.
Geum parviflorum Smith. Damp places, subalpine rocks.
—— *uniflorum* Buch. Alpine meadow.
Acaena Sanguisorbae Vahl. Plentiful.
—— —— var. *pilosa* Kirk. Plentiful, subalpine meadow.
—— *microphylla* Hook. f. Lowland meadow.

Geraniaceae.

Oxalis magellanica Forst. Abundant in alpine meadow.
Geranium microphyllum Hook. f. Lowland meadow.
—— *sessiliflorum* Cav. Lowland meadow.

Coriariaceae.

Coriaria ruscifolia L. Lowland heath.
—— *angustissima* Hook. f. Subalpine heath.

Leguminosae.

Sophora tetraptera J. Mull. Creek-bank.
Corallospartium crassicaule Armstrong. Creek-bank, abundant.

Elaeocarpaceae.

Aristotelia racemosa (A. Cunn.) Hook. f. Lowland scrub.
—— *fruticosa* Hook. f. Lowland scrub.

Violaceae.

Viola filicaulis Hook. f. Throughout.
—— *Cunninghami* Hook. f. Throughout.
Hymenanthera dentata R. Br. var. *alpina* Kirk. Subalpine, dry places.

Thymelaeaceae.

Pimelia laevigata Gaertn. Subalpine meadow.
Drapetes Dieffenbachii Hook. Subalpine meadow.
—— *Lyallii* Hook. f. Subalpine meadow.

Myrtaceae.

Leptospermum scoparium Forst. Lowland heath.

Onagraceae.

Epilobium pictum Petrie. Lowland meadow.
—— *chloraefolium* Haussk. Subalpine heath.
Fuchsia excorticata L. f. Lowland scrub.

Araliaceae.

Nothopanax Colensoi Hook. f. Lowland scrub.
Pseudopanax crassifolium (Sol.) C. Koch. Lowland scrub.

Umbelliferae.

Hydocotyle novae-zealandiae D. C. Damp places.
Schizeleima Haasti Benth. & Hook. f. Wet rocks, 3,000 ft.
—— *hydrocotylioides* Benth. & Hook. f. Wet rocks, 3,000 ft.
Aciphylla Colensoi Hook. f. Abundant, subalpine.
—— *Munroi* Hook. f. Alpine rocks, shingle-slips.
—— *Spedeni* Cheeseman n. sp. (*ante*, p. 93). Alpine rocks, shingle-slips.
Anisotome brevistyle Hook. f. Alpine rocks.
—— *piliferum* Hook. f. Alpine rocks.
—— *aromaticum* Hook. f. Subalpine meadow.
Angelica Gingidium Hook. f. Damp rocks.

Cornaceae.

Griselinia littoralis Raoul. Lowland scrub.

Ericaceae.

Gaultheria antipoda Forst. f. var. *depressa* Hook. f. Subalpine meadow.
—— —— var. *erecta* Cheeseman. Subalpine scrub.
—— *rupestris* R. Br. Subalpine scrub.
Styphelia Fraseri (A. Cunn.) F. Muell. Subalpine heath.
Dracophyllum Urvilleanum A. Rich. Subalpine heath.
—— *longifolium* (Forst. f.) R. Br. Subalpine heath.
—— *prostratum* T. Kirk. Subalpine heath.

Epacridaceae.

Pentachondra pumila (Forst. f.). Subalpine heath.

Myrsinaceae.

Suttonia nummularia Hook. f. Subalpine heath.
—— *divaricata* A. Cunn. Creek-bank.

Gentianaceae.

Gentiana corymbifera T. Kirk. Subalpine meadow.
—— *bellidifolia* (?) Hook. f. Subalpine meadow.

Convolvulaceae.

Dichondra repens Forst. Lake-side.

Boraginaceae.

Myosotis macrantha Hook. f. Rocks, at 3,000 ft.
—— *pulvinaris* Hook. f. Alpine meadow, above 5,000 ft.

Scrophulariaceae.

Veronica salicifolia Forst. f. Heath, common.
—— *buxifolia* Bentham. Heath, common.
—— *propinqua* Cheeseman. Heath, common.
—— *Thomsoni* Cheeseman. Alpine meadow.
—— *subalpina* Cockayne. Subalpine heath.
—— *monticola* Armst. Subalpine heath.
—— *linifolia* Hook. f. Damp rocks, at 3,000 ft.
—— *Lyallii* Hook. f. Damp rocks, common.
—— *Buchanani* Hook. f. Rocks, at 5,000 ft.
—— *Bidwilli* Hook. Damp rocks.
Ourisia caespitosa Hook. f. Subalpine meadow.
—— *glandulosa* Hook. f. Subalpine meadow.
Euphrasia zealandica Wettst. Mountain meadow.

Rubiaceae.

Coprosma rugosa Cheeseman. Heath.
—— *propinqua* A. Cunn. Lowland heath.
—— *ramulosa* Petrie. Lowland heath.
—— *serrulata* Hook. f. Subalpine heath.
—— *parviflora* Hook. f. Lowland heath.
—— *repens* Hook. f. Subalpine meadow.
Galium umbrosum Sol. Lowland meadow.

Campanulaceae.

Pratia angulata (Forst. f.) Hook. f. Damp situations.
Wahlenbergia gracilis (Forst. f.) A. D. C. Lake-side.
—— *saxicola* A. D. C. Plentiful.
Lobelia linnaeoides Petrie. Alpine meadow.

Stylidiaceae.

Phyllachne clavigera (Hook. f.) F. Muell. Alpine meadow.
Donatia novae-zealandiae Hook. f. Alpine meadow.
Oreostylidium subulatum (Hook. f.) Berggr. Alpine meadow.
Forstera sedifolia L. f. Wet rocks.

Compositae.

Abrotanella inconspicua Hook. f. Mountain meadow.
Lagenophora pumila Forst. f. Lowland heath.
—— *petiolata* Hook. f. Lowland heath.
Brachycome Sinclairii Hook. f. Subalpine meadow.
Olearia virgata Hook. f. Subalpine heath.
—— *moschata* Hook. f. Subalpine heath.
—— *nummularifolia* Hook. f. Subalpine heath.
—— —— var. *cymbifolia* Hook. f. Subalpine heath.
—— *avicenniaefolia* (Raoul) Hook. f. Subalpine heath.
—— *nitida* Hook. f. Subalpine heath.
Celmisia Walkeri T. Kirk. Subalpine, dry rocks.
—— *ramulosa* Hook. f. Subalpine, dry rocks.
—— *prorepens* Petrie. Rocks on creek-bank, at 3,000 ft.
—— *discolor* Hook. f. Subalpine meadow, to 4,500 ft.
—— *incana* Hook. f. Subalpine meadow.
—— *Sinclairii* Hook. f. Subalpine meadow, at 4,500 ft.
—— *petiolata* Hook. f. Creek-bank, from 2,500 ft.
—— *spectabilis* (?) Hook. f. Dry rocks, at 3,550 ft.
—— *Haastii* (?)* Hook. f. Alpine meadow.
—— *verbascifolia* Hook. f. Creek-bank, 3,000 ft.
—— *Lyallii* Hook. f. Damp alpine meadow.
—— *longifolia* Cass. Throughout.
—— —— var. *alpina* Kirk. Wet alpine meadow, above 3,750 ft.
—— *Hectori* Hook. f. Abundant above 3,750 ft.
—— *sessiliflora* Hook. f. Common, subalpine meadow, from 4,500 ft. upwards.
—— *bellidioides* Hook. f. Wet rocks, common.
—— —— var. Dry rocks.
Gnaphalium trinerve Forst. f. Lowland meadow.
—— *luteo-album* L. Lowland meadow.
—— *paludosum* Petrie. Wet subalpine meadow.
—— *Traversii* Hook. f. Wet subalpine meadow.
Raoulia glabra Hook. f. Common.
—— *australis* Hook. f. Common.
—— *grandiflora* Hook. f. Alpine meadow.
Helichrysum bellidioides (Forst. f.) Willd. Subalpine meadow.
—— *filicaule* Hook. f. Meadow.
—— *Selago* Benth. & Hook. f. Dry rocks, common.
—— *glomeratum* Benth. & Hook. f. Creek-bank, at 2,000 ft.
Cassinia Vauvilliersii Hook. f. Subalpine heath.
Craspedia uniflora Forst. f. var. *robusta* Hook. f. Damp alpine meadow.
Cotula pectinata Hook. f. Alpine meadow.
Senecio bellidioides Hook. f. Common on creek-banks.
—— *Lyallii* Hook. f. Common on wet rocks.
—— *cassinioides* Hook. f. Subalpine heath, common.
—— *revolutus* Kirk. Subalpine heath, common.

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* Probably an undescribed species.

Art. XXXV.—*New Species of Tertiary* Mollusca.

By Henry Suter.

[*Read before the Philosophical Institute of Canterbury, 4th December, 1912.*]

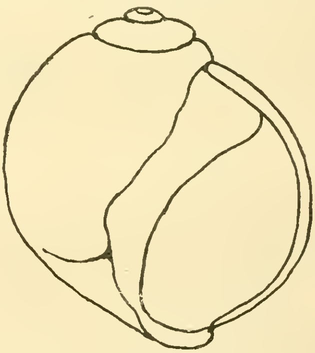
Plates XII–XIV.

Dr. P. Marshall and Mr. R. Speight sent me a number of New Zealand Tertiary fossils they had been collecting for examination, and amongst them I found a number of species I consider to be new to science, and the most important ones are described hereafter. Of quite especial interest is the occurrence of the subgenus *Perrona* in a form very nearly allied to a species of the Pliocene of French India.

I am much obliged to the two gentlemen for bearing the cost of photographing the type specimens.

Polinices ambiguus sp. nov.

Shell small, rotundly ovate, with spiral lines, umbilicus covered up in the adult, suture impressed. *Sculpture* consisting of inequidistant fine spiral cords, fine microscopic lines in the interspaces, crossed by oblique flexuous growth-lines. *Spire* broadly conoidal, about one-third the height of the aperture. *Protoconch* of one papillary whorl. *Whorls* 5, first slowly increasing, but the last rather large; they are convex, the body-whorl slightly flattened below the suture, base narrowed. *Suture* deep, but not canaliculate. *Aperture* oblique, narrowly ovate, slightly effuse below. *Outer lip* thin and sharp, convex; the basal lip narrowly rounded. *Columella* short, arcuate. *Inner lip* rather broad, not very callous, with a distinct pad below the suture; *umbilicus* slightly open in young specimens, but completely closed up in adult shells.



Polinices ambiguus; × 3½.

Height, 13 mm.; diameter, 10·5 mm. (holotype).

Holotype and 2 *paratypes* in the Canterbury Museum, Christchurch.

Locality.—Hundalee, Amuri Bluff (R. Speight). Pliocene.

Remark.—The spiral ornamentation and deep suture approach this species to *P. suturalis* Hutton.

Clavatula (Perrona) neozelanica sp. nov. Plate XII, fig. 3.

Shell rather large, fusiform, imperforate, with scalar spire, narrowly excavated shoulder, spirally lirate, with a somewhat shallow, broadly rounded labial sinus on the shoulder and extending over the keel. *Sculpture* of narrow spiral cords, flattish, separated by linear interstices, getting broader and more conspicuous upon the base; they are crossed by oblique fine growth-lines. *Spire* conical, gradate, of the same height as the aperture without canal; angle 45°. *Protoconch* obtuse, slightly tilted. *Whorls* 6½, the last large and somewhat ventricose, with a rounded keel, narrow and concave

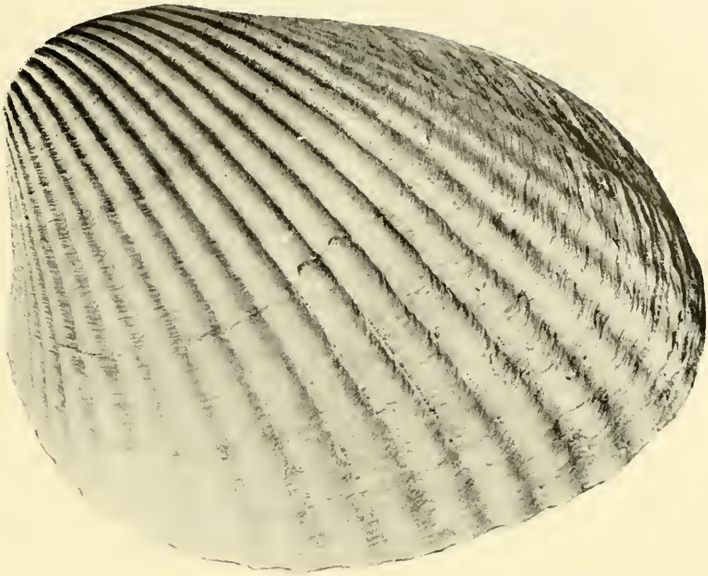


Fig. 1.—Venericardia ponderosa *Suter.*

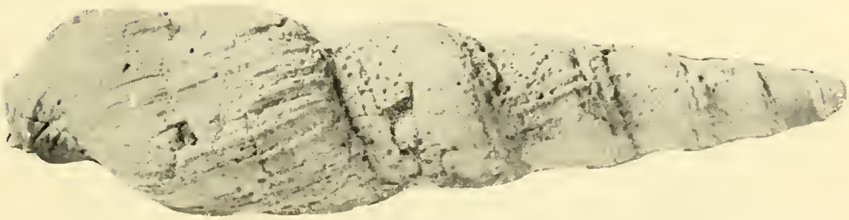


Fig. 2.—Terebra orycta *Suter.*

Fig. 3.—Clavatula (Perrona) neozelanica *Suter.*

Face p. 294.]

Fig. 1.

Fig. 2.

Pecten (Patinopecten) marshalli *Suter*

shoulder above it, straight, flat below; the body-whorl flatly convex, contracted below. *Suture* well impressed, submargined below by a rather broad and but little raised convex band. *Aperture* vertical, pyriform, channelled above, produced below into a short canal, its base notched. *Outer lip* thin and sharp, with a sinus above. *Columella* vertical and almost straight, turned to the left towards the canal. *Inner lip* thin and narrow; an elevated rib descending towards the right side of the canal, and inside it is the distinct siphonal fasciole with laminate growth-periods.

Height, 60 mm.; diameter, 25 mm. (holotype).

Holotype in the Canterbury Museum, Christchurch.

Locality.—Lower gorge of Waipara, lower horizon (R. Speight). Miocene.

Remarks.—This is the first species of *Clavatula* recorded from New Zealand. It is very nearly allied to *C.* (*Perrona*) *unisulcata* Cossman, from the Pliocene of Karikal, French India, and, less so, to *C.* (*Perrona*) *semimarginata* Lamarck, from the Miocene of Bordeaux, France.

Terebra orycta sp. nov. Plate XII, fig. 2.

Shell fairly large, subulate, the whorls swollen below the suture, thence slightly excavated, with faint indications of axial plications. *Sculpture* consisting of 18 to 20 axial plications, and there seems to be no spiral ornamentation; all the specimens are in such a bad state of preservation that it is impossible to ascertain the sculpture with certainty. *Spire* high, subulate; angle about 20°. *Protoconch* lost in all specimens. *Whorls* about 10 to 12, somewhat swollen below the suture, straight or slightly concave to the suture below; base contracted. *Suture* not much impressed. *Aperture* vertical, subrhomboidal, with a short, open canal below, its base notched. *Outer lip* thin, sharp, somewhat contracted at the middle. *Columella* vertical, straight, bent to the left below towards the canal. *Inner lip* narrow, thin, with a rib issuing underneath it and descending to the base of the canal, leaving a lamellate siphonal fasciole between it and the margin of the canal.

Height, 47 mm.; diameter, 12 mm. (holotype, imperfect).

Holotype and 5 *paratypes* in the Canterbury Museum, Christchurch.

Locality.—Lower gorge of Waipara, lower horizon (R. Speight). Miocene.

Remark.—This species is no doubt nearly allied to the South Australian ***T. angulata*** Tate, and also, though more distantly, to ***T. biplex*** Hutton.

Pecten (Patinopecten) marshalli sp. nov. Plate XIII, figs. 1 and 2.

Shell large, inequivalve, subinequilateral, slightly oblique, ears large, the right valve with dichotomous scaly radial ribs, the left valve with distant, broadly rounded radial ribs, slightly more inflated than the right valve. *Beaks* small, approximate. *Ears* large, subequal, the anterior somewhat larger, on the right valve with a byssal notch and ctenolium. *Anterior end* slightly shorter, roundly angled above the middle, dorsal margin concave, descending, margin regularly arched below the angle. *Posterior end* narrowly convex at the middle, broadly rounded towards the convex basal margin, dorsal margin straight, descending. *Sculpture: Right valve* having on the anterior ear 2 to 3 strong radial ribs and close, lamellar, sinuous, concentric striae, the posterior ear with inconspicuous radial ribs, rendered scaly by the irregular concentric striae; disc with about 11 dichotomous, narrow, rounded, scaly radial ribs, the division of the ribs beginning at the umbo, occasionally some ribs are trichotomous, and the width of the ribs is very variable; the interstices between the ribs are mostly of the same width as the ribs; the whole surface ornamented with distant concentric striae, imbricating the ribs. *Left valve* with subequal triangular ears, the anterior ear with fine radial riblets crossed by distant laminar concentric striae; the posterior ear without distinct radial riblets, but rather distant lamellar concentric striation; disc with 11 subequidistant, high, rounded radial ribs, the 3 posterior interstices with a low, broadly rounded rib in the centre, bringing the total number of ribs up to 14; the whole surface with fine, dense concentric striation. *Margins* smooth inside. *Hinge-plate* solid, with a large, oblique, triangular resilifer, directed forwards. *Adductor-scar* very large, rounded, slightly longer than high, vertically striated, situation central or slightly posterior.

Right valve: Height, 115 mm.; length, 120 mm.; diameter, 20 mm. (holotype).

Left valve: Height, 107 mm.; length, 108 mm.; diameter, 25 mm. (holotype).

Holotypes in the collection of Dr. P. Marshall, Otago University, Dunedin.

Locality.—Muddy Terrace, Waikaia (Dr. P. Marshall). Miocene.

Remarks.—The upper part of a right valve from limestone on coast, ten miles north of Raglan (loc. 97), is in the Museum of the Geological Survey, Wellington. This specimen has the anterior ear in perfect condition.

Venericardia ponderosa sp. nov. Plate XII, fig. 1.

Shell large and solid, rounded trigonal, inequilateral, the umbo near the anterior end, with flatly rounded, nearly smooth radial ribs, the anterior ones narrow and scaly, the posterior ribs inconspicuous, concentric striation prevailing. *Beak* very near the anterior end, large, inflated, incurved, prosogyrate. *Anterior end* very short, flatly convex, the margin rounded, dorsally deeply excavated. *Posterior end* very long, moderately ventricose, broadly rounded, the dorsal margin almost straight and long, slowly descending; basal margin broadly convex. *Lunule* small, cordate. *Escutcheon* linear. *Sculpture* consisting of 25 conspicuous radial ribs, to which about 5 inconspicuous posterior ribs have to be added; the 6 anterior ribs are narrow, rounded, scaly, the interstices broader than the ribs; the median ribs of the valve are broadly convex, stout, crossed by fine concentric growth-lines, the interstices very narrow; on the posterior end of the valve the ribs are flattish, low, inconspicuous, lamellar concentric striation predominating. *Margins* distinctly plicated, thick. *Hinge-plate* broad and heavy, left valve with 2 cardinal teeth, the anterior tooth short and thick, blunt, oblique, the posterior tooth long, nearly horizontal, arched, finely transversely striated. *Ligament* rather long, external. *Adductor-scars* unequal, large, deep, the anterior elongately oval, the posterior rounded subtrigonal.

Left valve: Height, 80 mm.; length, 100 mm.; diameter, 38 mm. (holotype).

Holotype in the collection of Dr. P. Marshall, Otago University, Dunedin.

Locality.—Muddy Terrace, Waikaia (Dr. P. Marshall). Miocene.

Chione (Lirophora) speighti sp. nov. Plate XIV, figs. 1 and 2.

Shell rather large, ovate, subpentagonal, flatly convex, inequilateral, with submedian and posterior angle, with distant concentric lamellae, and a submedian and posterior ridge, angulating the concentric lamellae. *Beaks* approximate, very little raised, incurved and directed forwards, with an

Fig. 1.

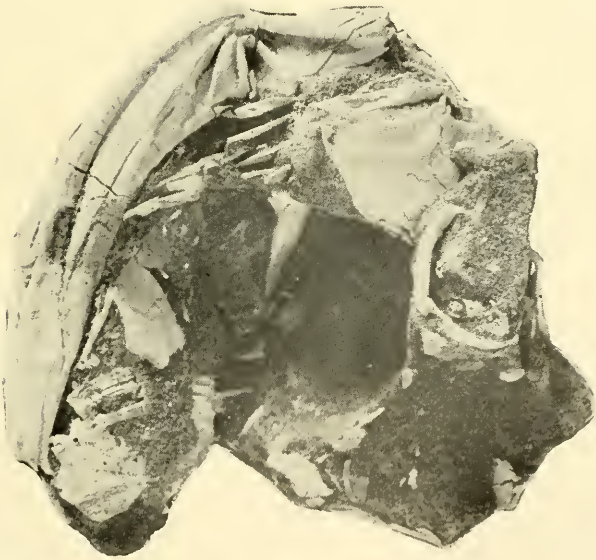


Fig. 2.

Chione (Lirophora) speighti *Suter*.

anterior and posterior angle. *Anterior end* short, not quite one-fifth of the total length, convex, the dorsal margin descending, concave; *posterior end* very distinctly truncated, the dorsal margin convex; *basal margin* broadly convex, with an angle behind the middle and on meeting the posterior truncation. *Lunule* narrow and long. *Escutcheon* depressed, long and narrow. *Sculpture* consisting of distant (about 10 on adult shells), thin, erect, inequidistant concentric laminae, sharply raised posteriorly and at the intersection of the submedian and posterior ridge; interspaces with fine growth-lines and traces of fine radiate striae. *Margins* finely crenulate. *Left valve* with a subvertical, long and narrow cardinal; the median tooth stout, triangular, bifid; the posterior cardinal nearly horizontal, long and thin.

Length, 61 mm.; height, 54 mm.; diameter, 12 mm. (× 2) (holotype).

Holotypes (2) and *paratypes* (5) in the Canterbury Museum, Christchurch.

Locality.—Lower gorge of Waipara, lower horizon (R. Speight). Miocene.

Remarks.—This species is very nearly allied to the Pliocene and Recent *Chione yatei* Gray. Small specimens of *C. speighti* are also in the collection of the Geological Survey, from the Miocene of the lower part of the Pareora River (Enys coll.); loc. 458. *C. yatei* is most likely the descendant of *C. speighti*. The species is named in honour of Mr. R. Speight, Geologist at the Canterbury Museum.

ART. XXXVI.—*Some Localities for Fossils at Oamaru.*

By P. MARSHALL, M.A., D.Sc., Professor of Geology, Otago University, and G. H. UTTLEY, M.A., M.Sc., Waitaki High School.

[*Read before the Otago Institute, 3rd December, 1912.*]

THE district of Oamaru has attracted attention ever since geological observations have been made in New Zealand. Mantell,* probably the first qualified geologist to visit the South Island, gave a general description of the district in 1850. In this description he names several fossils that were found in the Ototara limestone, one of the most important strata that occur in the district.

More recently McKay, whilst engaged in the geological survey of New Zealand, paid several visits to the region, and the results that he obtained are embodied in the reports of the Geological Survey, a list of which will be found at the end of this paper. So important was Oamaru considered by Captain Hutton that he established the district as the typical locality of his Oamaru system, then considered by him to be the equivalent of the Lower Miocene of Europe.† At the same time he classed the upper strata at Oamaru in a distinct system, called by him the Pareora system, and considered equivalent to the Upper Miocene. In 1885 he still held in general to this division, but he then correlated the Oamaru system with the Oligocene.‡

* Q.J.G.S., vol. 6, 1850, pp. 319 *et seq.*
† "Geology of Otago and Southland," p. 46. Dunedin, 1875.
‡ Q.J.G.S., vol. 41, p. 194.

Hector* included the lower rocks of Hutton's Oamaru system in his Cretaceo-tertiary division. Some of the higher strata he placed in the Upper Eocene, and a few of the highest in the Lower Miocene.

Park† has lately placed the whole of the Oamaru beds in the Miocene.

Marshall, Speight, and Cotton‡ have lately stated that the Oamaru rocks represent a portion of a conformable series extending in age from the early Cretaceous to the late Miocene. This view has also been put forward by Marshall in the "Regional Geology"§ and in the "Geology of New Zealand."||

This general statement of the various opinions that have been expressed in regard to the age of the Oamaru rocks shows that despite their generally fossiliferous nature and the clear character of their stratigraphy it is still possible to interpret the facts in terms that are widely different, if not, indeed, wholly opposed to one another. It is evident that in such a district, where there are few or no difficulties in interpreting the stratigraphy in the field, actual observations may be relied on for definitely determining the true relations of the strata. There has, however, been a tendency to neglect the clear and *per se* unmistakable field evidence, as it has been held that the fossil remains found in the various members of the series of rocks in the district are of such a nature as to indicate that different geological periods are represented by them. Such opinions have caused some observers to break up the series into integral portions, and to endeavour to find structures in the field that might support the conclusions that were derived from palaeontological work. It is not the intention of the present authors to quote and discuss the statements that have been made in regard to the evidence offered by field-work in favour of stratigraphical breaks in the rock-series. Some reference has already been made to this aspect of the subject in the paper by Marshall, Speight, and Cotton on the younger rock-series of New Zealand. It need only be remarked here that those who have split up the series into different geological periods show few points of agreement among themselves.

It is believed by the present authors that the difficulties which have presented themselves from the palaeontological standpoint have resulted from a failure to recognize the full significance and effect of a relatively rapid movement of depression during the deposition of the sediments. The succession of the material from conglomerate through sands, greensands to limestone shows that the effect of depression in deepening the water was far more important than the effect of deposition in shallowing it. The natural result of this was to cause a great overlap of the upper strata over the lower, a rapid lateral change in the nature of the strata, and a complete change of biological station at various points along a single vertical line. The effects of such important influences as these must be clearly sorted out before any reliance can be placed upon conclusions derived from the collection of fossils.

Finally, the collections of fossils have been most incomplete, and in some cases it appears that identifications have been most unsatisfactory. The failure to identify fossils with accuracy could only be expected, for hitherto the nomenclature and synonymy have been most perplexing.

* "Handbook of New Zealand Geology," pp. 51–59.

† "Geology of New Zealand," p. 113. Whitcombe and Tombs, Christchurch, N.Z., 1911.

‡ Trans. N.Z. Inst., vol. 43, 1911, p. 393.

§ "Regional Geology," 1911, band 7, i, pp. 22–23. Carl Winter, Heidelberg.

|| "Geology of New Zealand," p. 188. Government Printer, 1912.

It is only now that the labours of Mr. H. Suter, to whom the authors are most deeply indebted, are rendering complete identification possible.

An attempt has been made by the authors to collect as fully as possible from some definite horizon in the district, with the object of finding out exactly what species are associated together in the more fossiliferous beds. The results so far obtained are somewhat surprising, and they show at least that previous collecting has been far from complete, and that generalizations based upon them are far from convincing.

Collections have been made from four different localities. One of these—the banks of the Awamoa Stream (fig. 1)—is very well known, and has yielded fossils to several collectors. A second locality—the road-cutting near Pukeuri—has had collections made from it previously, but they have been far from exhaustive. The other two localities have not previously been described: we have called them respectively Target Gully and Ardgowan (fig. 1).

Awamoa Beds.

All who have collected from these are generally agreed that the horizon is distinctly younger Tertiary. They were placed in the Lower Miocene by Hector, in the Pareora or Miocene by Hutton, and in the Miocene by Park. There is thus a very substantial agreement as to the age of these beds.

Hutton, in the "Geology of Otago" (p. 59), gives a list of fossils which he found in the Awamoa beds, which he places in his Pareora system, of Miocene age. McKay, in the "Reports of Geological Explorations, 1876–77," states, on page 48, that a considerable collection of fossils was made from these beds, but he does not give the names of these fossils. In the Reports for 1883–84, on page 64, he states that the Awamoa beds, of Miocene age, succeed the Upper Eocene quite comformably; but again he gives no list of fossils from the Awamoa beds.

Park, in Trans. N.Z. Inst., vol. 37, p. 512, states that the Awamoa beds belong to the same formation as the greensands on which they rest at the rifle butts, as there is in that place a complete conformity between them. These greensands are his equivalents of the Upper Eocene of McKay. Park classes both beds in the Miocene.

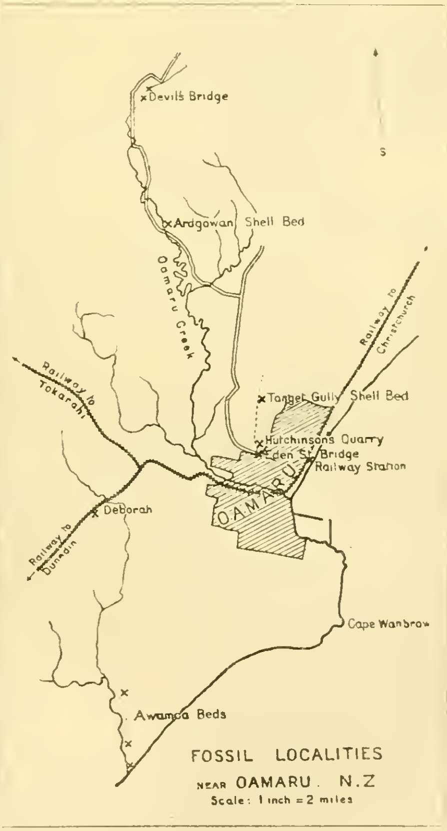


Fig. 1.

The beds are lithologically somewhat sandy blue clays, often containing a little glauconite. They are well exposed in the bed of the creek, between a quarter and half a mile from the beach. The strata are dipping about 3 degrees to the east. Their actual stratigraphical position is not clear in the stream itself, or on its banks, but it is generally admitted that at the rifle butts, a mile and a half distant, they rest conformably on the greensands which Park probably rightly correlates with the Hutchinson Quarry beds—that is, the Upper Eocene of McKay. These greensands rest conformably on the limestone, though Park differs slightly from the last opinion, and maintains that the beds in reality lie between two limestones, the upper of which is not represented in this section, but, if present, would overlie the Awamoa beds. We have failed to see any evidence of this in the district. A collection of fossils was made with considerable care from the Awamoa beds during several days, but it does not pretend to be exhaustive at present. Nearly all the identifications have been made by Mr. H. Suter.

Emarginula striata Q. & G.
Trochus tiaratus Q. & G.
Cerithidea n. sp.
Turritella rosca Q. & G.
,, *carlottae* Watson.
,, *concava* Hutton.
Struthiolaria cincta Hutton.
Calyptraea maculata Q. & G.
,, *alta* Hutton.
Crepidula crepidula L.
,, *costata* Sowerby.
,, *gregaria* Sowerby.
Natica zelandica Q. & G.
Polinices huttoni Ihering.
,, *ovatus* var. *imperforatus* Suter.
,, *suturalis* Hutton.
Ampullina undulata Hutton.
,, *drewi* Murdoch.
Cypraea n. sp.
Cymatium cfr. *minimus* Hutton.
Phalium achatinum pyrum Lam.
Epitonium browni Zittel.
Vexillum linctum Hutton.
Siphonalia dilatata Q. & G.
,, *costata* Hutton.
Cominella huttoni Kobelt.
Murex octogonus Q. & G.
Typhis maccoyi T.-Woods = *T. hebetatus* Hutton.
Galeodea muricata Hector.
Lapparia corrugata Hutton.
Ancilla pseudaustralis Tate.
Ancilla bicolorata Gray.
Hemiconus traílli Hutton.
Marginella harrisi Cossmann = *M. ovata* Harris.
,, *conica* Harris.
Drillia fusiformis Hutton.
,, sp.
Turris altus Harris.
Daphnella n. sp.
,, n. sp.
Terebra tristis Deshayes.
Dentalium mantelli Hutton.
,, *giganteum* Hutton.
Nucula hartvigiana Phil.
Malletia australis Q. & G.
Placunanomia incisura Hutton.
Arca decussata Sowerby.
,, *(Cucullaria) australis* Hutton.
Glycimeris globosa Hutton.
Pseudamusium huttoni Park.
Cucullaea alta Sowerby.
,, var. B Sowerby.
Corbula kaiparaensis Suter.
Lima colorata Hutton.
Venericardia australis Lam.
,, cfr. *inaequalis* Phil
Ostraca sp.
Crassatellites obesus A. Ad.
,, *traílli* Hutton.
,, *attenuatus* Hutton.
Limopsis aurita Brocchi.
Macrocallista assimilis Hutton.
,, *multistriata* Sowerby.

Hutton, in the "Geology of Otago," 1875, and in the Trans. Linn. Soc. N.S.W., mentions fifty-seven species, almost the same number as in this list, but only twenty-two are identical, even when allowance is made for synonyms. It is probable that his Awamoa list included specimens from other localities near Oamaru, for he states that the formation extends along the east side of the low hills that extend behind Oamaru as far north as the Waitaki Valley. Park (Trans. N.Z. Inst., vol. 37, p. 512) names twenty-eight species, but of these, even allowing for synonyms, only ten occur in our list.

It is remarkable that neither Hutton nor Park mention *Cucullaea,* for we found it in considerable numbers, and it is always conspicuous. We found that the following were the most abundant : *Lima colorata, Cucullaea alta, Marginella harrisi, Venericardia inaequalis, Malletia australis,* and *Turritella rosea.*

TARGET GULLY. (Fig. 1.)

This shell-bed is situated half a mile along a small gully that extends north from Eden Street directly after it crosses the bridge (fig. 2). Hutchinson's Quarry is at the entrance of this gully. The order of succession is—Target Gully shell-bed, Hutchinson's Quarry beds, calcareous tuffs. Though no continuous section is exposed, the field relations are

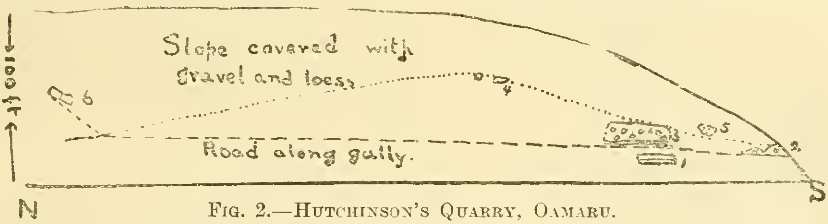


FIG. 2.—HUTCHINSON'S QUARRY, OAMARU.
(Scale : 4 in. = half a mile.)

1. Calcareous tuffs. 2, 3, 4. Volcanic breccias. 5. Greensands, Hutchinson's Quarry beds. 6. Target Gully shell-beds.

clear, and we have no doubt that the three beds are conformable. It appears that the Target Gully beds have escaped notice hitherto, for we can find no reference to them by McKay or Hutton, and Park states that there is nothing in the neighbourhood of the Hutchinson's Quarry beds to indicate their age.

The bed from which our collection has been made is about half-way up the east side of the gully, about 50 ft. above sea-level. One hundred yards distant the calcareous tuffs crop out, about 25 ft. lower. The bed is mainly composed of drifted shells, of which many are broken. They are contained in grey sand, weathering orange from the oxidation of the iron contained in the glauconite, which occurs in the sand in some quantity. The shell-bed is 4 ft. thick, and is 8 ft. long in the exposed portion. From this limited exposure sixty-nine species of *Mollusca* have been identified at present. There are, in addition, several small species that we have not been able to identify, and we hope to give a more complete list next year.

Trochus tiaratus Q. & G.
Turritella carlottae Watson.
,, *concava* Hutton.
,, *rosea* Q. & G.
Struthiolaria papulosa Martyn.
Calyptraea maculata Q. & G.
,, *alta* Hutton.
,, sp.
Crepidula crepidula L.
,, *unguiformis* Lam.
,, *costata* Sowerby.
,, *incurva* Zittel.
Siphonalia nodosa Martyn.
,, *dilatata* Q. & G.
,, *costata* Hutton.
Cominella maculata Martyn.

Cominella lurida Phil.
Murex octogonus Q. & G.
Trophon cfr. *plebeius* Hutton.
,, *paivae* Crosse.
Typhis maccoyi T.-Woods.
Alectrion socialis Hutton.
Latirus brevirostris Hutton.
Fulguraria arabica Martyn.
Lapparia corrugata Hutton.
Ancilla pseudaustralis Tate.
,, *bicolorata* Gray.
Marginella harrisi Cossman.
Drillia fusiformis Hutton.
,, sp.
Genota robusta Hutton.
Terebra tristis Deshayes.
Cylichnella striata Hutton.
,, *enysi* Hutton.
Dentalium mantelli Hutton.
,, *conicum* Hutton.
Nucula hartvigiana Phil.
Malletia australis Q. & G.
Placunanomia incisura Hutton.
Anomia huttoni Suter.
Arca decussata Sowerby.
,, *australis* Hutton.
,, n. sp.
Limopsis zitteli Ihering.
Glycimeris laticostata Q. & G.
,, *globosa* Hutton.
,, sp.
Modiolus australis Gray.
Pecten burnetti Hutton.
Pseudamusium huttoni Park.
Lima colorata Hutton.
Ostraea angasi Sowerby.
,, *nelsoniana* Zittel.
Crassatellites obesus A. Ad.
,, *trailli* Hutton.
,, *attenuatus* Hutton.
Venericardia difficilis Deshayes.
,, cfr. *patagonica* Ihering.
Diplodonta globularis Lam.
Tellina glabrella Deshayes.
Zenatia acinaces Q. & G.
Dosinia magna Hutton.
Macrocallista multistriata Sowerby.
Chione meridionalis Sowerby.
,, *crebra* Hutton.
,, *yatei* Gray.
Psammobia lineolata Gray.
Corbula pumila Hutton.
Panopaea sp.
Cucullaea alta Sowerby.

Ardgowan.

No systematic collection appears to have been made from the locality near Ardgowan (fig. 1). It possibly corresponds with a locality mentioned by McKay in Geological Reports, 1881, p. 122, "Index of Fossiliferous Localities," No. 175.

Stratigraphically, there is no definite rock-succession exposed in the immediate neighbourhood of the shell-beds. At the Devil's Bridge, one mile distant, it is evident that the dip of the beds there would carry them not far below the Ardgowan exposure. The equivalents of the Hutchinson's Quarry beds and the calcareous tuffs also outcrop about one mile to the east in a manner that supports this conclusion. Lithologically the shells and shell-fragments are embedded in a loose grey sand with some glauconite; in fact, the beds are almost exactly similar to the Target Gully beds, and they appear to belong to the same horizon.

The following species of *Mollusca* were obtained there:—

Trochus tiaratus Q. & G.
Turritella rosea Q. & G.
,, *cavershamensis* Harris.
Struthiolaria tuberculata Hutton.
Calyptraea maculata Q. & G.
,, *inflata* Hutton.
Crepidula crepidula L.
,, *costata* Sowerby.
Natica zelandica Q. & G.
Polinices suturalis Hutton.
Cymatium cfr. *minimus* Hutton.
Epitonium browni Hutton.
Surcula fusiformis Hutton.
Turris altus Harris.
Fusinus spiralis A. Ad.
Latirus brevirostris Hutton.

Siphonalia dilatata Q. & G.
Murex octogonus Q. & G.
Terebra tristis Deshayes.
Alectrion socialis Hutton.
,, sp.
Typhis maccoyi T.-Woods.
Trophon paivae Crosse.
Fulguraria arabica Martyn.
,, *gracilis* Swainson.
Lapparia corrugata Hutton.
Mitra enysi Hutton.
Ancilla pseudaustralis Tate.
,, *bicolorata* Gray.
Hemiconus trailli Hutton.
Drillia sp.
Mangilia sinclairi E. A. Smith.
Cylichnella striata Hutton.
Dentalium giganteum Hutton.
,, *mantelli* Hutton.
Nucula hartvigiana Phil.
Malletia australis Q. & G.
Placunanomia incisura Hutton.
Glycimeris globosa Hutton.
Pecten zelandiae Gray.
Pseudamusium huttoni Park.
Lima colorata Hutton.
Crassatellites obesus A. Ad.
,, *trailli* Hutton.
,, *attenuatus* Hutton.
Venericardia australis Lam.
,, *difficilis* Deshayes.
Diplodonta globularis Lam.
Limopsis zitteli Ihering.
Zenatia acinaces Q. & G.
Dosinia magna Hutton.
Macrocallista assimilis Hutton.
Corbula pumila Hutton.
Panopaea orbita Hutton.

PUKEURI.

Park* appears to have been the first to collect from the beds at Pukeuri. He gives a list of eighteen fossils, and states that their nature is such as to indicate that the beds are lower than the Oamaru stone, but that the actual stratigraphic relations are obscured by drift. We find that less than a mile along the main road in the Waitaki Valley the limestone is dipping in such a manner as to carry it below the Pukeuri beds. The sandy, slightly glauconitic, character of the beds, as well as their fossil-contents, in our opinion support the conclusion that the beds exposed in the Pukeuri cutting are above the limestone.

We found the following fossils at Pukeuri :—

Trochus tiaratus Q. & G.
Turritella rosea Q. & G.
,, *carlottae* Watson.
Struthiolaria tuberculata Hutton.
Calyptraea maculata Q. & G.
Natica zelandica Q. & G.
Polinices ovatus Hutton.
Cymatium cfr. *minimus* Hutton.
Vexillum linctum Hutton.
Siphonalia dilatata Q. & G.
Cominella huttoni Kobelt.
Alectrion socialis Hutton.
Hemiconus trailli Hutton.
Turris altus Harris
Fulguraria arabica Martyn.
Marginella harrisi Cossman.
,, *dubia* Hutton.
Surcula fusiformis Hutton.
Drillia sp.
Cylichnella striata Hutton.
Dentalium opacum Sowerby.
Nucula hartvigiana Phil.
Malletia australis Q. & G.
Placunanomia incisura Hutton.
Cucullaea alta Sowerby.
Limopsis aurita Brocchi.
Pecten fischeri Zittel.
Pseudamusium huttoni Park.
Lima colorata Hutton.
Crassatellites obesus A. Ad.
,, *trailli* Hutton.
Venericardia difficilis Deshayes.
,, *australis* Lam.
Macrocallista assimilis Hutton.
Chione meridionalis Sowerby.
Corbula pumila Hutton.

* Trans. N.Z. Inst., vol. 37, p. 519.

Devil's Bridge.

Park appears to be the only geologist who has collected in this locality. The reading of the stratigraphy as given by him is wholly different from that observed by the authors. At the lower end of the small gorge the

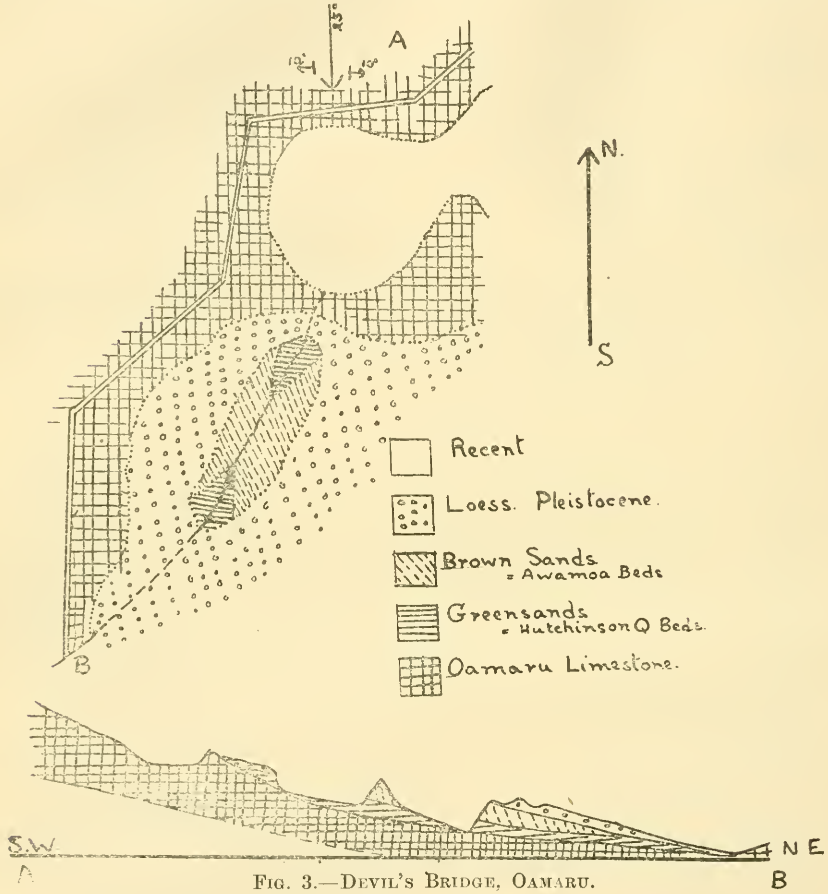


Fig. 3.—Devil's Bridge, Oamaru.

(Scale: 5 in. = half a mile.)

greensands are clearly lying on the limestone, and the greensands are succeeded by brown and yellow sands, in which we found the following fossils :—

Trochus tiaratus Q. & G.
Turritella rosea Q. & G.
Calyptraea maculata Q. & G.
Natica zelandica Q. & G.
Cymatium cfr. *minimus* Hutton.
Crepidula costata Sowerby.
Siphonalia nodosa Martyn.
Fulguraria gracilis Swainson.
Ancilla bicolorata Gray.
Alectrion socialis Hutton.
Dentalium mantelli Hutton.
Nucula hartvigiana Phil.
Malletia australis Q. & G.
Pecten beethami Hutton.
Pseudamusium huttoni Park.
Crassatellites obesus A. Ad.
,, *traill*i Hutton.
Venericardia difficilis Deshayes.
,, *australis* Lam.
Limopsis aurita Lam.
Lima colorata Hutton.
Macrocallista assimilis Hutton.
Zenatia acinaces Q. & G.

Fossils are not so plentiful here as in the other localities mentioned, but the collection is probably far from complete.

It will probably be evident from the statements made that in the opinion of the authors, based on stratigraphical evidence, all the fossiliferous beds referred to above actually belong to the same horizon, or, at any rate, that they are separated by quite small thicknesses of sediment. This conclusion is borne out by the identifications of the fossils. At the same time, attention must be drawn to certain differences between the fossils found in the different localities. It is noticeable that species that are extremely common in one locality may be rare or even absent from the others. Thus, *Venericardia* is abundant everywhere except at the Devil's Bridge, where it is quite unusual; *Terebra tristis* is abundant at the Target Gully; *Cucullaea* we did not find at the Devil's Bridge, but it occurs at each of the other localities; *Malletia australis* is fairly common in every locality; *Crassatellites traill*, *Drillia fusiformis*, and *Dentalium mantelli* were found in each place, as well as *Lima colorata*, but the last is far more abundant at Awamoa than elsewhere; *Turritella* is abundant on every collecting-ground, but the species show considerable differences.

Whilst the general affinities of the fossils of each locality from which collections have been made are quite pronounced, there are, on the other hand, considerable differences between the collections. These differences are certainly in part due to the incomplete nature of the collections, but they must also, in part at least, be due to the different conditions that existed during the deposition of the deposits. Such differences are certainly indicated by the nature of the sediments. At Target Gully and at Ardgowan the deposits are formed of shells and shell-fragments that drifted along the sea-floor, mixed with a small quantity of glauconite. At Awamoa the fine character of the sediment shows that there was practically no current-action. At Pukeuri and at the Devil's Bridge the stratification of the sands is quite regular: there can have been little current-action, and yet the water was comparatively shallow.

The greatest importance of our lists of fossils is seen when comparison is made with those that have been quoted by other authors. Such comparison is, however, rather difficult, because the veil of synonymy can only be partly lifted at the present time—that is, until Mr. Suter's revised list of the New Zealand *Mollusca* is published, and also his catalogue of Tertiary fossils.

If comparison is made with the lists published in 1886 by Hutton, it will be found that about seventy of the species found by us are mentioned. Of these, about sixty are said to be restricted to his Pareora (Upper Miocene) system, and two only to his Oamaru (Oligocene) system, and fifteen are common to both. This result loses much of its force in suggesting an actual distinction between his systems when it is recalled that he lists 184 Pareora species that do not occur in his Oamaru system, and only thirty-three Oamaru species that do not occur in his Pareora system, and that the latter species occur largely in the limestone rocks, which, having been deposited in much deeper water, necessarily contain fossils that are decidedly different from the species contained in the shallower-water sandstones.

Park's zonal fossils of his Waihao beds—the lowest division of his Miocene—are two in number, *Lapparia parki* and *Pleurotoma hamiltoni*. The former is now stated by Suter to be synonymous with *L. corrugata*, which occurs in nearly all the localities from which we have collected. He afterwards states that *L. corrugata* does not occur outside of his Awatere system, of older Pliocene age. Such "zonal" fossils are obviously of no importance, for the other species is at the present time represented by a single specimen only.

Of Park's list of twenty-three Waihao species, as many as sixteen species occur in the lists that we have given. In the middle division of his Miocene there are twenty-four species of *Mollusca* given as most distinctive: thirteen of these are given in our lists. Finally, twenty-nine are given as most abundant in the upper division of his Miocene, and some twenty-three of these were recognized by us. This list of twenty-nine represents in all but two the species that he found at Awamoa, so the percentage of them that would be expected to be found in our lists would necessarily be high.

It appears, then, that the horizon from which we have collected—viz., that immediately above the Hutchinson's Quarry greensands—corresponds palaeontologically almost equally with any of his three Miocene horizons. Finally, Park gives a list of ten species which he says never occur above the Ototara-Waitaki stone. Of these, all except one species are in our lists. In each of our localities the beds lie above the limestone, of which we believe that there is but one horizon. At the Devil's Bridge the fossil horizon obviously rests above the limestone, in that locality called by Park the Waitaki or Upper limestone. The same position cannot be questioned for the Ardgowan beds, and in our opinion the beds at Awamoa, Pukeuri, and Target Gully obviously have the same position.

The actual age of these beds is very difficult to state. Until Mr. Suter's revision of the *Mollusca* appears we are not able to say how many of the species are Recent, but we are able to assert that it is not less than 40 per cent., and that it may be as much as 50 per cent. Our lists include seven species—*Trochus tiaratus*, *Ampullina undulata*, *Phalium achatinum pyrum*, *Murex octogonus*, *Trophon plebeius*, *Trophon paivae*, and *Tellina glabrella*—which have never been found below Pliocene rocks previously, and six of these species are Recent. There are some eight new species that we hope that Mr. Suter will describe in the future. One genus—*Cypraea*—has not previously been known to have representatives in New Zealand, though Mr. Suter now states in MSS. that Hutton's *Volvaria ficoides* should be placed in that genus.

A comparison between these beds and those of the Mount Brown horizon of the Lower Waipara described by Speight* is interesting. In the Waipara beds *Mactra*, *Glycimeris*, and *Natica* are extremely common, but *Limopsis* is absent and *Cucullaea* is most unusual. However, in this locality the most fossiliferous beds appear to be about 1,000 ft. above the limestone, and therefore the fossils in all probability represent a higher horizon than the one from which we have collected.

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[The abbreviations used are: T.N.Z.I., Transactions of the New Zealand Institute; Rep. G.S., Reports of the Geological Survey of New Zealand; Q.J.G.S., Quarterly Journal of the Geological Society.]

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Art. XXXVII.—*On the Igneous Intrusions of Mount Tapuaenuka, Marlborough.*

By James Allan Thomson, M.A., D.Sc., F.G.S., Palaeontologist to the Geological Survey of New Zealand.

(By permission of the Director of the Geological Survey.)

[*Read before the Wellington Philosophical Society, 23rd October, 1912.*]

Introduction.

Mount Tapuaenuka,* the highest point of the Inward Kaikoura Range, has long been known to be intersected by numerous igneous intrusions. The aim of this paper is to give a preliminary petrographical account of some of these. The material studied consists of a series of rock-specimens obtained from boulders in the gorge of the River Dee, Middle Clarence Valley, by Mr. C. A. Cotton and the writer in the early part of 1912. The Dee is a mountain-torrent rising in enormous screes on the abrupt slopes of Tapuaenuka, from which it carries in flood-time boulders of very large size. In its bed there is little to be found but crystalline rocks of varying textures and colours, and there is no reason to doubt that these rocks come from within the watershed of the torrent. Care was taken to confine the collection to the upper part of the gorge, above the intersection of the "Post-Miocene conglomerate," in order that possible exotic rocks should be excluded.

Our knowledge of the structure of the Inward Kaikouras is due almost entirely to the labours of A. McKay, who traversed the Middle Clarence Valley in 1884–85, and the Awatere Valley in 1888–89. The three lengthy reports in which he embodied his results are full of details of stratigraphical and structural geology of the highest interest, and will probably long remain the chief source of information on the geology of Marlborough.† Only those parts which relate to the intrusions need be noticed here.

The Inward Kaikoura Range is composed of sandstones, grits, greywackes, argillites, and jasperoid slates of uncertain age, but Jurassic or Lower Cretaceous at the latest. McKay placed them in the Maitai series, of Carboniferous age, with a saving clause that the only evidence obtained indicates a Secondary age. On each side the range is bounded by Upper Cretaceous and Tertiary rocks, let down along tremendous faults. On the Clarence Valley side the Lower Tertiary rocks are covered uncomformably by the "Post-Miocene conglomerate," which is interposed between them and the fault-plane.

Volcanic rocks of Cretaceous age occur in the Clarence Valley, opposite the Bluff River and in the Gore River, but below Tapuaenuka they are absent, and dykes through the Cretaceous and Tertiary rocks are rare. A greater development of Cretaceous volcanic rocks is found in the Awatere Valley, and these are seamed by dense dykes, which pass uninterruptedly into the greywacke series, and run almost to the top of the range.

* Also spelt Tapuaenuku.

† "On the Geology of the Eastern Part of Marlborough Provincial District." Rep. Geol. Expl., vol. 17, pp. 27–136; 1886.

"On the Geology of Marlborough and the Amuri District of Nelson," Rep. Geol. Expl., vol. 20, pp. 85–185; 1890.

"On the Geology of Marlborough and South-east Nelson, Part II," Rep. Geol. Expl., vol. 21, pp. 1–28; 1892.

Innumerable dykes, forming a perfect network, traverse the older rocks in the upper part of the watersheds of the Branch, Dart, and Muzzle Rivers, Clarence Valley, and trend north to the top of the Inward Kaikoura Range into the watersheds of the Dee and Mead Rivers. The rocks are described as green porphyritic rock, light-grey elvan rock, hornblende rock, fine-grained basaltic rock, &c. It is, doubtless, from these dykes that the specimens studied were derived. There is a great development of similar

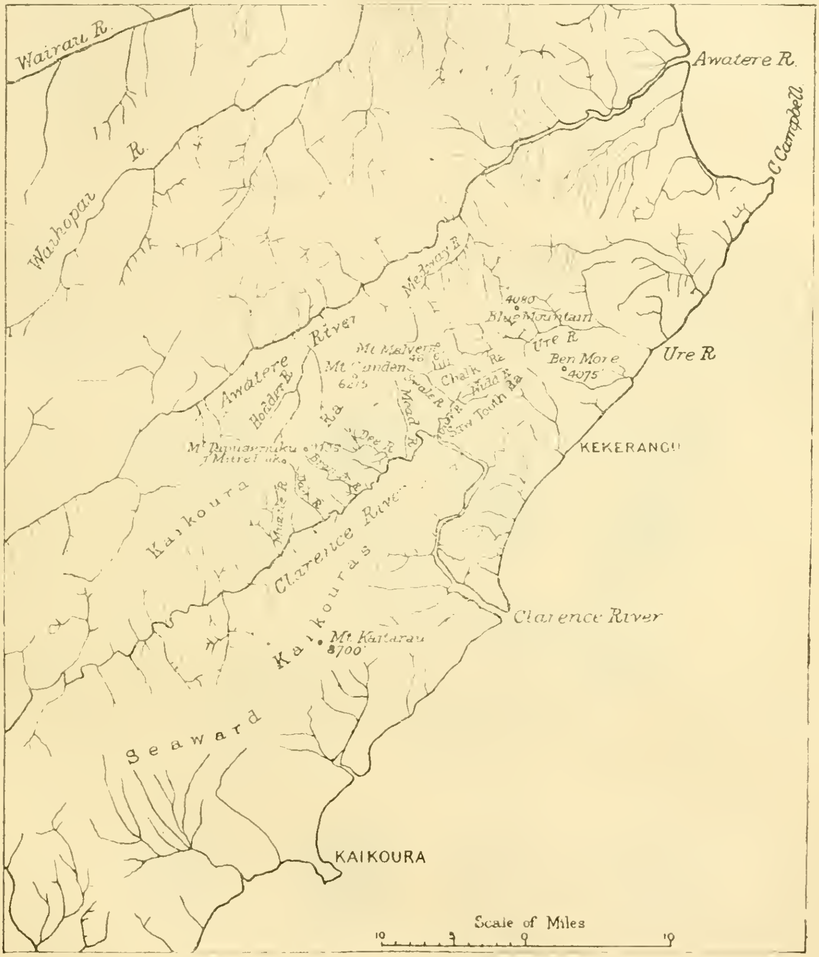

Fig. 1.—Locality Map.

dykes on the Awatere side of the range. McKay considers that these dykes belong to a series older than those intersecting the Cretaceous rocks, since the basal Cretaceous conglomerates contain pebbles of similar character. The pre-Cretaceous dykes he again divides into two series, relying on the fact that the darker and denser dykes usually intersect the lighter syenitic intrusions.

The rocks described in this paper consist apparently of the pre-Cretaceous series of McKay. There is such an *air de famille* about the whole collection as to suggest that they all belong to one series of intrusions. Naturally, if this is the case, a considerable amount of intersection is to be expected, and the district is evidently a favourable one for determining the sequence of intrusions. As to their absolute age, nothing may be certainly stated; until the boulders in the Cretaceous conglomerates are examined and shown to be similar, it is unsafe to affirm that the dykes are pre-Cretaceous. The petrographical character of the Cretaceous volcanics in the Awatere and Clarence Valleys is as yet unknown, and it seems possible that the coarser rocks that form dykes in Tapuaenuka are intrusions from the same magma that poured out the lavas and the dense dykes intersecting them. In this connection it must be remembered that considerable differential elevation has taken place since Cretaceous times, and that in all probability there was then a continuous sea from the Clarence to the Awatere Valley, over the present site of Mount Tapuaenuka.

DESCRIPTION OF THE SPECIMENS.

Minerals.

As the nature of the minerals is similar in many of the specimens, it will be convenient to notice them first.

The *olivine* is a clear variety, with an axial angle approaching 90°. It is penetrated by the usual cracks, along which opaque iron-ores have segregated, and shows in addition a fairly well-developed schiller structure, due

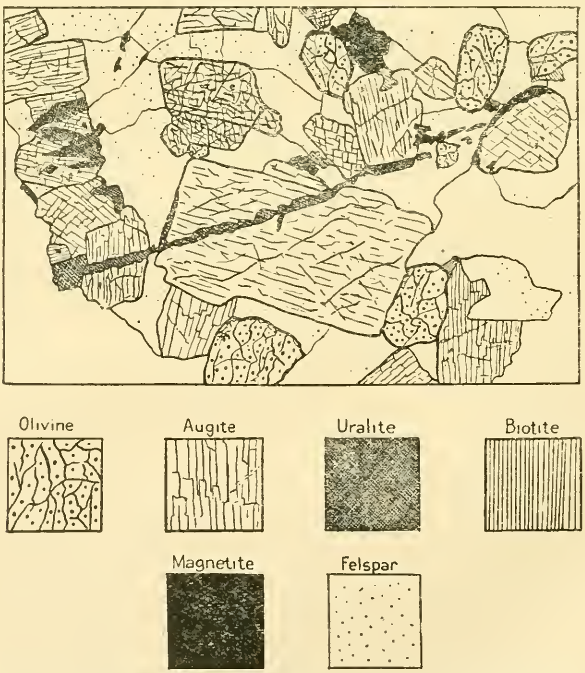

Fig. 2.—Olivine-biotite-dolerite crossed by a shear-zone along which uralite has developed from the augite. Magnified 5 diameters.

to the enclosure of arborescent crystallites of opaque material along vertical planes of the crystals. The commonest alteration is into a tangled mass of talc scales, with occasional prisms of tremolite. This may be termed pilite, in accordance with current practice, although the original pilite of Becke was a mixture of chlorite and tremolite after olivine. Another mode of alteration is into iddingsite, which can be easily distinguished from the biotite present in the rocks by its greener colours, poorer pleochroism and cleavage, and less-regular birefringence. It frequently retains the schiller structure of the olivine. Serpentinous alteration has not been observed in any of the rocks.

The *augite* is a pale lilac-brown titaniferous variety, and frequently exhibits zoning characterized by varying intensity of colour. It has a dispersion so strong that many sections do not yield complete extinction. The axial angle is moderate, the mineral being optically positive. The commonest alteration is to a bright-green uralite both around the edges and along shear-zones (see fig. 2). In many of the rocks the former presence of augite is inferred from the inclusion of greenish or colourless amphibole within brown hornblende.

Amphiboles of various colours and habits are present in most of the rocks. Original common brown hornblende is very common. In the basic dolerites it occurs in subordinate quantity, mostly on the exteriors of augite crystals, and is generally in parallel crystallographic position to them. Sometimes it is intergrown marginally with the augite; at other times it appears to result from a partial magmatic resorption of that mineral. In the rocks with lamprophyric affinities it forms independent crystals or encloses only relatively small cores of augite, and in the spessartites forms also elongate prisms of a second generation. In the acid rocks the original hornblende is a green variety with brown tones. Green hornblende, more or less fibrous, is common as uralite. In many cases the original crystals of brown hornblende contain outgrowths of massive green hornblende which must be interpreted as migrated uralitic material from the augites undergoing that change. As before mentioned, tremolite is found along with talc in pseudomorphs after olivine.

A strongly pleochroic *biotite* is common in most of the rocks, but is sometimes absent. In the dolerites it is usually subordinate to the olivine and augite, and is clustered around these minerals and the iron-ores. Very beautiful intergrowths with augite occur, and in one case a triple intergrowth of augite, biotite, and brown hornblende was observed. The relative abundance of biotite in the basic rocks points to a higher potash-percentage than in normal dolerites.

The *iron-ores* appear to belong to magnetite in all the rock types, and may often be seen by their decomposition-products to be titaniferous. In the doleritic rocks they form large allotriomorphic masses, being moulded on the other minerals; they are seldom decomposed, and show no traces of the rhombohedral structure of ilmenite in reflected light. In the lamprophyric rocks they form small idiomorphic octohedra, and are often altered in part to a white leucoxenic product. Alteration to limonite is also not uncommon. Pyrite is very abundant in all the rocks, and is generally present as a replacement of the magnetite.

The *feldspars* consist of plagioclase in the basic and subbasic rocks, and of potash-feldspars and plagioclase in the acid rocks. The species of plagioclase ranges from bytownite in the most basic dolerites to albite in some of the rocks with lamprophyric affinities. The basic feldspars are generally clear, but the more acid plagioclase and potash-feldspar are extensively sericitized, so that identification is sometimes impossible. In the granites a microperthite forms the dominant feldspar, but owing to its state of alteration the nature of its components has not been determined.

In the identification of the species of plagioclase the methods advocated by Flett and Dewey* have been used for the determination of albite, and extended for the determination of bytownite. These writers point out that the use of extinction angles is not always satisfactory, but that a feldspar with indices less than that of balsam, and with optically positive sign, must be albite or oligoclase-albite. Similarly a feldspar showing symmetrical extinction angles as high as 34° in albite lamellae (and therefore as basic as labradorite), if it is also optically negative, must be as basic as bytownite. The optical sign is determined by the Becke method (observation of the effect obtained by introducing a gypsum plate at 45° to the nicols when studying the interference figure).

The use of the Becke effect (displacement of the halo into the medium of lesser refractive index when focussing downwards) is considerably minimized by the method of preparation commonly used in New Zealand—viz., the use of an adhesive made of a mixture of Canada balsam and shellac, and of liquid Canada balsam for the cover-glass. The drying-off of the covering balsam is seldom carried so far as is the custom in slides made purely with Canada balsam, and consequently the usual data for the refractive index of the dried balsam cannot be used in the few cases where, owing to breaks in the cement, the balsam touches the minerals at the side as well as above. The index of the cement is equally unknown, and must be variable, unless the proportions of shellac and balsam and the period of heating are constant. The advantages of the cement seem thus to be outweighed by its disadvantages, for the use of pure balsam furnishes one of the most delicate methods of distinguishing certain species of plagioclase. The chief advantage of the cement is the ease of mounting, or, rather, the obviation of the necessity of learning by repeated failures the exact amount of cooking necessary to produce the best result with balsam. A good lapidary, however, will work just as quickly with the pure balsam as with a cement.

In the slides used in writing this paper the index of the cement was always appreciably greater than that of the (partially baked) balsam, and less, in all cases where it could be observed, than those of quartz.

The *secondary minerals*, other than those mentioned above, call for little mention. Epidote forms conspicuous nests in some of the hand-specimens of the lamprophyric rocks, but is not markedly abundant in the slides. Chlorite and carbonates are both widespread.

Rock Types.

Certain clearly marked rock types may be distinguished, but there are no sharp lines separating the basic and intermediate biotitic and hornblendic rocks. Any classification must therefore be more or less arbitrary, and this would be probably still more the case if a larger series of specimens were studied. The so-called dolerites are coarse-grained rocks, but nevertheless they must be regarded as hypabyssal and not plutonic.

Olivine-biotite-dolerites.

These are the most basic rocks collected, and are very abundant in the gravels. They are dark-coloured coarse rocks, sometimes resembling gabbro-pegmatites. Olivine, augite, and a basic plagioclase (labradorite or bytownite) are the main constituents; biotite, iron-ore, and occasionally brown hornblende occur in subsidiary amount; while apatite is the most common accessory. The structure is simple, both olivine and augite showing

* Geol. Mag., dec. 5, vol. 8, pp. 203–4; 1911.

idiomorphic outlines to the feldspar, which generally surrounds them as tabular prisms of smaller size, but at times is moulded on them in large crystals. The iron-ores are clearly moulded on olivine and augite, but appear to be anterior to the feldspar. Biotite and hornblende are of late crystallization, and clustered around the iron-ores, olivine, and augite. An interesting feature of the rocks is the presence, in some cases, of a reaction-rim between olivine and feldspar.

Biotite-dolerites.

This type, also fairly abundant in the Dee gravels, differs from the former not only in the absence of olivine, but also in the greater amount of feldspar compared to the augite, and the richer development of biotite. The feldspar is more often zoned, and, on the whole, more acid (andesine to labradorite). Apatite and iron-ores are more abundant, and zircon makes its appearance as an accessory. Brown hornblende is only an occasional constituent, but green uralite is very common.

Structurally these rocks differ from the former in an inversion of the relative order of the feldspar and augite. This is most marked in the more feldspathic types. The feldspars are quite idiomorphic, and are frequently enclosed by the augite, which occurs for the most part interstitially, without forming large ophitic plates. The iron-ores are moulded both on feldspar and augite, but are anterior to the biotite. In some cases, however, the latter must have commenced crystallization at an earlier stage, since it is found intergrown with the augite.

One rock, somewhat similar in composition to the biotite-dolerites, differs from them in the greater abundance of allotriomorphic magnetite, and in the structure. Large crystals of augite are fairly common, but for the most part this mineral occurs in quite small grains, of similar size to the magnetite, and forms with it and basic plagioclase a fine-grained groundmass. There are a few larger feldspars which might be considered as phenocrysts did they not enclose numerous small grains of augite and magnetite. Biotite occurs in large honeycombed plates, and pilite pseudomorphs of olivine are occasionally seen. Although at first sight the rock seems porphyritic, a more careful inspection suggests that this appearance is deceptive, and that crystallization has been uninterrupted.

Biotite-quartz-dolerite.

Only one of the specimens collected is to be placed in this category. Its augite is completely uralitized, but otherwise it differs mineralogically from the biotite-dolerites only in the presence of a moderate amount of primary interstitial quartz. Structurally an ophitic structure is better exhibited, and the iron-ore is anterior both to the feldspar and the pseudomorphs of augite. The biotite has the same relationships as before, and appears to have been intergrown with the original augite.

So far as the writer is aware, this is the first recorded instance of a quartz-dolerite (or quartz-gabbro) in New Zealand.

Doleritic Rocks with Lamprophyric Affinity.

Two rocks agree qualitatively in mineral composition with the olivine-dolerites, but are distinguished by a very different structure. There are a few large plates of augite, but this mineral occurs mostly in quite small and often long prisms. The other minerals—olivine (represented by pilite pseudomorphs), brown hornblende, biotite, and magnetite—all occur in small idiomorphic crystals of characteristic shapes. Large crystals of labradorite enclose all these minerals and abundant prisms of apatite in poecilitic fashion. The chief mineralogical difference from the olivine-dolerites lies in the greater relative abundance of hornblende and apatite and the lesser amount of olivine. The resemblance to the lamprophyres lies in the small size and elongate prismatic habit of the ferro-magnesians.

Two rocks are of a very unusual type. Augite (partially uralitized), brown hornblende, iron-ore, and an acid plagioclase are the principal constituents. Apatite and sphene occur in lesser amount. Chlorite, epidote, calcite, leucoxene, pyrite, and sericite are abundant as secondary products. The order of consolidation appears to have been apatite, sphene, iron-ore, augite, hornblende, and feldspar. The most marked feature of the structure is the perfect idiomorphism of the brown hornblende towards the feldspar, although it encloses augite, iron-ore, and apatite abundantly. The texture is coarse, like that of the average dolerites.

The feldspars are seldom twinned, and are very sericitic. Since, however, they have indices less than both balsam and cement, and are optically positive, they must be referred to albite or oligoclase-albite. The rocks show some superficial resemblances to the Cornish minverites, but differ in the absence of basic plagioclase in addition to the albite. A re-examination, based on fresher material, is necessary before they can be correctly named

The Spessartites.

The spessartites, according to Rosenbusch, bear the same relationship to vogesites as kersantites bear to minettes—*i.e.*, they contain plagioclase instead of, or in addition to, orthoclase. Camptonites are distinguished by containing barkevicitic hornblende and aegerine borders to the augite. Moreover, the olivine of camptonites is never pilitized.

A considerable number of the rocks from the Dee Gorge are hornblende lamprophyres. Like most rocks of this class, they are considerably altered, and in consequence the determination of the feldspars presents considerable difficulty. Orthoclase has not been certainly determined, while the plagioclase ranges from albite to a semibasic species. Owing to the lack of the distinctively camptonitic characters, and the presence of pilite in some of the rocks with lamprophyric affinities, it is safer to class the hornblende lamprophyres with the spessartites.

No two of the rocks examined agree in all respects, and the degree of variation is considerable. The presence of phenocrysts and needles of brown hornblende is the most constant character. Feldspar occasionally occurs as phenocrysts, more or less sericitized, and is abundant as small prisms or microlites in the groundmass. Titano-magnetite also occurs in two generations, and often shows a marginal alteration into sphene. Augite is not always present, but is sometimes abundant in large and small crystals. Biotite occurs only in the groundmass. Apatite is fairly abundant, sometimes in prisms of sufficient size to justify the name of phenocrysts. Calcite, chlorite, and epidote are abundant.

There are considerable variations in grain-size, but the groundmass is always holocrystalline, the feldspars being sometimes in short prisms and sometimes in radial aggregates. Some of the rocks vary rapidly in texture from place to place, and appear to consist of dark parts veined by clearer material.

Acid Rocks.

Only three specimens of the acid rocks have been studied, and of these one is too near the junction of an argillite inclusion to show its normal characters. The other two rocks are granitic in texture and structure, but in each case the amount of quartz is rather low for a granite. One of the two consists predominatingly of microperthite, with smaller amounts of plagioclase, hornblende, biotite, and accessory zircon, and might be termed a quartz-syenite. The other contains augite in addition to the above minerals, and in it the microperthite does not predominate so much over the plagioclase ; it is a hornblende-granite or a quartz-diorite.

Affinities of the Rocks.

It cannot be definitely asserted that the acid rocks belong to the same rock-series as the more basic rocks, but it is probable that they do. The dolerites are not normal lime-alkali rocks, differing in the presence of titaniferous augite and in the abundance of biotite. At the same time, they are not definitely of alkaline affinity. Chemical analyses are necessary before the true position of the rocks can be made out, and it was not considered advisable to undertake these on river-gravels, the more particularly as a much better series of rocks could probably be collected from the dykes *in situ.*

A very similar series of rocks has been described by Bell and Fraser from the Hokitika Sheet, North Westland Quadrangle.* They are described as "pyroxene-camptonite, hornblende-camptonite, hornblende-porphyrite, pyroxene-porphyrite, diabase, augite-diorite, and olivine-basalt." A re-examination of their microscopical sections suggests that the "camptonites" are better termed spessartites. The "augite-diorite" is very similar to the hornblende-albite rock described above from the Dee gravels, but is more easily deciphered ; it is an albitized hornblende-dolerite, passing in places into a hornblendite. Bell and Fraser believe the dykes to be of early or middle Tertiary age, because of the lithological similarity to the olivine-basalt of Koiterangi Hill, which rests on a denuded surface of the (Tertiary) coal-measures. This lithological similarity is not brought out in their petrographical description, and, as they admit that the dykes have been found only in pre-Tertiary rocks, considerable doubt must attach to their conclusion as to the age.

Dr. J. Henderson has kindly shown me sections of many similar rocks, found for the most part as boulders in river-gravels near Reefton. They include pilite-spessartites, and some of them approach the odinites in the structure of the groundmass (Dr. Henderson had already identified the rocks as spessartites and odinites). It is perfectly possible, however, that true camptonites also occur in Westland and west Nelson, since alkaline plutonic rocks (ditroite) are known.

The closest analogies with British rocks lie with the pilite-spessartites of the central Highlands, which are associated with vogesites.†

ACKNOWLEDGMENTS.

Messrs. C. A. Cotton and J. A. Bartrum have given much help in the writing of this paper, including the preparation of the thin sections. Mr. Bartrum has also assisted in the determination of the mineral composition, and in the identification of the rocks.

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* Bull. No. 1 (n.s.), Geol. Surv. N.Z., pp. 82–84 ; 1906.

† Flett, J. S. : The Geology of Sheet 55, Mem. Geol. Surv. Scotl. ; 1905.

Art. XXXVIII.—*The Tuamarina Valley: A Note on the Quaternary History of the Marlborough Sounds District.*

By C. A. Cotton, Victoria College, Wellington.

[*Read before the Wellington Philosophical Society, 23rd October, 1912.*]

Plates XV, XVI.

Introduction.

Immediately after leaving Picton the railway to Blenheim climbs a low saddle, and afterwards follows a comparatively straight valley—that of the Tuamarina—for its full length of ten miles, emerging on the Wairau Plain at the junction of the Tuamarina River w.th the Wairau.

Fig. 1.—Locality Map, Central New Zealand.

P, Picton; B, Blenheim; T, Tuamarina River; Q, Queen Charlotte Sound; TC, Tory Channel; PS, Pelorus Sound.

The writer was able recently to make a few observations which may be of some value, inasmuch as they throw light on points connected with the physical geography of this portion of Marlborough to which little attention has hitherto been directed.

Our previous knowledge of the physiography of the Marlborough Sounds and adjoining country may be summed up as follows:—

1. The Sounds are submerged river-systems.*

2. Subsidence to the extent of 5 ft. in the neighbourhood of Blenheim was noted at the time of the earthquake of 1855.†

3. The line of the Wairau Valley has been recorded as an "active" fault marked by earthquake-rents.‡

* Marshall, P., "The Geography of New Zealand" (Christchurch, no date), p. 68.
† Lyell, C., "Principles of Geology," 10th ed., 1868, p. 87.
‡ McKay, A., Rep. Geol. Expl., 1890–91 (Wellington, 1892), map, p. 1.

GEOLOGICAL STRUCTURE.

Various authors* have recorded their observations of the geology in the neighbourhood of Tuamarina.

A brief general statement will here suffice. The Sounds district is composed almost entirely of sandstone or greywacke and schists, all much deformed. Practically nothing is known of the structure, but it is certainly complex.†

According to McKay,‡ the boundary between the sandstone (his Upper Devonian) and schist (his ? Silurian) coincides very nearly with the line of the Tuamarina Valley. He regards it as probable that the junction is the line of a fault,§ and it is certainly true that at the low saddle, mentioned above between the Tuamarina Valley and the stream at the head of Picton Bay, there is present a small outlier of Tertiary mudstone which probably owes its preservation to its having been faulted in.

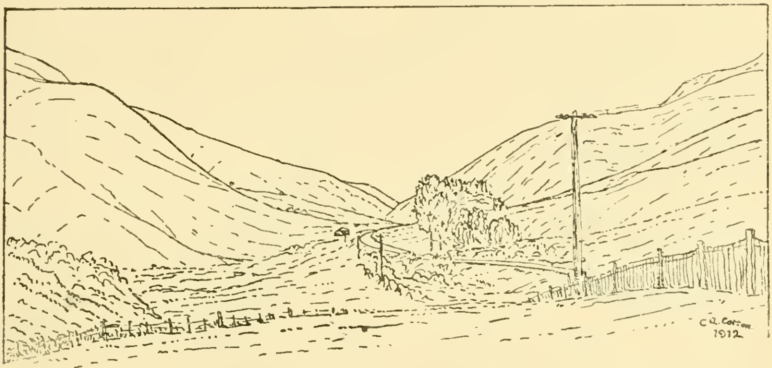

FIG. 2.—THE LOW SADDLE (250 FT.) BETWEEN THE TUAMARINA VALLEY AND THE STREAM FLOWING INTO PICTON BAY.

Elevation Railway-station is on the saddle, and the railway to Blenheim passes around to the left. View looking north-east.

The low pass, an unusual feature (see fig. 2), is accounted for by the presence of the weak mudstone, and it is possible that the position of the valley is determined by the fault, but it is by no means certain that a fault exists for the full length of the valley. Nor is it at all necessary to assume its existence in order to account for the position of the valley, for other parallel valleys are present. It is possible that the drainage-lines are determined by systems of master joints, if not by bedding.

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* See especially Hochstetter, F. von., "Geology of New Zealand" (Auckland, 1864), p. 93, and atlas, map 6; Hutton. F. W., "Report on the North-east Portion of the South Island," Rep. Geol. Expl., 1873–74 (Wellington, 1877), p. 31; Hector, J., Progress Report in Rep. Geol. Expl., 1873–74 (Wellington, 1877), p. ix; McKay, A., "The District between the Kaituna Valley and Queen Charlotte Sound," Rep. Geol. Expl., 1878–79 (Wellington, 1879) pp. 86–97; McKay, A., "On the Geology of Marlborough and the Amuri District of Nelson," Rep. Geol. Expl., 1888–89 (Wellington, 1890), pp. 85–185 and map opp. p. 96.

† See McKay, *loc. cit.* (1879), p. 89.

‡ *Loc. cit.* (1890), map opp. p. 96.

§ *Loc. cit.* (1890), p. 103.

Sculpture of the Sounds Block.

The Tuamarina Valley differs from its neighbours only in having, at its head, a low pass. In other respects it is a typical example of the valleys which, before the subsidence, drained this mountainous district.

The present Sounds area had then been, so far as one can now judge, dissected to the early mature stage by normal agencies in a single erosion cycle. There are many outrunning spurs both in the Tuamarina Valley and in Queen Charlotte Sound which show very even and apparently horizontal crest-lines suggesting successive cycles in the sculpture of the valleys; but it is significant that flat-topped remnants are absent. The writer prefers to ascribe these even-crested spurs, and the apparent coincidence of level of neighbouring spurs which is sometimes observed, to subequal spacing of parallel streams determined by systems of master joints,* and to assume, in the absence of other evidence to the contrary, that the Sounds valleys were the work of a single erosion cycle.

The relief was strong (2,000 ft. to 4,000 ft.), and hill-slopes and valley-sides were steep. The valley-floors, however, were graded and broadly opened, flood-plains being developed nearly to their heads. The amount of subsidence which ensued has not been sufficient to submerge the flood-plains entirely. The town of Picton, for example, has been built upon one unsubmerged remnant at the head of a tributary of Queen Charlotte Sound, while another tributary with its flood-plain still unsubmerged opens upon the Sound a little farther east as Waikawa Bay (see fig. 3).

The subsidence which allowed the sea to enter this valley-system was local. The extent of the block affected by it has not been investigated, but it is important to note that it did not extend beyond the broad valley of the Wairau, for southward and eastward there is abundant evidence of recent uplift. Possibly movement took place along a fault-plane situated somewhere in the Wairau Valley, or perhaps the explanation is to be found in the formation of a flexure along the same line.

Amount of Subsidence.

The amount of subsidence in the Sounds block may be arrived at to a rough approximation. The observer who enters one of the Sounds by steamer may be tempted to produce the steep sides downward, in imagination, until they meet at the bottom of a V-shaped gorge thousands of feet in depth—a veritable cañon. As mentioned above, however, flood-plains exist at the heads of the valleys, indicating that they were graded, flat-floored, and broadly opened. Into such valleys a moderate amount of subsidence will allow the sea to enter and penetrate far. A rough estimate, based on probable grade, places the subsidence at between 250 ft. and 500 ft.

It is possible, also, to arrive at a rough estimate from a consideration of the present depth of water shown by soundings. The method can, however, be applied only if it can be shown that the accumulation of marine sediment in the valleys since subsidence is probably not great.

The amount of deposit will be small if—(1) subsidence took place recently; (2) tidal currents have sufficient strength to keep the finer sediment in suspension and carry it out to sea; and (3) the area of deposition is large compared with the area supplying sediment.

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* See Hobbs, W. H., "Repeating Patterns in the Relief and in the Structure of the Land," Bull. Geol. Soc. Am., vol. 22, 1911, p. 123.

(1.) While it cannot be determined whether subsidence took place slowly or rapidly or by successive steps, it is certain that the subsidence was completed very recently. This follows from the fact that, while the Sounds are, in places, extensive sheets of water, and the rocks of the hillsides are deeply weathered, marine erosion has nowhere developed cliffs and rock platforms to any extent, except along the flood-plain remnants at the valley-heads, where lines of low cliffs have been cut in the fluviatile gravels.

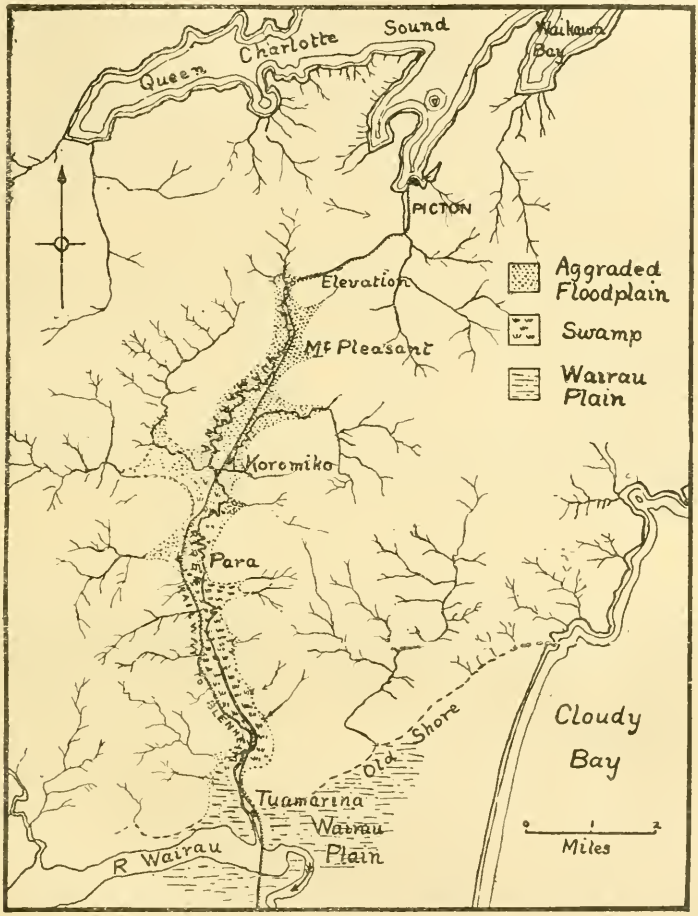

FIG. 3.—SKETCH-MAP OF THE TUAMARINA VALLEY.

(2.) Tidal currents, with an exception which will be noted later, are fairly strong. In the entrance of Pelorus Sound the strength of the tide is 3 knots.*

(3.) The area of land in the Sounds block is but little greater than that of water. Hence the supply of waste cannot be great in comparison with the area of deposition.

For these reasons it seems fair to assume that the thickness of marine deposits in the Sounds is not great. The maximum depth of water given

* Admiralty Chart, New Zealand, sheet 5.

by soundings near the mouths should therefore indicate only a little less than the total amount of subsidence.

For the following reason Pelorus Sound (PS, fig. 1) is selected for the application of the test. The soundings in Queen Charlotte Sound* present irregularities, the chief of which is a bar of shallow water (11 fathoms) just within the main entrance (Q, fig. 1). This is accounted for by the fact that the flood tide enters, not by the broad, main entrance, but by a smaller opening, Tory Channel (TC, fig. 1), on the south-east s'de and then flows down the Sound, causing permanent slack water at the mouth, which has thus become a locus of d position for fine sediment. This anomaly is a result of the northward flow of the flood tide through Cook Strait.

Pelorus Sound, on the other hand, exhibits no similar irregularity. There is general agreement of the depth of water in the arms of Pelorus Sound with that within Queen Charlotte Sound, and in the former there is a gradual increase in depth from the head to the mouth. The tide runs with sufficient strength to carry the bulk of the sediment out to sea.

In the mouth of Pelorus Sound soundings indicate a depth of 40 fathoms, suggesting that the subsidence is about 300 ft. This estimate agrees fairly well with that based on normal river grade, but the whole argument is ineffective if at some stage of the subsidence a very long pause occurred, allowing of the accumulation in the Sounds of a great thickness of sediment.

The Tuamarina Valley, unlike those opening on Queen Charlotte Sound, is not now occupied by an arm of the sea. Clearly, however, it has been affected by the same subsidence, and invaded by the sea. In fact, the railway traveller cannot fail to note its resemblance to the Sound left behind at Picton. It is occupied now by flat land and swamp.

The Old Shore of Cloudy Bay.

Again, after Tuamarina Railway-station is passed and the valley left behind, an old abandoned coast opens out, bold and straight, while at the foot of the cliffs, instead of the sea, the Wairau Plain is spread out.

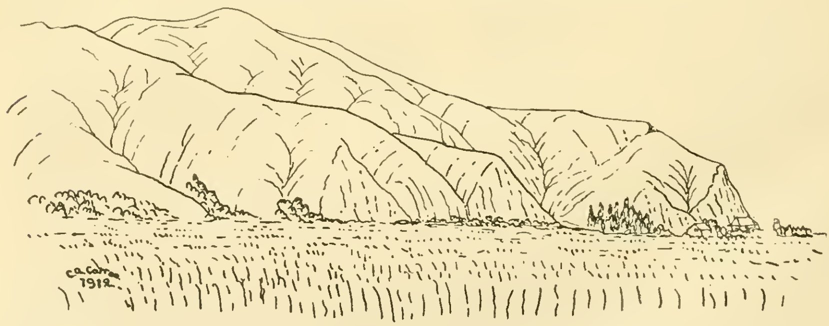

Fig. 4.—A View along the Old Shore North-eastward from Tuamarina.

The straightness of this fossil coast, coupled with the fact that it truncates rock structures indifferently, suggests that its course was determined

* See Admiralty Chart, New Zealand, sheet 5.

by a fault which separated a heaved Sounds block from a thrown block which underlies the Wairau Plain and the extension of Cloudy Bay which formerly occupied its site. It will be noted that the fault which it seems necessary to postulate here, while following approximately the line of the hypothetical fault or flexure along which the Sounds block has recently subsided, had its downthrow in the opposite direction. It must also be supposed to be of earlier date, antedating the dissection of the Sounds block.

The bold scarp, part of which is shown in fig. 4, and the line of which is indicated in fig. 3 as "Old Shore," cannot be regarded as preserving any remnants of the original fault-scarp. The line of cliff-facets might be produced—(1) by recent faulting, (2) by lateral cutting by the Wairau River, or (3) by marine erosion. The continuity of its line with the actual sea-coast a few miles to the north-east indicates with a fair degree of certainty that it is marine erosion which has been responsible for the cutting of the actual facets. The rock platforms of the old shore are buried beneath alluvium.

CHANGES BROUGHT ABOUT BY THE ADVANCE OF THE WAIRAU PLAIN INTO CLOUDY BAY.

The Wairau Plain has been built forward along the old shore either as an ordinary delta or, as suggested by Mr. L. J. Wild,* filling a great lagoon, a portion of Cloudy Bay enclosed by a spit of gravel supplied by the Awatere River.

The advancing alluvial deposits closed the mouths of the Tuamarina and neighbouring valleys, and at Tuamarina the surface of the plain is now about 20 ft. above sea-level.

DEPOSITS IN THE TUAMARINA VALLEY.

The Tuamarina Valley was thus converted from an arm of the sea into a lake or lagoon. Into the lake the main stream and its tributaries would continue to pour their loads of waste. There would be now, however, no tide to aid in the distribution of the waste and to carry the finer material to sea. Before the mouth of each small stream, therefore, a delta of the coarser waste would be built, while the finer would be spread over the floor of the lake. To the local supply would be added during floods a generous contribution from the fine silts of the Wairau as the Wairau Plain was built up from sea-level to its present height of 20 ft. The result would be that the lake would be filled, forming a flat at sea-level, above which would rise the sloping fan-like surfaces of the deltas of the main and tributary streams. After that stage was reached the waste brought in would all be dropped as the streams emerged upon the flat, fans would be built forward, and farther up each stream aggradation would take place, the fluviatile beds all being laid down parallel to the adjusted grade of each stream, and gradually extending outward over the sea-level flats.

At the valley-mouth the surface would slope gently up to the level of the Wairau Plain.

If the above reasoning is correct, the deposits in the valley should have the structure indicated in fig. 5, from which, for the sake of clearness, the delta and fluviatile deposits of side streams are omitted. They should have a similar structure to that of the deposits of the main stream.

* Oral communication.

It is impossible to demonstrate the internal structure of the deposits in the valley, but a study of their surface indicates that the theory outlined is probably correct.

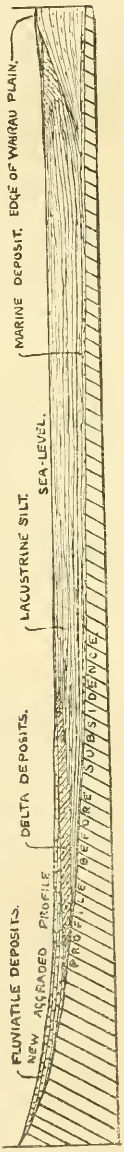

Fig. 5.—Hypothetical Longitudinal Section of Deposits in the Tuamarina Valley.

At the Elevation (see figs. 2 and 3) the height is 250 ft. At about half a mile from the head of the valley, and at a height of about 200 ft., the flood-plain begins, and extends with normal grade to Koromiko (fig. 3), three miles from the head, where the height is 55 ft. Throughout this distance the plain is well drained and crops are grown. Much gravel is present in streams and in the soil. Plate XV, fig. 1, is a view of the valley-floor at Mount Pleasant, one mile from the head of the valley, and Plate XV, fig. 2, is a view of the valley-floor at Koromiko.

Below Koromiko the valley-floor becomes swampy in places. It has, however, still a little fall. Near Para, five miles from the head, may be placed the extreme edge of the fluviatile plain which has descended to within a few feet (certainly less than 20 ft.) of sea-level.

Five miles of valley still remain before the mouth is reached, and this portion of the valley is a continuous swamp, composed entirely of fine silt, and but little above sea-level. There is only an occasional patch of dry flat in a bay, the alluvial fan of a tributary stream. Plate XVI, fig. 1, is a view of the swamp one mile above the mouth.

Clearly the swamp marks that portion of the valley occupied by lacustrine deposits over which the fluviatile plains of aggrading streams have not yet advanced. For the greater part of the length of the swamp the Tuamarina River traverses it in a channel with banks only 2 ft. or 3 ft. high. Towards the mouth, at Tuamarina, the swampy flat gives place to cultivated land as the level of the surface rises to that of the comparatively well-drained Wairau Plain. This portion of the valley-floor is illustrated in Plate XVI, fig. 2. It should be regarded rather as an offshoot of the Wairau Plain than as a part of the Tuamarina Valley floor. The actual rise towards the mouth is well shown in the banks of the lower reaches of the Tuamarina River, which increase in height in about half a mile from 2 ft. or 3 ft. to about 15 ft. The stream is extremely sluggish, and its surface must mark an almost true level. The difference in the height of the banks must therefore mark the rise of the ground from the swamp within to the Wairau Plain without.

Fig. 1.—The Aggraded Flood-plain at Mount Pleasant.
View looking south-west.

Fig. 2.—At Koromiko: the Valley-floor becomes Swampy in Places.
View looking west.

 [*C. A. Cotton, photo.*

Fig. 1.—The Swamp at its Lower End, One Mile above Tuamarina.
View looking north.

Fig. 2.—The Slope up to the Wairau Plain at Tuamarina
Swamp begins on the right. View looking north-west.

[C. A. Cotton, photo.

ART. XXXIX.—*Notes on the Chief Physiographic Features of Norfolk Island.**

By R. M. LAING, B.Sc.

[*Read before the Philosophical Institute of Canterbury, 6th November, 1912.*]

NORFOLK ISLAND is a small volcanic island with a well-known history, whose geological characteristics have received less consideration than they deserve. The "town" lies in latitude 29° 3′ south, and longitude 167° 6′ east. The greatest length of Norfolk Island (from north-west to south-east) is about six miles, and its greatest breadth (north to south) is about four miles. It contains 8,500 acres, and is roughly rectangular in shape.

SKETCH-MAP OF NORFOLK ISLAND.
(Scale, 1½ miles to an inch, approximately.)

Approximately it is distant 400 miles (geographical) from New Caledonia, 420 miles from the north end of New Zealand, 490 miles from Lord Howe Island, 780 miles from the Australian coast, and 750 miles from the Kermadecs. Though not lying on the New Zealand plateau as defined by Farquhar,† the soundings between it and New Zealand probably do not exceed 1,000 fathoms, and its fauna and flora have undoubted relationships with those of New Zealand.

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* These notes are the result of a five-weeks trip to Norfolk Island in January–February, 1912. They make little pretence to completeness, as the time spent upon the island was given chiefly to botanic research.

† Trans. N.Z. Inst., vol. 39, p. 136.

In addition to the main islet, there are two smaller ones—Nepean, a low islet of coral-sandstone, a few acres in extent, lying about half a mile south of Emily Bay; and Philip Island, between three and four miles south, a volcanic mass about 900 ft. high, a mile and a half long from east to west, and three-quarters of a mile wide from north to south.

Norfolk Island is surrounded by cliffs, rising in the north and west to 300 ft. or 400 ft., and elsewhere to the height of 200 ft. The only exception to this is the coast-line between Bloody Bridge and Bumbora. Here the coast is protected for a distance of about a mile by rocks of coral-sandstone. This erosion does not seem to have been much greater on one side than the other, but it has obviously been very long continued, and the island is now much smaller than it originally was. This is further indicated by numerous outlying rocks, particularly on the northern side. In most places at the foot of the cliffs there are narrow beaches, usually of shingle. At Anson Bay the heavy shingle on the beach is sometimes replaced by sand. Thus Backhouse, who visited the island in March, 1835, records that "This [Anson Bay] was formerly a landing-place, but the sand has been washed away, and large stones remain, too rough for boats to venture upon."* This spot was chosen for the shore end of the Pacific cable, partly on account of the sand, as it was feared that boulders would chafe the cable. Shortly after the landing of the cable, some ten years ago, the sand was replaced by boulders, which were still there at the time of my visit. Such changes as these indicate the violence of waves and currents along the coast. On the south coast, opposite to Philip Island, there has been least erosion. Here there has been a considerable growth of coral-sandstone. This growth may have been due in the first place to the protection of Philip Island, which probably at one time extended farther towards Norfolk Island. The coral itself now forms an additional protection, though this too is undergoing rapid erosion. It doubtless at one time extended continuously to Nepean Island, which is now often subjected to a fierce sea that must soon destroy it. In spite of the present rapid formation of the coral,† it can scarcely be doubted that it is now being destroyed much more quickly than it is being formed, for reasons perhaps not at present apparent. The long-continued period during which erosion has been going on is further indicated by the high cliff on the south side of Philip Island. This rises to the full height of the island, 900 ft., thus probably indicating that half of the island has been destroyed by wave-erosion, as in the case of such subantarctic groups as the Aucklands and the Snares.

The interior of Norfolk Island consists of comparatively level uplands from 300 ft. to 500 ft. high, intersected by narrow stream-valleys, sometimes forming ravines often 50 ft. or more deep. The streams in most places fall over cliffs into the sea—*e.g.*, at the Cascades, Keripae, and Duncombe Bay. It is clear that this conformation is due to the fact that the ocean is wearing away the island at a greater rate than the streams can cut down their beds. It is only on the south coast of the island that any of them are able to reach the sea except by a waterfall over a cliff. Thus at Bloody Bridge, Bumbora, Town, and Beef-steak the stream-valleys slope down to sea-level, and are not truncated as elsewhere. In this region, but more especially between the cemetery and the pier, the coast-line is protected by coral reefs and coral-sandstone, the product of the older reefs, as already

* "A Narrative of a Visit to Australian Colonies," p. 258.

† Carne, Rept. Dept. Mines, N.S.W., 1885, p. 147.

mentioned. The coral-sandstone here extends from a quarter to half a mile inland, and rises to a height of 30 ft. to 50 ft., with the strata lying horizontal or dipping slightly, usually inland. According to Etheridge (p. 116), the structure of this deposit is practically the same as the coral-sand rocks found on Ascension and Lord Howe Islands:* "Touching the deposits at Ascension and Norfolk Islands, their descriptions would almost embrace that at our island. Of the former, Darwin says, 'It consists of small well-rounded particles of shells and corals, of white, yellowish, and pink colours, interspersed with a few volcanic particles.'† Mr. Carne's description of the latter is identical, almost word for word." The consolidation of this rock is doubtless largely due to the percolation of rain through it. This dissolves out carbonate of lime, which cements together the particles below as it evaporates. Of the Lord Howe deposit, Etheridge (*loc. cit.*, p. 124) says, "When first I examined this deposit *in situ* I regarded it as of aqueous deposition; but after due consideration of all the facts for and against I have abandoned this view in favour of an aeolian origin." Unfortunately, I was unable to give much time to the investigation of this interesting formation on Norfolk Island, but have no doubt that it has been formed in the same way as on Lord Howe. My cursory examination of it did not enable me to determine whether there have been two distinct periods of formation, as at Lord Howe Island (Etheridge, p. 118, *loc. cit.*).

The main body of Norfolk Island consists of streams of basaltic lava, usually lying approximately horizontal. They are very much weathered, so that it is difficult to get fresh specimens of rock. The whole surface of the island except the rocky ridge of Mount Pitt and the precipitous portions of its western slopes is covered to a depth of 150 ft. to 200 ft. with a somewhat compact though porous layer of decomposed volcanic rock, through which wells can be dug without much difficulty. These wells, together with rain-water, provide the water-supply of the inhabitants. The deepest well is near Bloody Bridge, and goes to a depth of 186 ft.

This stratum apparently resembles the laterites of tropical regions in some of its characters. Unlike these, however, it provides a very fertile soil, often brown, and contains a grit, probably consisting largely of iron segregated from the volcanic earths; but, like the laterites, this surface earth has none of the impermeability of a clay; and, indeed, there is probably no true clay on the island. What has led to this immense weathering and decomposition of the volcanic rocks it is not easy to determine; but it can scarcely be doubted that it shows the island is by no means of recent formation. It is, of course, impossible to determine the age of Norfolk Island without data of a more definite character, and these are at present wanting.

Strewn over the surface of the soil in most parts of the island are boulders of all sizes, evidently the remnants of the harder undecomposed cores of the rock-masses. I was not able in the time at my disposal to detect any old crater-vents or fissure-lines. Possibly the rocky ridge of Mount Pitt may represent the portion of an old crater-wall. This lies about a mile distant from the west coast, and roughly parallel with it, and runs through the northern half of the island. Between Mount Pitt and the sea the country is rather rough and considerably broken by cliffs.

* "The Physical and Geological Structure of Lord Howe Island," by R. Etheridge jun. ("Memoirs Australian Museum," No. 2).

† Darwin, Geol. Observ. of Volc. Islands, 1844, p. 49.

Further evidence of denundation and weathering can be obtained from the cliffs between Anson Bay and the Cascades, on the northern half of the island. Thus at Duncombe Bay there is a series of stratified volcanic tuffs, conformably bedded from 75 ft. to 100 ft. in thickness, lying under basaltic rocks, which show columnar structure. Immediately under this basalt lies red followed by yellow tuffs, and then by a tuff with pisiform nodules. At the eastern end of the bay these strata dip at an average angle of 45°, but elsewhere they are approximately level. Here these stratified tuffs come down to high-water mark; but at Anson Bay, where the same or a similar series is found, they are at a height of 50 ft. or more above sea-level, and are underlain as well as overlain by basaltic rocks.

I did not see any dykes on the island, except a narrow band some 6 in. wide, exposed only for a few feet near the landing-rock at the Cascades. Dykes are said to occur plentifully at Philip Island, which is apparently of somewhat different structure from Norfolk Island, and very possibly has never formed a portion of the same land-mass. Unfortunately, I was only able to give this off-lying islet a very cursory examination. I made one excursion to it in a whale-boat, but our visit was cut short by the rising surf. Philip Island, like Norfolk Island, is ringed with cliffs, low on the side facing Norfolk Island, high on the outer side, as already noted. A landing can only be effected in fine weather. The surface of the island is covered with brilliantly coloured blue, red, yellow, and brown volcanic earths, which are conspicuous from a distance. Here and there are exposures of harder undecomposed rocks. I had hoped to examine the cliffs on the northern side of the island for dykes or sedimentary rocks, but the abrupt ending of our visit prevented me from doing so.

The island at one time bore a fairly abundant vegetation, but this is fast disappearing. The destruction of plant-life by the pigs and rabbits introduced by convicts and settlers has led to a loosening of the soil. This is being fast washed away, and the island is rapidly becoming desert. I hope, however, to deal with this matter further in a paper on the botany of Norfolk Island.

Art. XL.—*On a Collection of Rocks from Norfolk Island.*

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

[*Read before the Philosophical Institute of Canterbury, 6th November, 1912.*]

(See sketch-map in previous paper by R. M. Laing.)

The specimens of rocks referred to in this paper were collected by Mr. R. M. Laing during a visit to the group in the summer of 1911–12, and were subsequently handed to me for identification. They include representatives from all parts of the island, and also a few specimens collected during a hurried visit to Philip Island, a small and rapidly disappearing islet situated about three miles south of Norfolk Island, The only reference that I can find to the nature of the rocks in the group is that contained in Appendix II of the Annual Report of the Department of Mines, New South Wales, for the year 1885 (Sydney, 1886), where there is a short descriptive account of the geological features of the islands by J. E. Carne, and a petrological description of a few rock-specimens by T. W. E. David. The collection made by Mr. Laing is as complete as the circumstances of his visit allowed, and gives a thoroughly accurate idea of the general geological structure and origin of the islands. As it includes numerous specimens from localities not referred to by Carne or David, I think it right to publish a short description of the collection, especially as interest always attaches to apparently trivial facts bearing on the geological history of islands remote from large land-masses, since they are the only means at our disposal for acquiring a knowledge of vast tracts of the earth's surface now covered by the ocean, and since a careful consideration of their formation may throw light on the troublesome questions of land connections and the origin of faunas and floras. This is especially true in the case of Norfolk Island, because from a consideration of the biological evidence it can be concluded with certainty that this isolated spot of land once had a fairly close connection with New Zealand on the one hand and with Australia and New Caledonia on the other. This has been admitted by all zoologists who have studied the question, among whom may be mentioned Wallace, Forbes, Hutton, Hedley, and Oliver. The last-named, from a consideration of the distribution of the birds inhabiting the Lord Howe Group, the Norfolk Islands, and the Kermadec Islands, came to the conclusion that Norfolk Island had never formed part of an actual land connection, but existed as an island off the coast of a land stretching from New Zealand to New Caledonia, and including Lord Howe Island as an integral part of its western shore-line.*

The fact that plutonic rocks occur in the Kermadec Group has been recorded by Thomas† and the present author,‡ thus proving that a landmass of continental character did once exist over a part of the earth in that region which is now covered by sea. These islands occupy a position between New Zealand and Oceania analogous to that of Norfolk Island between New Zealand and New Caledonia, so that the rocks of Norfolk Island were examined with a special object of determining, if possible, whether or not they would yield similar material of deep-seated origin, especially as the biological evidence of a continental connection is so much stronger in its case than in that of the Kermadecs. I have, however, been somewhat disappointed in the result, there being only the very slightest indication, afforded by an inclusion in the tuffs of Philip Island, that below the volcanics which now compose almost the entire island there exists a rock of different character, if not of different origin. This evidence will be given in more detail later. Apart from this occurrence, the rocks as a whole are very monotonous, being basalts of varying degrees of coarseness and basaltic tuffs, almost entirely the product of surface volcanic action, a doubtful dyke being recorded from Norfolk Island, although Carne reports that they are common on Philip Island,

The reports by Carne and David, referred to previously, contain descriptions of only two specimens from Norfolk Island—viz., the coral-sandstone from Emily Bay and a basaltic lava from Anson Bay. Mr Laing's collection includes numerous samples of the former, and from them it appears to be a yellowish-brown rock composed largely of clear colourless calcite, and containing numerous fragments of corals and tests of *Forminifera* of various genera, and a small amount of volcanic matter. In treating of the volcanic

* Trans. N.Z. Inst., vol. 44, p. 217; 1912.
† Trans. N.Z. Inst., vol. 20, p. 315; 1888.
‡ Trans. N.Z. Inst., vol. 42, p. 244; 1910.

rocks it will be most convenient to refer in sequence to the various localities whence specimens have been obtained, and these will be taken in order, going round the coast in a general clockwise direction, starting from Emily Bay (see map, p. 323).

Headstone, Hundred Acres.

The two specimens from here may be taken as typical of many of the rocks of the group. In the hand-specimen they are of dark-greyish colour, vesicular, somewhat coarse-grained basalts, with numerous weathered olivines clearly visible. The specific-gravity determinations are unsatisfactory, owing to their vesicular nature, but the value given by one rock was 2·60, and the other 2·50.

Under the microscope both rocks appear to be alike, and are somewhat weathered. They are doleritic in character, and of an even-grained texture. The constituent minerals are plagioclase (medium labradorite) in broad laths, augite sometimes ophitically intergrown with the feldspar, but usually in grains ; magnetite and other iron ores ; but the most important constituent appears to be the olivine, which occurs in grains up to 1·5 mm. in diameter, and much stained with brown hematite as a decomposition-product ; occasionally, however, it is perfectly clear.

Bumbora Bay, South Side of the Island.

Three specimens were obtained from this locality. All are dolerites of dark-grey colour, slightly vesicular, and with numerous small olivines visible to the eye ; specific gravity = 2·86. In section they are formed of broad laths of plagioclase (labradorite) ; faintish-green augite with high extinction angle, ophitically intergrown with the plagioclase ; large olivines up to 1 mm. in diameter, edged and seamed with brown limonite, some crystals being idiomorphic ; titaniferous magnetite in grains, laths, and broken-comb forms. Two of the specimens are much stained by chloritic matter derived from the augite, these rocks being decidedly diabasic in character.

Included in the collection from this locality is a piece of pumice, but it is in all probability of drift origin, as it is much wave-worn, and differs mineralogically from the other rocks of the island.

Anson Bay, North-west of the Island.

The sequence of rocks in this locality appears to be as follows: The underlying bed consists of scoriaceous basalt, and then come beds of stratified tuff, which are succeeded by a coarse basalt exhibiting well-marked columnar structure.

The rock from the lowest bed is dark grey in the hand-specimen, very scoriaceous, with the cavities partly filled with a yellowish-green substance. Under the microscope it appears to be a somewhat coarse-grained dolerite, the feldspars (med. labradorite) are in larger size than is usual with other rocks of similar species from the islands ; the olivines are occasionally serpentinized, but sometimes quite clear ; the augite is much altered, and passes into a green chloritic material which colours a great part of the section ; and there is much secondary magnetite and limonite. This rock appears to be of a less basic type than the remaining specimens, and more diabasic in character.

The tuffs, which according to Mr. Laing are distinctly stratified, are of two kinds—the lower is a coarse tuff of reddish tint composed of fragments up to 2 cm. in diameter imperfectly cemented together. The higher tuff is much finer in texture, and of yellowish-brown colour. These rocks are so friable that it is impossible to make sections from them, but a microscopical examination of fragments shows that they are composed of essentially the same material as the overlying rocks, and grains of olivine, decomposed augite, and feldspar form the bulk of their substance. Between the upper and lower portions of these tuffs is a variety, largely composed of volcanic material, greenish-grey in colour, soapy to the feel, but microscopically presenting no marked features to differentiate it from the overlying beds.

The uppermost member of the series in this locality consists of a dark-grey moderately coarse-grained rock in which the feldspars and olivine grains are clearly visible to the eye. It is even-grained in texture and slightly vesicular; its specific gravity is 2·60.

The microscope shows that it is composed of broad lath-shaped feldspars (med. labradorite), which are usually perfectly clear and unaltered, and frequently enclosed ophitically by crystals of faintly coloured augite. The olivines are numerous in large grains, 1·4 mm. in diameter, often arranged in aggregates, with many smaller pieces scattered through the section; they are occasionally clear, but usually stained with iron oxide. There is a considerable quantity of titaniferous magnetite in grains and broken-comb shaped aggregates; some of this is certainly secondary. The rock is therefore a dolerite of distinctly basic character.

Duncombe Bay, North Side of the Island.

At Duncombe Bay, on the north of the island, tuffs of similar character occur, overlaid by both fine-grained and coarse-grained basic rocks. The tuffs are similar in mineral composition to those at Anson Bay, the lower beds being yellow in tint, while the upper beds are distinctly red.

The rock immediately overlying the tuffs is a dolerite of somewhat open texture, grey in colour, with abundant olivine showing in the hand-specimen; its specific gravity is 2·74. In section it appears to be principally composed of plagioclase (basic labradorite) in broad laths, exhibiting at times a rude parallel arrangement; augite in grains 0·5 mm. in length, much altered; and olivine in grains up to 0·6 mm. in diameter, occasionally fresh and clear, but usually stained brown with iron oxide round the edges or in cracks; a considerable amount of magnetite is also present. Associated with this is a finer-grained type of similar mineral composition. No glass is present, but the olivine phenocrysts are exceptionally prominent. The specific gravity of this rock is 2·87.

Cascades, North-east Side of the Island.

The collection from this locality includes specimens of columnar basalt, a coarse-grained basalt, a fine-grained basalt, and a reddish vesicular rock from a dyke. The specific gravity of the specimen from the boulder is 2·74. In section these rocks are all of the same general type, with varying degrees of coarseness. The columnar basalt and the specimen from the boulder are remarkably fresh rocks, the freshest in the collection. The groundmass appears in section to be composed of laths of plagioclase (labradorite) with fluxion arrangement, numerous grains of augite, much magnetite with rectangular outlines. The phenocrysts are exclusively of fresh olivine; occasionally the crystals show idiomorphic outlines, but are frequently packed together in nests of irregular grains. No glass is visible in the slide. In another specimen the feldspar laths and augite crystals are of larger size, and the structure is occasionally ophitic. The vesicular rock is noted by Mr. Laing as coming from a dyke, but I think it has in all probability come from a flow, judging from its texture and from its close resemblance to the dolerite from flows in other parts of the island. On inquiry from Mr. Laing, I find that he is not certain on the point, as the exposure was a small one, and not clearly visible.

Ball Bay, East Coast of the Island.

Two specimens come from this locality. They are grey in colour, closer grained than usual, showing to the eye phenocrysts of olivine and augite. Under the microscope they appear to be the ordinary coarse-grained basaltic type found elsewhere on the island. They have a specific gravity of 2·82.

Mount Pitt and Middle of the Island.

A number of specimens come from the neighbourhood of Mount Pitt, the highest point in the island, situated towards its north-west corner. Two samples are from near the summit; one of these is a fairly compact rock and the other very scoriaceous, the former having a specific gravity of 2·65. They are both pinkish-grey in colour. In section the compact rock appears to belong to the doleritic type, with large olivine phenocrysts, fresh or with a brown fringe. The scoriaceous rock contains the same minerals, and, in addition, there are broken-comb forms of ilmenite and an occasional phenocryst of feldspar (med. labradorite).

A specimen from what is known as the Pop Rock, a prominent physical feature situated about half-way up the southern slope of the mountain, is a dark grey, vesicular, and with specific gravity 2·71. Under the microscope it exhibits large phenocrysts of olivine, some fresh, others stained with iron oxide. Augite occurs in small grains in the groundmass, never in large crystals nor with idiomorphic outlines, but usually packed in between the feldspar laths; these appear to be a medium labradorite. Some brown glass full of inclusions is also present.

A specimen from Ghost's Valley, on the western side of Mount Pitt, closely resembles this in general features, but it is very scoriaceous, with the vesicles filled with alteration-products.

Specimens similar to the usual type come from boulders scattered on the surface of the middle of the island.

Philip Island.

The rocks collected by Mr. Laing at this interesting remnant of a larger land-mass prove in every case to be tuffs. One of these is largely composed of lapilli of the size of a small pea, which under the microscope prove to be formed largely of yellowish glass full of vesicles, and containing crystals of clear olivine and augite and laths of plagioclase (med. labradorite) with an occasional feldspar phenocryst. The vesicles are full of decomposition-products; in some cases this is calcite, and in others it appears to be stained with chlorite.

The most interesting feature of these tuffs is an inclusion of pinkish-brown colour and fine-grained texture. In section it is composed of comminuted fragments of quartz, plagioclase, some orthoclase, biotite, and a greenish hornblende, minute zircons, and an irresoluble base full of grains of iron-ore probably derived from mica. There is not sufficient evidence to say definitely what was the nature of the parent rock—whether it was volcanic or plutonic ; but the evidence that exists points perhaps in the direction of the latter. If this is the case, it would afford some slight evidence that the present volcanic mass of these islands was built up on a foundation of plutonic rocks, and even if the fragments are not derived from rocks of deep-seated origin there is undoubted evidence that the islands are built up on a foundation of igneous rocks entirely different from those now exposed everywhere on the surface.

In general facies the rocks of the group appear to be more closely connected with those of Lord Howe Island, and have no relationship to those of the Kermadecs. It is impossible to give any idea of their age, except that the extent to which nearly all are weathered and the diabasic character of some suggest an early Tertiary date for their extrusion.

Art. XLI.—*On a Shingle-spit in Lake Coleridge.*

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

[*Read before the Philosophical Institute of Canterbury, 4th December, 1912.*]

Plate XVII.

In a paper on the physiography of the Mount Arrowsmith district* I drew attention to two hooked spits in Lake Heron, whose formation, judging from the conditions in which they occur, must be attributed entirely to wave-action, and not to the dominant influence of a long-shore current. I do not wish to infer from their occurrence that all spits are so formed, for in the building-up of marine spits currents and tides do undoubtedly play a very important part. Still, I think that the importance of waves as spit-formers is not adequately appreciated, and if their efficiency in lakes where currents do not occur can be thoroughly demonstrated the proper value to be attached to wave-action in the sea may be perhaps more accurately estimated. Some authorities, indeed, have insisted on the importance of wave-action. One need only mention in this connection that Gilbert, in his illuminating paper on the "Topographic Features of Lake-shores,"† notes that Cialdi was of opinion that waves were a dominant factor in the formation of spits in the Mediterranean, although Gilbert himself insists on currents being mainly responsible for them. In a recent paper on the "Shingle-spit as a Plant-habitat,"‡ Professor Oliver, as a result of observations on spits on the English coast, states that in certain cases, at any rate, storm-waves do exert a marked effect on the shape of hooked spits. In Professor Oliver's paper there are numerous observations on minute points of interest in the structure of spits, to some of which I shall have occasion to refer later, and which I shall be able to confirm from observations in Lake Coleridge.

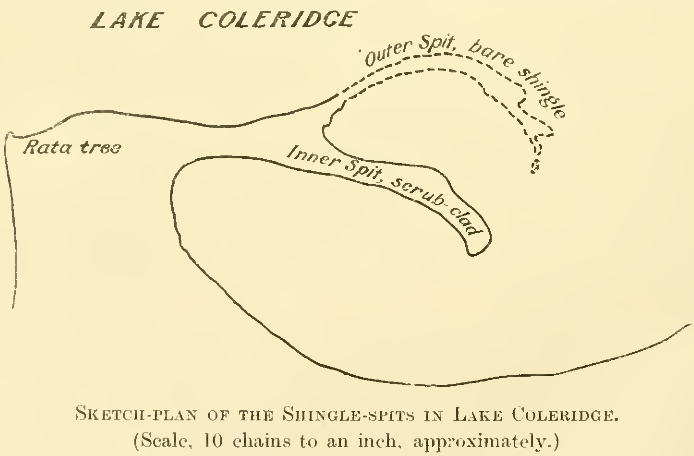
* Trans. N.Z. Inst., vol. 43, p. 324, 1911.
† United States Geological Survey, Fifth Annual Report, 1883–84.
‡ New Phytologist, vol. 11, No. 3, March, 1912.

I referred briefly in my note on the Lake Heron spits to their peculiar form, which appeared to be a fairly common feature, if one can judge from the frequency with which spits of similar shape are figured in publications dealing with the physiography of lake-shores. This I attributed directly to wave-action, for when watching the waves coming down Lake Heron before the strong north-westerly wind I noticed that when they broke on the spit they were invariably parallel to its shore, the change in the direction of the wave-front being due to the retardation produced by the pronounced friction of the bottom in the shallower water near the beach as compared with its comparatively slight effect in the deeper water off shore. The form of the spit, with its general convex curve lakewards, is therefore that of the involute of the different wave-fronts as they break, so that it must have an intimate mathematical relation to the circumstances determining the formation and speed of waves in the immediate vicinity. Unfortunately, I have not sufficient knowledge of mathematics to tackle such a difficult problem, and I cannot demonstrate the exact curve which should result from its solution, although I am confident that it should be obtainable by mathematical methods, and the result would confirm the inferences drawn from observations in the field.

The present note is intended to draw attention to a hooked spit occurring in Lake Coleridge whose formation appears to me to be entirely due to wave-action.

Situation and General Surroundings.

The spit to which I wish to refer particularly is situated in the south-west corner of Lake Coleridge, about a mile from the Lake Coleridge homestead. At its proximal end, where it is joined on to the solid land, there is a *roche moutonnée* with distinctly striated and fluted surfaces, and on its extreme point grows the rata-tree made historical by references in Lady



Sketch-plan of the Shingle-spits in Lake Coleridge.
(Scale, 10 chains to an inch, approximately.)

Barker's "Station Life in New Zealand." It is satisfactory to note that this tree is still flourishing, although it is the only one growing on that part of the lake-shore. From this tree stretches first of all a true beach, and then the free portion of the spit, about 20 chains in length. The spit varies in width up to about 3 chains. About half-way along it divides into two, the outer part being of recent formation and separated from the parent spit by a strip of shallow water. The water is comparatively deep within the loop of the spit, and between its end and the shore is as much as 20 ft.

Lake Coleridge is a long narrow lake, some eleven miles in length, and a mile and a half wide at its widest part, narrowing to three-quarters of a mile about half-way up, where a peninsula juts out from the eastern side. It is very deep, with steep under-surface slopes. Its length lies directly in the line of the northerly winds which sweep down from the Southern Alps, and at times raise a nasty and dangerous sea. The spit is placed at a spot where these waves would in all probability reach their maximum height and have a maximum effect. No other wind is deserving of serious consideration as far as this spit is concerned. There can be no current in the lake in the vicinity of the spit, since what small discharge there is takes place from the other end of the lake, eleven miles away.

Origin of the Material of which the Spit is built.

The spit is formed entirely of the greywacke which is the principal rock occurring in all the mountain district of Canterbury. The pebbles attain a diameter of about 3 in., but included among them is a large quantity of small material. Finer detritus mixed with peaty matter has formed a fringe of swamp along the inner margin of the hook, especially towards its proximal end, where there is a considerable area of boggy ground. The great bulk of the material of which the spit is formed has come from farther up the lake, where there is a supply of pebbles of all sizes in the cliffs of glacial boulder-clay fringing its shore. These cliffs commence about 10 chains away from the point on which the rata-tree grows, and extend with intermissions of solid rock for nearly three miles up the western side of the lake. It is remarkable, however, that pebbles can be transported along a shore which deepens so rapidly. I have been able to secure a tracing of the minute and accurate survey made by Mr. F. T. Kissel, the Resident Engineer for the power scheme, and I find that in places along this stretch of shore the 60 ft. subsurface contour-line is at times within 2 chains of the margin of the lake, although in others it is as much as 6 chains. It would seem that even these stretches of steep slope are not thoroughly efficient in preventing the transport of beach-shingle. That it does so travel is certain, for at the intake of the tunnel for the power-supply, which is about a mile and a half from the spit, a peculiar form of hard slaty greywacke was encountered. The spoil from the tunnel is thrown into the lake, and this is carried down and forms small beaches between it and the spit, and is, indeed, transported across the water, 20 ft. in depth, which separates the distal end of the spit from a beach at the southern end of the lake. This beach is formed of fine shingle, some of which is undoubtedly derived from the tunnel, and its presence serves to emphasize the importance of waves as transporting agents even when there are no appreciable tides or currents to aid them. Mr. Kissel has pointed out to me that the strongest waves occurring in the lake tend to destroy the small beaches round its shore, because the loose material is carried outwards to greater depths by the stronger undertow and dropped down the steep subsurface slopes into deep water, and is thus removed from the belt along shore where waves exert influence. Moderate waves are, therefore, in this case more potent beach-formers, because they do not move the shingle so far out. This factor is perhaps of relatively small importance in the neighbourhood of the spit, since the water deepens off shore gradually, and shingle is not likely to be carried out into deep water by the undertow. No doubt this did really occur in former times, before this part of the lake was made shallower by detrital accumulations.

Form of the Spit.

The form of this spit is by no means as perfect as those in Lake Heron. It is modified to some extent by the doubling of the loop, but both show a decided convexity to the lake. Gilbert insists that lake-spits usually exhibit a concavity towards the open water, but this feature is absent in all lake-spits that I have seen. If spits are formed in the way I suggest, then they must necessarily, in their initial states at least, be convex to the open water, as the evolute of a number of wave-fronts will have its outward curve turned in that direction. There is, however, a process in operation in some spits, and certainly in those in Lake Coleridge, which will turn a convex curve into a concave one. All along the distal portion of this spit there are signs that it is being moved bodily backward towards the shore by the action of the waves. During strong winds, and at times when the level of the lake is above normal, the beach is driven landwards and built up in the form of a *levée*, and this in spite of the stability which has been given to it by the covering of scrub and other vegetation. This spit is covered with low forest containing the following trees: Manuka, kowhai, the cabbage-tree, and the scrub-formers such as *Discaria* and *Suttonia*, together with flax and other swamp-plants. These are being rapidly uprooted along the outer margin, and the shingle beach is piled among those which are still standing. Growing flax which has been dislodged can also be seen beneath the water of the lake. During especially high winds the waves break over this *levée*, and form small washouts on the inner side, which continue the landward movement of the spit. This process is continued, though in a slightly less intense form, by the percolation of water through the bank when the waves are not so high. Small washouts are thus formed in a manner analogous to that described by Professor Oliver in the case of the Chesil Bank, on page 88 of his paper. The resemblance seems to be exact, except that the phenomena in Lake Coleridge are on a smaller scale. However, in both cases the net result is to move the spit landwards. I am not fully aware of all the circumstances of those spits referred to as concave by Gilbert, but I would suggest that this process will make even a convex spit sag landwards eventually. The movement may continue till the proximal portion of the spit becomes a true shore beach. This has occurred in the Lake Coleridge spit. It is also true in one of the most notable spits in New Zealand—viz., that near Nelson, locally called the Boulder-bank. This is some thirteen miles in length, and where tied on to the land is distinctly concave; but its distal portion is convex, and its end has the typical form of a true incurved spit.

In his paper Professor Oliver evidently accepts Gilbert's statement that lake-spits are concave to the open water, and, as he notes that marine spits are frequently convex, he concludes that there is some inherent difference between the formation of lake and sea spits. It appears to me that this distinction is not based on a solid foundation. Some lake-formed spits are undoubtedly convex, and some marine ones are concave. The difference in form appears to be due to the relative importance of wave-action and current-action during the process of building. If the former is predominant, then in their initial stages, at all events, spits will tend to be convex. They may become concave owing to sagging shorewards at a later date, a result accelerated by a slight depression of the land or rise in the water of

Fig. 1.—Showing Inner Spit covered with Scrub.
The rata-tree is just visible in the distance.

Fig. 2.—Showing Outer Spit of Bare Shingle just above Surface of Lake.

 [R. Speight, photo.

the lake. The shape of current-formed spits, or those in which current-action is predominant, will naturally be determined by the direction of the current. This will always tend to sag shorewards as it passes from point to point—the usual position of a spit—and therefore spits formed in this way will naturally present a concavity to the open water.

The end of the inner spit in Lake Coleridge is covered with a small clump of manuka, which seems to have established itself on the raised rounded termination of the loop, a feature which strongly marks the Lake Heron spits. This slight elevation is due to the swing-round of the waves before breaking, owing to differential retardation, and thus there can be little onward movement of the detrital matter in the direction of the spit's length. The beach is therefore raised slightly by the direct piling-up action of the waves coming from nearly all directions. This raised knob at the end of spits I have noticed in numerous illustrations, and it undoubtedly occurs at the end of the Nelson Boulder-bank.

The inner spit is not so perfect in form as those in Lake Heron, a feature no doubt due to the deep water off shore allowing of little differential retardation, and the spit is chiefly built up by the send of the seas past the point where the rata-tree is growing. However, it approximates to the shape which I should expect. The ideal is more nearly reached by the outer spit, which, according to Mr. Kissel, has increased appreciably from the spoil thrown out from the tunnel-works. Its inner margin is, however, tolerably even, but the outer edge is distinctly serrated, three marked jags no doubt indicating the work of successive storms. The end is distinctly incurved, and approximates closely to the ideal form.

ART. XLII.—*Redcliff Gully, Rakaia River.*

By R. SPEIGHT, M.Sc., F.G.S.

[*Read before the Philosophical Institute of Canterbury, 4th December, 1912.*]

IN Redcliff Gully, on the south bank of the Upper Rakaia River, there is a small outlier of pink-coloured limestone, which derives some importance from the fact that Captain Hutton, in his paper on the "Origin of the New Zealand Fauna and Flora,"* cited the occurrence as a proof of his contention that the Rakaia Valley during early Tertiary times was eroded to a deeper level than at present, and that there could have been no plateau to the south of the Rakaia, as demanded by Haast in his explanation of the former extension of our glaciers. McKay also mentions† that the Redcliff limestone was placed on or near the line of one of the great structural faults which he postulated as being responsible for the preservation of several of the small outliers of Tertiary limestone and other beds which lie in the remote recesses of several of our alpine valleys. He suggested that they were remnants of a wide extent of Tertiary beds which had been faulted down, and so escaped to some extent the erosive action of the great Pleistocene glaciers. Seeing that the occurrence was of somewhat varied interest, and that no accurate account of the locality was available, the present author examined

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* "Annals and Magazine of Natural History," 1884 and 1885.

† "Report of the New Zealand Geological Survey for 1890–91," p. 15.

the beds towards the end of the year 1912, and this paper gives an account of his conclusions arrived at on that occasion. I must take this opportunity to express my obligation to Mr. W. F. Robinson, Lecturer on Surveying at Canterbury College, who accompanied me on the visit, and gave material assistance in determining the relative position of various points of importance, and to whom I am indebted for the sketch of the locality on page 339.

Position and General Features of the Locality.

(See map and topographic sketch.)

Redcliff Gully is situated on the south bank of the Rakaia River, about fifteen miles above the Gorge Bridge, and forms part of Mr. Gerard's Double Hill Station. On the opposite side of the Rakaia lies Lake Coleridge, and the pipe-line of the power scheme connected with it reaches the Rakaia about two miles below the mouth of the gully, so that if at any future occasion it is intended to apply this power for the manufacture of calcium carbide or other calcium compound the position is eminently favourable for carrying it to a successful issue.

The level of the bed of the Rakaia is at this spot approximately 1,260 ft. above the sea, while the highest point of the limestone exposure is 3,060 ft. The mountains in the immediate vicinity reach to nearly 7,000 ft., and about five miles to the south-east is Mount Hutt (7,180 ft.), the highest of all the peaks in the range which rises directly from the Canterbury Plains. At the head of the gully is Redcliff Saddle (2,980 ft.), from which an easy track leads south to the head of a branch of the North Ashburton. This pass forms a well-marked depression in the range which bounds the Rakaia on the south, and shows in its flowing contours and U-shaped cross-section unmistakable signs of severe glacial erosion ; glacial shelves are common, and morainic matter is scattered over the surface and at times masks with a covering of variable thickness the limestones and beds associated with them. Signs of glaciation are also clearly visible on the main valley of the Rakaia in the vicinity. Stranded lateral moraines; *roches moutonnées* rising from the floor of the valley; the silt-filled lake-bed which has been now drained by the erosion of the river; and the imposing wall-like sides of the valley with its steep even slopes rising to 2,000 ft. above its floor; the truncated spurs; and just across the river the great barrier of glacial drift, full of scratched stones, forming the dam across the lower end of the lake, and through which passes the pipe-line for the power scheme—all furnish undoubted proofs of the severity of the glaciation. It is evident from the slope of the glacial shelves in the Redcliff Pass and from the general form of its valley that an overflow of ice from the basin of the Rakaia took place at the height of the glaciation. On the shoulder of the spur from Mount Hutt which juts out into the angle between the tributary valley and the main stream this action is very pronounced. One can easily picture the great ice-stream impinging on this part of the mass of Mount Hutt, and causing pronounced abrasion as the ice was packed at the angle before it flowed away either down the main stream or was diverted towards the Ashburton.* The thickness of ice must have reached 2,000 ft., and it probably exceeded this amount.

The block of reddish limestone from which this locality takes its name lies a little back behind the general line of the valley-walls, and no doubt

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* A similar overflow of ice must have occurred higher up the Rakaia Valley, at the junction of the Lake Stream with the main river.

owes its preservation primarily to this position. On both sides of it streams have cut down along the junction of the limestone and the underlying greywacke, so that it is partially isolated, but the level of its upper surface is practically that of the saddle, and there is no marked physical feature isolating it in this direction. The front block, whose thickness exceeds 150 ft., forms a great cap slightly tilted forward, a position perhaps due to creep of the beds towards the Rakaia. The creek on the western side of this block is known as Packer's Creek, named so from a narrow pack-track leading along its side, while the stream on the eastern side, the larger of the two, is known as Cascade Creek. The latter rises from the saddle itself, and on its steep western bank is a slip in which are exposed all the beds of the series associated with the limestone. Between these two creeks the limestone forms a prominent scarp, extending round in a rude semicircle with its convexity facing the Rakaia. The position of the two creeks has been naturally determined by the line of junction of the limestone with the underlying greywacke, but Cascade Creek is placed on the axis of a small anticline of the folded greywackes.

STRATIGRAPHY.

The relative position of the beds occurring in the locality can be best studied in a section that runs in a westerly direction from Cascade Creek, up the slip mentioned previously, over Redcliff Hill, towards Packer's Creek. The underlying beds, of probable Mesozoic age, in Cascade Creek, consist of slaty shales with bands of greywacke having a northerly strike and a nearly vertical dip (see fig. 1). The arrangement here is distinctly

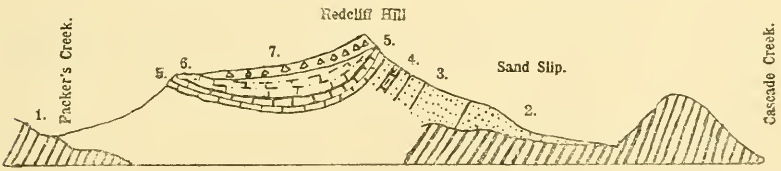

FIG. 1.—SECTION ALONG LINE AB, FROM PACKER'S CREEK TO CASCADE CREEK.

Length, 1 mile. Direction, N.W. to S.E. 1. Greywackes, &c., varying dip and strike. 2. Greensands (darker towards top), 500 ft. 3. Light-coloured sands, with darker glauconitic layers, 150 ft. 4. Marly and sandy beds, with concretionary layers, 20 ft. to 30 ft. 5. Limestone, 150 ft., probably more. 6. Sands and shell-beds, over 50 ft. 7. Moraine.

anticlinal. The direction of the strike is remarkably variable, for on the southern side of the slip the dip is to the south-west, at an angle of 60°. Similar beds also occur in a *roche moutonnée* in the bed of the river, with a strike a little south of east and an approximately vertical dip. This variation can be seen at times in a very small section, and small faults and marked contortions are frequently visible, emphasizing the intensity of the earth-movements which produced the folding.

Resting unconformably on these greywackes are the beds with which we are more nearly concerned. The following sequence is exposed in the slip :—

1. *Greywackes and slaty shales.*

2. *Greensands*, with an estimated thickness of 500 ft. These beds are light-green below, but become darker in the higher parts. They strike

N. 70° E., and dip at an angle of 55° towards the west. The angle of dip gets slightly steeper in the higher levels. The only sign of fossils that we saw were fragments of oyster-shells occurring towards the top. Their base rests on a highly eroded surface of the greywackes and slaty shales.

3. *Light-coloured yellow and white sands* with an estimated thickness of 150 ft. These are at times quite incoherent, but they are occasionally cemented together. In their higher levels they are interstratified with argillaceous bands, which become decidedly calcareous towards the top, where there is a thin band of calcareous sandstone, succeeded by a bed 20 ft. in thickness of sandy marl. The actual contact of this with the overlying limestones was not visible, owing to slip-accumulations.

4. *Limestone.*—The limestone which follows conformably is pinkish in colour, somewhat crystalline in character, flaggy in the lower parts, but more compact and even and breaking into cuboidal blocks towards the top. It contains numerous fragments of *Mollusca* and Echinoderms, but it was found impossible to extract them. The thickness of this bed is at least 150 ft. In the slip the strike is N. 70° E., and dip to the west at an angle of from 60° to 70°. The limestone forms the top of Redcliff Hill, but at the actual summit it is capped by a thin veneer of morainic matter.

5. *Calcareous sandstone and shell-beds.*—These lie conformably over the limestone, and attain a thickness exceeding 50 ft., the actual amount being uncertain. They become more sandy in their higher parts, and are interstratified with layers of concretionary sandstone. These contain well-defined bands composed of shell-fragments, but it was difficult to get good specimens for determination. The following genera and species were recognized: *Glycimeris globosa*, *G. laticostata*, *Cucullaea alta*, *Chione mesodesma*, *Crassatellites amplus*, *Mesodesma australe*, *Turritella* sp. ?, *Ancilla australis*, *Voluta* sp. ?, *Polinices gibbosus*, *Struthiolaria spinosa*, *Struthiolaria* sp. ?, *Siphonalia mandarina*.

6. *Morainic deposits.*—These cover up the surface in many places to a varying thickness. The material is invariably of greywacke, &c., from the Mesozoic rocks, and consists chiefly of boulders and blocks of large size. These beds lie unconformably on both the limestones and the older rocks.

This is the complete series as far as the locality is concerned, and, with the exception of the underlying greywacke and the overlying glacial material, it is conformable throughout. The age of the beds is determined with a certain amount of accuracy by the fossil-content of the sandy layers overlying the limestones. The species identified show that the fauna is of the same character as that occurring in the Pareora beds of North and South Canterbury, which are usually assigned to the Upper Miocene.

No other exposure in the locality shows the series as completely as that in the slip, since the general surface of the rocks in position is masked by material detached from the limestones and by morainic matter. There seems, however, to be no doubt that under the limestone scarp facing the Rakaia the sands of the lower part of the series occur, but they are quite hidden. It is probable, too, that they have formed a slipping surface, on which the great block of limestone which overlooks the bed of the river has been slightly canted forward (see fig. 2).

Captain Hutton states that there is no disturbance of the beds, a conclusion based, I believe, on an incomplete examination. The steep inclination of the series as seen in the slip facing Cascade Creek is continued towards the west, and on following the outcrop of the limestone towards the southwest it is found to swing round and become steeper still. There is a gap then in the line of outcrop, but the limestones appear again on the east side of the upper part of Packer's Creek, and here they are in all probability almost vertical, if not slightly overturned. This observation is, however, somewhat doubtful, as the planes of stratification could not be determined with certainty. The beds appear to form a basin-shaped syncline, although I could see no sign of the sandy beds which overlie the limestone in the position that they should occupy on its western wing, owing to the morainic and other detrital accumulations on the surface. This appears to me to be the most satisfactory explanation of the structure of the beds in this part of the area. On the north side of this syncline there is a block of limestone which also shows synclinal structure with the axis running nearly north. On the western flank the beds have a slight dip to the south-east, and are distinctly overlain by the shell-beds which usually cap the limestone. They are thus in the position required by the presence of the syncline. The limestone on the western wing of this syncline forms a high escarpment fronting

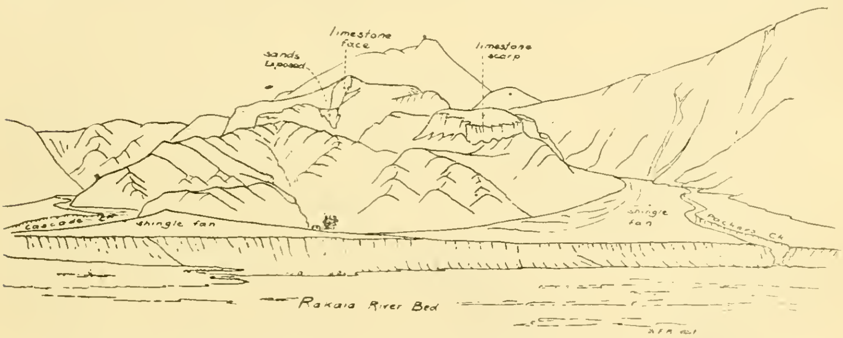

FIG. 2.—PROFILE OF LIMESTONE ESCARPMENTS, REDCLIFF GULLY.
As seen from Castle Rock Island, Rakaia River, looking south.

the middle part of Packer's Creek. Its southern termination is 500 yards distant from the block in the upper part of Packer's Creek, and is 300 ft. above it. It seems, therefore, that a fault is present, the effect of which has been to raise the middle block of limestone relatively to the southern block, or to depress the southern block relatively to the middle block (see fig. 3). This fault is in the nature of a *flaw* or *blatt* cutting the main direction of folding nearly at right angles. It is unfortunate that no exposure of rock allows the structure of the syncline to the south to be definitely determined, but this appears to be the only explanation, especially when taken in conjunction with the structure of the most northerly block—viz., that overlooking the Rakaia directly. This also appears to be separated from the middle block by a *flaw* or *blatt*, the effect of which is to cause an apparent downthrow of the block to the north. This fault does not pass right through the series to the east, but its effect is noticeable in the sagging downward of the limestone scarp on the east from its greatest height in the slip facing Cascade Creek as it is followed north to towards the Rakaia. On tracing this scarp round, it is found that the dip gradually flattens out till the cliff is reached at the northern end, where the beds are practically horizontal. On following the scarp towards Packer's Creek the dip changes gradually, and the inclination is to the east at very low angles, and this gradual swing continues till the fault is reached. This portion of the area thus exhibits a synclinal arrangement.

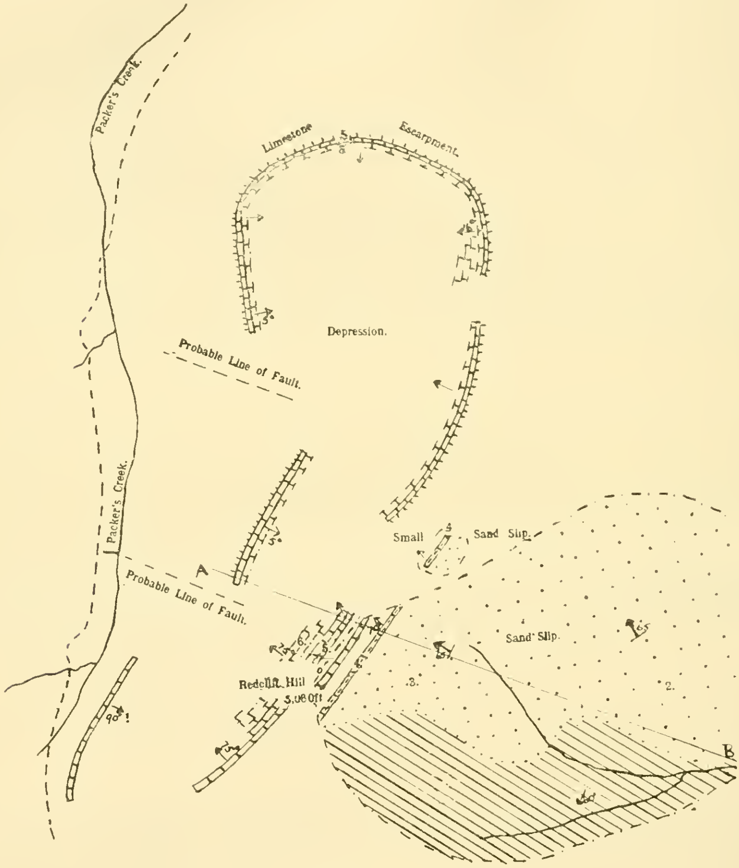

FIG. 3.—GEOLOGICAL SKETCH-MAP OF LIMESTONE, ETC., BEDS IN REDCLIFF GULLY, RAKAIA VALLEY.

Surface deposits not indicated. Scale, $1\frac{1}{2}$ in. to the mile (approximately). 1. Greywacke, slaty shale. 2. Greensands. 3. Sands. 4. Marl. 5. Limestone. 6. Calcareous sands and shell-beds.

It seems, therefore, that the beds have been subject to folding agencies which have operated in a roughly east-and-west direction, and that under their influences the middle block has been raised and cut off on its western margin from the neighbouring blocks whose edges preserve their proper alignment. This is the only sign that I observed of the beds having been affected by faulting. They show just that intensity of dislocation which can be observed in other parts of Canterbury, notably in the Trelissick basin at Castle Hill, distant sixteen miles to the north-east. Their elevation—fully 2,000 ft. above similar beds at the Curiosity Shop, three miles below the Gorge Bridge—implies that a considerable amount of differential elevation has taken place in the central parts of the Southern Alps, a fact which is also confirmed by a consideration of the Trelissick basin. This elevation, taken in conjunction with the slight folding which the beds exhibit, shows that the movements which formed these mountains had not ceased in late Tertiary times, although, judging from the absence of earthquakes associated with the chain, they have apparently ceased by now.

One statement of Captain Hutton's should not be passed over without comment—viz., that the mound in the bed of the Rakaia known as Castle Rock is composed of limestone. Although a casual examination of it from a distance, especially as it is coloured slightly red in places, suggests that it may be a fragment of the Redcliff limestone, a close examination of it shows that it is entirely composed of greywacke and slaty shale, with a strike a little south of east and a vertical dip. The rock is only 10 chains long, and from 3 to 4 chains wide, and about 25 ft. raised above the river-bed, so that there can be little doubt that a mistake has been made. No other rocks could be seen in the river-bed to which Captain Hutton's description could apply.

His argument as to the erosion of our valleys in pre-Tertiary times, as based upon this evidence, must therefore be taken with a considerable amount of reservation. At the same time, it must be admitted that the surface of the Alps had suffered erosion before the end of the Cretaceous period, and that during a subsequent time of depression the sea invaded the inlets thus formed, and portions of the marine beds then laid down were, in specially favourable localities, preserved from the erosion of glaciers and other denuding agents. Whether faulting has contributed to the preservation of these beds is still an open question as far as Canterbury is concerned. It must be admitted that a strong case can be made out in regard to the Trelissick basin, but the Redcliff outlier furnishes none, as far as my own observations go.

Further, there is no sign in the conjunction of beds of dissimilar lithological character, or in the landscape features, that any major line of faulting occurs connecting the Trelissick basin and Redcliff Gully. The former is a basin the result of folding, or prehaps a *senkungsfeld*, but it is quite isolated, and surrounded on the western and south-western sides by the uniformly high (between 6,000 ft. and 7,000 ft.) Craigieburn Mountains, in which there is no notch or other landscape peculiarity demanded by such an earth-movement as one accounting for the simultaneous formation of both of these limestone outliers would necessarily require.

Art. XLIII.—*Note on the Rate of Erosion of the Hooker and Mueller Glaciers.*

By P. Marshall, M.A., D.Sc., F.G.S., F.R.G.S., Professor of Geology, Otago University.

[*Read before the Otago Institute, 6th August, 1912.*]

Much discussion, and even controversy, has taken place amongst geological observers in all countries in regard to the importance of glacial erosion. By some, almost unlimited powers have been ascribed to it; by others, almost all effectiveness has been denied to it. Spirited as the discussions have been, there have yet been but few attempts to estimate the rate at which glacial erosion is acting at the present time. Whereas elaborate measurements have been made in regard to the rate at which rivers and all flowing water lowers the land-surface, glaciers and glacial streams have been to a great extent immune from such inquisitive activity.

In New Zealand in particular no attempts have been made to estimate the amount of sediment contained in the water of rivers that flow from glaciers. It was with the idea of initiating local inquiry that the following records were made. It was originally intended to take samples of the water of the Mueller River where it issued from beneath the ice of the glacier. It was, however, found that the outlet of the river had so changed its position that it was practically impossible to obtain samples of the water. This forced me to take samples from beneath the Hooker Bridge, a quarter of a mile below the Mueller outlet, and two miles below the source of the Hooker River. While this is somewhat unsatisfactory, it is thought that the amount of sediment contained in the water is practically the same as at the point where the rivers ac ually issue from beneath the ice.

It is, of course, recognized that the amount of sediment suspended in glacial water represents the amount of rock removed by one only of several different activities that are effective in glacial regions. The suspended matter is of an extremely fine and impalpable nature and of a pale-grey colour, and it almost certainly represents the material derived from the filing action of rock-fragments dragged over the rocky bed of the glacier during the slow movement of the ice. The amount and nature of the erosion due to the transport of morainic matter, to the plucking action of the ice, and to solution are not here referred to. The quantities of sediment were as follows:—

Nov. 17, 1911	.. .. 1 part in	9,009	of water.
,, 18, ,,	.. .. ,,	18,220	,,
,, 19, ,,	.. .. ,,	14,188	,,
,, 20, ,,	.. .. ,,	11,815	,,
,, 23, ,,	.. .. ,,	16,982	,,
,, 25, ,,	.. .. ,,	14,000	,,
Feb. 3, 1912	.. .. ,,	15,765	,,
,, 7, ,,	.. .. ,,	885	,,
,, 17, ,,	.. .. ,,	9,459	,,
,, 29, ,,	.. .. ,,	9,700	,,
Mar. 15, ,,	.. .. ,,	27,046	,,
,, 25, ,,	.. .. ,,	39,141	,,

The average of these estimations is 1 part of sediment in 15,523 parts of water.

Records of a similar nature made in other countries are not very numerous. The following are quoted from Hess, "Die Gletscher": The average for the Rhone Glacier is 1 part in 1,611 of water; the Arve, 1 in 4,166; the Aare, 1 in 7,042; the Muir Glacier, 1 part in 77 of water. From such records the inference has been drawn that the rate of glaciation depends largely upon the degree of glaciation, which is, of course, intense in Alaska, where the Muir Glacier flows.

Further records show that the annual variation is considerable. Thus, in 1890 the Bossons Glacier delivered water that contained 1 part of sediment in 437 parts of water, but in 1891 it contained only 1 part in 2,078 of water; the Tour Glacier in 1890 contained 1 part in 4,115, and in 1891 1 part of sediment in 32,193 parts of water.

It is probably in these records that an explanation is to be found of the low average of sediment in the water of the Hooker River. In November, when most of my samples were taken, the weather was extremely cold, and light snow fell on several occasions at the Hermitage, though the total precipitation was quite small, and the river during the whole of my visit was very low—not higher than winter level, in the opinion of the guides. Chief Guide A. Graham, who kindly took the later samples for me, states, "The river, on the whole, has not varied much during the summer, so the samples that I am sending you, with those taken by yourself, should give a fair average for this summer. With a summer like that of last year I am sure that the sediment would have been in much greater quantity. I took a sample of the water during one small fresh in February."

It is, of course, well known that the summer of 1911–12 was the coldest that has been experienced in New Zealand for a considerable time. Calculations based on the amount of sediment stated above show that if the erosion were supposed to be of equal amount over the whole of the *névé* and glacier area the rock-bed would be undergoing removal at the rate of $\frac{1}{63}$ in. annually, or 1 ft. in 756 years. This is an extremely slow rate when compared with the action of the Muir Glacier, which lowers its bed by $\frac{3}{4}$ in. annually. Despite the small amount of sediment in the water, the high precipitation in the region causes the rate of erosion to be more than twice as rapid as that of the Aare Glacier, which lowers its bed 1 in. in 170 years, or 1 ft. in about 2,000 years. It is, however, probably true that the effect of erosion is far more pronounced in the bed of the glacier, where the ice is thickest, than elsewhere; and if it is supposed that the action is so distributed that half the total of sediment is derived from 5 square miles of glacier-floor, then that floor would be eroded a depth of 4,000 ft.—the depth of many of our glacial valleys—in about 1,000,000 years. The action appears to be somewhat more rapid than stream-action in the same region.

Objection may be offered to these statements on the ground that some of the sediment is carried to the ice by streams that flow down the steep glacial walls in that part of the glacial valley that lies below the ordinary snow-line, and contribute water-derived sediment to the ice. This suggestion is discounted by the very nature of the sediment in rivers that have a glacial origin: it is unoxidized, and so fine that no settlement takes place in twenty-four hours. The hillsides mentioned are covered with snow for many months of the year, and their water is filtered by passing through the lateral moraine before they join the glacier. Even when flooded after heavy summer rain the water of these streams is almost clear of sediment.

It is hoped that, with the assistance of Chief Guide Graham, further records will be made in future years.

Art. XLIV.—*On Steiner's Envelope.*

By E. G. Hogg, M.A., F.R.A.S., Christ's College, Christchurch.

[*Read before the Philosophical Institute of Canterbury, 4th December, 1912.*]

The envelope of the pedal lines of a triangle is a tri-cusp hypocycloid, whose centre is at the nine-point centre of the triangle. This curve—known as "Steiner's envelope"—has been discussed in many memoirs, but, so far as the author of the present paper is aware, no determination has yet been made of the three points whose pedal lines are the cuspidal tangents of the hypocycloid, and the object of this note is to show how these points may be found, and to indicate briefly certain interesting properties which they possess.

The polar of any point O′ $(\alpha'\beta'\gamma')$ with respect to the circle, $S \equiv a\beta\gamma + b\gamma\alpha + c\alpha\beta = o$, circumscribing the triangle of reference ABC, is

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

If this line passes through the point $\left(\frac{1}{\alpha'}\ \frac{1}{\beta'}\ \frac{1}{\gamma'}\right)$, the isogonal conjugate of O′, then the locus of O′ is the cubic curve

$$C \equiv \alpha^2(b\beta + c\gamma) + \beta^2(c\gamma + a\alpha) + \gamma^2(a\alpha + b\beta) = o \qquad \ldots \quad \text{(i)}$$

If α be eliminated between the equations $S = o$ and $C = o$, the following cubic is given for finding the ratio $\beta : \gamma$ of the intersections of the two curves :—

$$c(c^2 - a^2)\beta^3 + 3bc^2\beta^2\gamma + 3b^2c\beta\gamma^2 + b(b^2 - a^2)\gamma^3 = o \ldots \quad \text{(ii)}$$

The functions H and G of this cubic are $H = -a^2b^2c^2$, $G = a^2bc^2\{b^2(a^2 + c^2) - (c^2 - a^2)^2\}$, whence $G^2 + 4H^3 = -16\triangle^2 a^4b^2c^4(c^2 - a^2)^2$, where $\triangle$ is the area of the triangle ABC.

Hence it follows that the roots of the cubic (ii) are all real—*i.e.*, the cubic C meets the circle ABC in three real points besides the vertices of the triangle ABC.

Let P be one of the points of intersection of the circle and cubic C. The tangent to the circle at P will, since it passes through the isogonal conjugate of P, be perpendicular to the pedal line of P, and the isogonal transformation of this tangent will be a parabola circumscribing the triangle ABC, and passing through the point P. The axis of this parabola will be perpendicular to the pedal line of P; it will also be parallel to one of the bisectors of the angles between the common chords of intersection AB, CP of the circle and parabola.

Let the arc AP subtend the angle $2x$ at O, the centre of the circle ABC; let D, E, F be the feet of the perpendiculars from P on BC, CA, and AB respectively; let PC meet AB in G, and let GX be the bisector of the angle BGC. Let PO and PD meet AB in H and N respectively.

Since FD and HP are parallel, FDP $= x =$ HPN. Hence in the triangles PNH, PNB, since HPN = PBN, and PNH is common, the two triangles are equiangular.

$$\begin{aligned}
\text{Again, } BGX &= \tfrac{1}{2}(A + x) = PHN \\
&= BPD \\
&= 90^\circ - (B + x) \\
\therefore A + x &= 180 - 2(B + x) \\
\therefore \quad 3x &= 180^\circ - 2B - A = C - B \\
\therefore \quad x &= \tfrac{1}{3}(C - B).
\end{aligned}$$

Hence the position of the point P is found.

If K be the orthocentre of the triangle ABC, then by a well-known theorem PK is bisected by DEF; DEF is parallel to OP; therefore DEF bisects OK—*i.e.*, it passes through the nine-point centre. Hence since DEF is a tangent to the hypocycloid and passes through the centre of the curve, it is a cuspidal tangent.

Since the cuspidal tangents meet at angles of 120°, the other points Q and R in which the cubic C meets the circle S and whose pedal lines are cuspidal tangents will form with P an equilateral triangle inscribed in the circle ABC. This follows from the fact that the pedal lines of the extremities of a chord of a circle meet at an angle equal to the angle at which the chord cuts the circle.

The trilinear ratios of the points P, Q, R are respectively :—

$$[\operatorname{cosec} x, \operatorname{cosec}(C - x), -\operatorname{cosec}(B + x)],$$
$$[\operatorname{cosec}(C - y), \operatorname{cosec} y, -\operatorname{cosec}(A + y)],$$
$$[-\operatorname{cosec}(B + z), \operatorname{cosec}(A - z), \operatorname{cosec} z],$$

where $2y$ and $2z$ are the angles subtended by QB and RC respectively at A.

The equations of the cuspidal tangents are

$$a\alpha \tan x - b\beta \tan(C - x) + c\gamma \tan(B + x) = o$$
$$-a\alpha \tan(C - y) + b\beta \tan y + c\gamma \tan(A - y) = o$$
$$a\alpha \tan(B + z) - b\beta \tan(A - z) + c\gamma \tan z = o.$$

The following properties of the points P, Q, R may be noticed :—

i. The tangent to the circle ABC at P is the axis of the parabola inscribed in the triangle ABC and having its focus at P.

ii. The rectangular hyperbola which is the isogonal transformation of OP has its asymptotes parallel and perpendicular to OP.

iii. If P′ be the other extremity of the diameter through P, then the pedal line of the point P′ will touch the nine-point circle of the triangle ABC.

iv. If the lines PA, PB, PC meet BC, CA, AB in A′B′C′ respectively, then the triangle A′B′C′ is self-conjugate with respect to the parabola, which is the isogonal transformation of the tangent to the circle ABC at P.

v. The asymptotes of the cubic $C = o$ are parallel to the tangents to the circle ABC at P, Q, R, and are concurrent at the centroid of the triangle ABC.

Art. XLV.—*On certain Tripolar Relations: Part I.*

By E. G. Hogg, M.A., F.R.A.S., Christ's College, Christchurch.

[*Read before the Philosophical Institute of Canterbury, 4th December, 1912.*]

§ 1. If any point P be taken in the plane of the triangle ABC, its tripolar co-ordinates are AP^2, BP^2, CP^2. Writing X, Y, Z for these quantities we have

$$X \sin^2 A = \beta^2 + \gamma^2 + 2\beta\gamma \cos A$$
$$Y \sin^2 B = \gamma^2 + \alpha^2 + 2\gamma\alpha \cos B$$
$$Z \sin^2 C = \alpha^2 + \beta^2 + 2\alpha\beta \cos C,$$

where (α, β, γ) are the trilinear co-ordinates of the point P.

The fundamental relation—due to Cayley—connecting the mutual distances of the points A, B, C, P is $a^2X^2 + b^2Y^2 + c^2Z^2 - 2bc \cos A\ YZ - 2ca \cos B\ ZX - 2ab \cos C\ XY - 2abc\ (a \cos A\ X + b \cos B\ Y + c \cos C\ Z) + a^2b^2c^2 = 0$ ... ... (i).

If $X : Y : Z = \lambda : \mu : \nu$, then there are two points P, Q which satisfy this relation—viz., the common points of the coaxial system of circles

$$\frac{X}{\lambda} = \frac{Y}{\mu} = \frac{Z}{\nu}$$

This system of circles is cut orthogonally by the circle ABC, and P, Q are inverse points with respect to the circle ABC.

§ 2. The equation $lX + mY + nZ = \kappa$ represents in general a system of concentric circles as κ varies. Transforming to trilinear co-ordinates the tripolar equation $lX + mY + nZ = o$, we have

$$(\alpha \sin A + \beta \sin B + \gamma \sin C) \left\{ \frac{\alpha}{\sin A} \left(\frac{m}{\sin^2 B} + \frac{n}{\sin^2 C} \right) + \frac{\beta}{\sin B} \left(\frac{n}{\sin^2 C} + \frac{l}{\sin^2 A} \right) + \frac{\gamma}{\sin C} \left(\frac{l}{\sin^2 A} + \frac{m}{\sin^2 B} \right) \right\}$$
$$= \frac{l + m + n}{\sin A \sin B \sin C} (\beta\gamma \sin A + \gamma\alpha \sin B + \alpha\beta \sin C).$$

Hence if $l + m + n = o$, the equation $lX + mY + nZ = o$ reduces to the product of the line at infinity, and the line

$$\frac{\alpha}{a} \left(\frac{m}{b^2} + \frac{n}{c^2} \right) + \frac{\beta}{b} \left(\frac{n}{c^2} + \frac{l}{a^2} \right) + \frac{\gamma}{c} \left(\frac{l}{a^2} + \frac{m}{b^2} \right) = o,$$

which, being satisfied by (cos A, cos B, cos C), is a diameter of the circle ABC.

The tripolar equation of the diameter through the point $(\alpha_1\beta_1\gamma_1)$ is

$$[(b^2 - c^2)\ a\alpha_1 + a^2\ (b\beta_1 - c\gamma_1)]\ X + [(c^2 - a^2)\ b\beta_1 + b^2\ (c\gamma_1 - a\alpha_1)]\ Y$$
$$+ [(a^2 - b^2)\ c\gamma_1 + c^2\ (a\alpha_1 - b\beta_1)]\ Z = o.$$

The following particular cases may be noted:—

Euler's line $\Sigma[(b^2 - c^2)X] = o$.
Brocard diameter $\Sigma[a^2(b^2 - c^2)X] = o$.
Diameter through in-centre $\Sigma[a(b - c)X] = o$.
Diameter through symmedian point of medial triangle of triangle ABC $\Sigma[\cos A \cos(B - C)X] = o$.
Diameter parallel to BC $aX - b\cos C\,Y - c\cos B\,Z = o$.
Diameter through vertex A $(b^2 - c^2)X - b^2Y + c^2Z = o$.
Diameter parallel to tangent to circle ABC at vertex A $a\cos(B - C)X - b\cos B\,Y - c\cos C\,Z = o$.

§ 3. If $l + m + n = o$, the equation $lX + mY + nZ = \kappa$ represents a straight line parallel to $lX + mY + nZ = o$. We may now find the equation in tripolar co-ordinates of the line whose trilinear equation is $p\alpha + q\beta + r\gamma = o$.

Let the required equation be written

$$L' \equiv lX + mY + nZ + 4\triangle^2\kappa = o,$$

where $l + m + n = o$ and $\triangle$ is the area of the triangle of reference.

Transforming L′ to trilinear co-ordinates and dividing out by $a\alpha + b\beta + c\gamma$, we have

$$\frac{\alpha}{a}\left(\frac{m}{\sin^2 B} + \frac{n}{\sin^2 C}\right) + \frac{\beta}{b}\left(\frac{n}{\sin^2 C} + \frac{l}{\sin^2 A}\right) + \frac{\gamma}{c}\left(\frac{l}{\sin^2 A} + \frac{m}{\sin^2 B}\right) + \kappa(a\alpha + b\beta + c\gamma) = o.$$

Hence, comparing coefficients, we have

$$\frac{m}{\sin^2 B} + \frac{n}{\sin^2 C} + \kappa a^2 = \lambda pa$$
$$\frac{n}{\sin^2 C} + \frac{l}{\sin^2 A} + \kappa b^2 = \lambda qb$$
$$\frac{l}{\sin^2 A} + \frac{m}{\sin^2 B} + \kappa c^2 = \lambda rc,$$

which give

$$2l + 4\kappa\triangle \sin A \cos A = \lambda \sin^2 A(-pa + qb + rc)$$
$$2m + 4\kappa\triangle \sin B \cos B = \lambda \sin^2 B(pa - qb + rc)$$
$$2n + 4\kappa\triangle \sin C \cos C = \lambda \sin^2 C(pa + qb - rc),$$

whence, by addition, we obtain

$$\kappa = \frac{\lambda R}{2\triangle}(p\cos A + q\cos B + r\cos C)$$
$$2l = \lambda a(-p + q\cos C + r\cos B)$$
$$2m = \lambda b(p\cos C - q + r\cos A)$$
$$2n = \lambda c(p\cos B + q\cos A - r).$$

Hence the required line is

$$L' \equiv (-p + q\cos C + r\cos B)aX + (p\cos C - q + r\cos A)bY + (p\cos B + q\cos A - r)cZ = o.$$

The tripolar equations of the sides of the triangle of reference are

$$aX - b\cos C\,Y - c\cos B\,Z = abc\cos A$$
$$-a\cos C\,X + bY - c\cos A\,Z = abc\cos B$$
$$-a\cos B\,X - b\cos A\,Y + cZ = abc\cos C.$$

The equation of the line through $(\alpha_1\beta_1\gamma_1)$ parallel to BC is

$$-(b\beta_1 + c\gamma_1)\,\alpha + \alpha_1\,(b\beta + c\gamma) = o,$$

whence, substituting $-(b\beta_1 + c\gamma_1)$, $b\alpha_1$, $c\alpha_1$, for p, q, r respectively in L′ we have

$$\begin{aligned} -aX + b\cos C\;Y + c\cos B\;Z + abc\cos A &= 4\triangle\alpha_1 \\ a\cos C\;X - bY + c\cos A\;Z + abc\cos B &= 4\triangle\beta_1 \\ a\cos B\;X + b\cos A\;Y - cZ + abc\cos C &= 4\triangle\gamma_1, \end{aligned}$$

relations by means of which we can transform from trilinear to tripolar co-ordinates.

These three relations constitute Lucas's Theorem. I am unaware of the method by which Lucas obtained them. Casey has proved them by an application of Stewart's Theorem.

By squaring these relations and making use of the fundamental relation (i) we obtain

$$\begin{aligned} 4a^2\alpha_1^2 &= 4YZ - (Y + Z - a^2)^2 \\ 4b^2\beta_1^2 &= 4ZX - (Z + X - b^2)^2 \\ 4c^2\gamma_1^2 &= 4XY - (X + Y - c^2)^2 \end{aligned}$$

Hence, since

$$\begin{aligned} &2\triangle\Sigma\,[(Y - Z)^2\cos A] \\ &= \Sigma\,(a^2X^2) - 2\,\Sigma\,(bc\cos A\;YZ) \\ &= 8R\triangle\;\,[\Sigma\,(a\cos A\;X) - 2R\triangle], \end{aligned}$$

we easily deduce that

$$\begin{aligned} &4\,(a^2\cot A\;\alpha_1^2 + b^2\cot B\;\beta_1^2 + c^2\cot C\;\gamma_1^2) \\ &= \left[2\,\Sigma\{a^2\cot A\,(Y + Z) - \Sigma\,(a^4\cot A)\}\right] \\ &\qquad - 4R\;[\Sigma\,(a\cos A\;X) - 2R\triangle], \end{aligned}$$

whence

$$\begin{aligned} &8R^2\,(\sin 2\,A\alpha_1^2 + \sin 2\,B\beta_1^2 + \sin 2\,C\gamma_1^2) \\ &= [4R\,\Sigma\{a\cos(B - C)\;X\} - 2R\,\Sigma\,(a^3\cos A)] \\ &\qquad - 4R\;[\Sigma\,(a\cos A\;X) - 2R\triangle] \\ &= 8R\;[\Sigma\,(a\cos B\cos C\;X) - 4R\triangle\cos A\cos B\cos C] \\ &= 16R^2\cos A\cos B\cos C\;[\Sigma\,(\tan A\;X) - 2\triangle]. \end{aligned}$$

Hence the tripolar equation of the polar circle of the triangle ABC is

$$\tan A\;X + \tan B\;Y + \tan C\;Z = 2\triangle.$$

It will be noticed that if in the relation

$$4a^2\alpha_1^2 = 4YZ - (Y + Z - a^2)^2$$

X be substituted for α_1^2, the result is the tripolar equation of the parabola which has its focus at A and has BC for its directrix.

If the two lines $lX + mY + nZ = \kappa$ and $l'X + m'Y + n'Z = \kappa'$ be parallel, then

$$\Sigma\,(l) = o \quad \Sigma\,(l') = o \quad \text{and}\ \frac{l}{l'} = \frac{m}{m'} = \frac{n}{n'}$$

The conditions that the two lines should be at right angles to each other are $\Sigma\;(l) = o$, $\Sigma\;(l') = o$, and $a^2\;(mn' + m'n) + b^2\;(nl' + n'l) + c^2\;(lm' + l'm) = o$.

§ 4. If d_1, d_2, d_3 be the lengths of the sides of the pedal triangle of the point P $(\alpha_1\beta_1\gamma_1)$, then

$$d_1^2 = \text{X} \sin^2\text{A},\ d_2^2 = \text{Y} \sin^2\text{B},\ d_3^2 = \text{Z} \sin^2\text{C}.$$

Hence if the sum of the squares of the sides of the pedal triangle of P be given, the locus of P is the circle $a^2\text{X} + b^2\text{Y} + c^2\text{Z} = \kappa$, a circle whose centre is at the symmedian point of the triangle ABC.

The minimum value of $d_1^2 + d_2^2 + d_3^2$ is $\dfrac{3a^2b^2c^2}{\Sigma\,(a^2)}$

The locus of points whose pedal triangles are right-angled is

$$a^2\text{X} = b^2\text{Y} + c^2\text{Z}$$

and two similar circles.

The above circle passes through B and C and has its centre at the point in which the tangents to the circle ABC at B and C intersect.

If the pedal triangle of P be equilateral, then $a^2\text{X} = b^2\text{Y} = c^2\text{Z} = \kappa$. Substituting in relation (i) we obtain the quadratic equation in κ

$$\kappa^2\ [\Sigma\,(a^4) - \Sigma\,(b^2c^2)] - \kappa a^2b^2c^2\,\Sigma\,(a^2) + a^4b^4c^4 = o.$$

The roots of this equation are real, showing that every triangle has two points whose pedal triangles are equilateral.

It is easily deduced that the areas of the two triangles are

$$\frac{\sqrt{3}\,\triangle^2\ [\Sigma\,(a^2) + \sqrt{3}\,\triangle]}{2\ [\Sigma\,(a^4) - \Sigma\,(b^2c^2)]} \text{ and } \frac{\sqrt{3}\,\triangle^2\ [\Sigma\,(a^2) - \sqrt{3}\,\triangle]}{2\ [\Sigma\,(a^4) - \Sigma\,(b^2c^2)]}.$$

The coaxial circles $a^2\text{X} = b^2\text{Y} = c^2\text{Z}$ are the circles of Apollonius, and their common points P, P′ lie on the Brocard diameter.

The distance between P and P′ is $\dfrac{\sqrt{3}\,abc\,\triangle}{\Sigma\,(a^4) - \Sigma\,(b^2c^2)}$

§ 5. If P $(\alpha_1\beta_1\gamma_1)$ and Q $\left(\dfrac{\kappa^2}{\alpha_1}\ \dfrac{\kappa^2}{\beta_1}\ \dfrac{\kappa^2}{\gamma_1}\right)$ be isogonal conjugates, and if $\text{AP} = \text{P}_1$, $\text{BP} = \text{P}_2$, $\text{CP} = \text{P}_3$, $\text{AQ} = \text{Q}_1$, $\text{BQ} = \text{Q}_2$, $\text{CQ} = \text{Q}_3$, then

$$\text{P}_1^2 \sin^2\text{A} = \beta_1^2 + \gamma_1^2 + 2\beta_1\gamma_1 \cos\text{A}$$

$$\text{Q}_1^2 \sin^2\text{A} = \kappa^4\left(\frac{1}{\beta_1^2} + \frac{1}{\gamma_1^2} + \frac{2\cos\text{A}}{\beta_1\gamma_1}\right)$$

$$= \kappa^4\,\frac{\text{P}_1^2 \sin^2\text{A}}{\beta_1^2\gamma_1^2}$$

hence $\text{Q}_1\beta_1\gamma_1 = \pm\,\kappa^2\text{P}_1$, $\text{Q}_2\gamma_1\alpha_1 = \pm\,\kappa^2\text{P}_2$, $\text{Q}_3\alpha_1\beta_1 = \pm\kappa^2\text{P}_3$.

Multiplying these in turn by $a\alpha_1$, $b\beta_1$, $c\gamma_1$ and adding

$$\alpha_1\beta_1\gamma_1\,(a\text{Q}_1 + b\text{Q}_2 + c\text{Q}_3) = \kappa^2\,(a\text{P}_1\alpha_1 \pm b\text{P}_2\beta_1 \pm c\text{P}_3\gamma_1)$$

Also $$\kappa^2\left(\frac{a}{\alpha_1} + \frac{b}{\beta_1} + \frac{c}{\gamma_1}\right) = 2\triangle,$$

hence $$(a\beta_1\gamma_1 + b\gamma_1\alpha_1 + c\alpha_1\beta_1)\,(a\text{Q}_1 + b\text{Q}_2 + c\text{Q}_3)$$
$$= 2\triangle\ (a\text{P}_1\alpha_1 \pm b\text{P}_2\beta_1 \pm c\text{P}_3\gamma_1).$$

If d be the distance between $(\alpha_1\beta_1\gamma_1)$ and the circum-centre, then

$$a\beta_1\gamma_1 + b\gamma_1\alpha_1 + c\alpha_1\beta_1 = \frac{\triangle}{\text{R}}\,(\text{R}^2 - d^2)$$

Hence

$$a\text{Q}_1 + b\text{Q}_2 + c\text{Q}_3 = \frac{2\text{R}}{\text{R}^2 - d^2}\,(a\text{P}_1\alpha_1 \pm b\text{P}_2\beta_1 \pm c\text{P}_3\gamma_1).$$

From the above relations we easily obtain

$$Q_1S_1 = \pm\, 2\triangle P_1\alpha_1$$
$$Q_2S_1 = \pm\, 2\triangle P_2\beta_1$$
$$Q_3S_1 = \pm\, 2\triangle P_3\gamma_1,$$

where $S_1 \equiv a\beta_1\gamma_1 + b\gamma_1\alpha_1 + c\alpha_1\beta_1,$

therefore $$\alpha_1 : \beta_1 : \gamma_1 = \frac{Q_1}{P_1} : \frac{Q_2}{P_2} : \frac{Q_3}{P_3}, \quad \ldots \quad \ldots \quad \text{(ii)}$$

The signs of the ratios following those of the co-ordinates

Also $$\frac{aQ_1S_1}{P_1} = \pm\, 2\triangle a\alpha_1$$
$$\frac{bQ_2S_1}{P_2} = \pm\, 2\triangle b\beta_1$$
$$\frac{cQ_3S_1}{P_3} = \pm\, 2\triangle c\gamma_1.$$

hence $$S_1\left(\frac{aQ_1}{P_1} + \frac{bQ^2}{P_2} + \frac{cQ_3}{P_3}\right) = 2\triangle\,(a\alpha_1 \pm b\beta_1 \pm c\gamma_1)$$
$$= 4\triangle^2.$$

If $(\alpha_1\beta_1\gamma_1)$ move on a circle of radius d concentric with the circum-circle, $S_1 = \frac{\triangle}{R}(R^2 - d^2)$, and therefore

$$\frac{aQ_1}{P_1} + \frac{bQ_2}{P_2} + \frac{cQ_3}{P_3} = \frac{4\triangle R}{R^2 - d^2}$$

Hence the theorem "If P be any point within the triangle ABC at a distance d from the circum-centre, and if Q be its isogonal conjugate, then

$$\frac{BC \cdot AQ}{AP} + \frac{CA \cdot BQ}{BP} + \frac{AB \cdot CQ}{CP} = \frac{4\triangle R}{R^2 - d^2} \quad \ldots \quad \ldots \quad \text{(iii)}$$

If P lie outside the triangle ABC, the relation (iii) must be modified in accordance with relation (ii), and $d^2 - R^2$ substituted for $R^2 - d^2$.

Art. XLVI.—*The Action of Phosphorus on Solutions of Copper Sulphate and certain other Metallic Salts.*

By H. Rands, M.A.

Communicated by Dr. W. P. Evans.

[*Read before the Philosophical Institute of Canterbury, 6th November, 1912.*]

Introduction.

A piece of ordinary yellow phosphorus when placed in a solution of copper sulphate becomes covered with a black film of copper phosphide and then with a firm coating of bright metallic copper. The black phosphide is always found between the phosphorus and the copper. This reducing action of phosphorus was made practical use of before 1865 in the manufacture of phosphor-copper, but the course of the reaction was first definitely investigated by Walter Straub in 1903. He concludes* that

* Journ. Chem. Soc., 1903, vol. 84, ii, 593.

the phosphide plays an important part in the reduction, which is explained by the action between metallic copper and phosphorus when placed in water in a vessel open to the air. In this case the water round the phosphorus slowly becomes black and opaque, and then dark-reddish, owing to the growth in it of exceedingly delicate feathery crystals of copper. Straub gives the following steps in the reaction :—

(*a.*) Phosphorus (oxidized by air) + copper (oxidized by air) = acid copper phosphate.

(*b.*) Acid copper phosphate + phosphorus + water = phosphide + phosphoric acid.

(*c.*) Phosphide + oxygen + water = copper + phosphoric acid.

He concludes that in the well-known action of phosphorus upon a solution of copper sulphate the same series of changes takes place, except that oxidation by the air is replaced by more rapid oxidation by the copper sulphate. The present paper is a summary of a series of experiments showing the inaccuracy of some of Straub's conclusions, and also extending the investigation to other metallic salts.

Phosphorus on Copper Sulphate.

By sealing up phosphorus and copper sulphate solution with the complete exclusion of air it can be shown that atmospheric oxygen is unnecessary for the progress of the reaction.

If the sulphate solution is very dilute, the phosphide formed is not at first attached to the phosphorus, but remains suspended as a black cloud in the solution. After a time, however, some of the phosphide may form a film on the phosphorus, and metallic copper will then soon appear. Thus, while the phosphorus and the solution are directly in contact, phosphide alone is formed. Further, the copper phosphide cloud and the sulphate solution may remain indefinitely in contact without change, showing that the bodies do not react in the manner stated by Straub.

If the phosphorus is suspended in the sulphate solution by means of a copper wire, metallic copper is deposited directly upon the wire as well as upon the phosphorus. This deposition of copper, which may take place several inches away from the phosphorus, is evidently not due to the intermediate formation of phosphide, and is not accounted for in Straub's explanation Under suitable conditions, long strands of bright metallic crystals of copper grow from the phosphorus down into the solution, clearing it of its blue colour as they develop. Each crystal of copper acts as a nucleus for the deposition of more metal, and beautiful fern-like growths several inches in length may be obtained. Here again we have direct deposition of copper independent of the phosphide. It can be shown to be due to the presence of reducing acid in the solution. Thus, after the copper strands have grown to some length, the decolorized liquid surrounding them will readily reduce potassium permanganate, bromine water, mercuric chloride, and gold chloride; warmed with zinc and sulphuric acid, phosphine is formed (by the nascent hydrogen), which turns a crystal of silver nitrate yellow (forming $PAg_3 3AgNO_3$); with silver nitrate it gives a white precipitate which gradually turns brown, but which if quickly washed and dissolved in dilute sulphuric acid decolorizes potassium permanganate solution. These facts prove that the liquid contains a lower acid of phosphorus. Although the available methods of analysis did not enable a definite distinction to be made between phosphorous and hypophosphorous acids in these solutions, the behaviour when titrating with permanganate in acid solution indicated the presence of two different reducing agents.

The Reaction between Phosphorus and Metallic Copper in Water.

This reaction, which is used by Straub to explain the reducing action of phosphorus on all metallic salts, proceeds in the following manner: A black cloud, consisting of extremely fine particles of copper phosphide, appears round the phosphorus. After a few days some of the phosphide forms a film on the phosphorus, and then metallic copper soon appears. As Straub suggests, the copper and the phosphorus are both oxidized by the air, and by diffusion soluble acid copper phosphate is formed. The case is then exactly analogous to that of phosphorus acting on very dilute copper sulphate, and it will be noted that the effects observed are the same. The presence of air is necessary, but the only function of the metallic copper and the atmospheric oxygen is to keep up the supply of copper phosphate. The fact that copper in the presence of water and acids—even very feeble acids like carbonic—readily absorbs oxygen from the air, and forms salts, is well known (*vide* Mendeléeff's Principles, ii, 425). The formation of metallic copper round the phosphorus in this case is seen to be really more complex than in the copper-sulphate case, and Straub is not justified in explaining the one by the other in the manner he does.

The black phosphide mentioned above was separated from the rest of the system, and found to consist of very fine particles, which pass through all ordinary filter papers and even through special baryta papers.

If left in the liquid and exposed to the air, the phosphide is slowly oxidized to the white phosphate; readily on boiling. It decolorizes acidified permanganate, being itself oxidized to phosphate and dissolved. It is slowly soluble in dilute mineral acids, most readily in nitric. With stronger acids it is dissolved readily with evolution of a gas. The phosphide does not react with copper sulphate alone.

Phosphorus on other Metallic Salts.

With copper nitrate reduction takes place with the formation of phosphide and copper, as in the case of the sulphate. On cupric chloride the action is somewhat different, the reduction being chiefly to white cuprous chloride. After several days a very little dark-red copper may appear here and there on the phosphorus. The reason a metallic film is not formed is that if metal is produced it is immediately acted on by the excess of cupric chloride with the formation of the cuprous salt. That the phosphide formed is not merely a secondary product due to combination of the reduced copper and phosphorus is shown by the fact that the black film appears long before any metallic copper, and also before the cuprous chloride.

In the action of phosphorus on copper acetate, besides the phosphide and metallic copper, a flocculent white precipitate appears round the phosphorus. This is copper orthophosphate (a mixture of the normal and the acid salts), which after a time decreases in amount, and ultimately disappears, its copper being deposited as metal.

Phosphorus readily reduces acid copper phosphate to phosphide and copper. Straub's explanation would require modification in this case, for we would have copper phosphate oxidizing copper phosphide to phosphate and itself being reduced to copper.

Phosphorus acts on silver salts with the formation of silver phosphide and metallic silver. The reduction proceeds much more quickly than with the copper salts, and long strands of beautiful white shining silver are developed in a few hours. The solution also becomes golden yellow in colour, owing to the formation of colloidal silver. This colour is destroyed by the addition of potassium nitrate, by warming, or by mere shaking. It is known that these differently coloured solutions of Carey Lea's allotropic silver are obtained by the action of weak reducing agents on silver salts, and hypophosphorous acid has been used by different investigators fo· this purpose.

With silver acetate, sulphate, and phosphate similar phenomena are observed. With a very dilute solution of gold chloride, ruby-red particles stream out from the phosphorus until the whole liquid is of this colour; with a stronger solution a deposit of brown metallic gold is formed on the phosphorus.

As with other reducing agents, ease of reduction of salts by phosphorus increases with rise of atomic weight in the group copper, silver, and gold.

GENERAL CONCLUSIONS.

The general conclusions arrived at from the whole series of experiments, of which the above is a brief summary, are as follows :—

1. Most, if not all, of the metallic copper is produced by means of the reducing action of a lower acid of phosphorus.

2. The phosphide is not a secondary but an intermediate compound, its formation probably being expressed by

$$2P_4 + 3CuSO_4 + 12H_2O = Cu_3P_2 + 6H_3PO_2 + 3H_2SO_4.$$

This equation theoretically involves two simpler ones—

$$(a)\ 2[P_4 + 6H_2O = 3H_3PO_2 + PH_3];$$

$$(b)\ 2PH_3 + 3CuSO_4 = Cu_3P_2 + 3H_2SO_4.$$

With (*a*) compare

$$P_4 + 3KOH + 3H_2O = 3KH_2PO_2 + PH_3,$$

which is a very well-known reaction.

Thus in the presence of metallic salts a reaction can take place between phosphorus and water similar to that between phosphorus and the alkalis. Cross and Higgins* concluded that some such action as this was possible between amorphous phosphorus and water at high temperatures.

If phosphide and reducing acid continued to be produced in equivalent quantities this explanation would suffice, but the amount of phosphide formed is always much less than this.

The action is apparently catalytic, and Straub's statement that the phosphide acts as an oxygen-carrier was meant to solve this difficulty.

If atmospheric oxygen were available and necessary, the following steps would be possible, and would explain all the phenomena observed :—

1. Phosphorus + sulphate + water = phosphide + reducing acid + sulphuric acid.
2. Phosphide + oxygen (atmospheric) + water = acid phosphate (soluble).
3. Phosphate + phosphorus + water = phosphide + reducing acid + phosphoric acid.

The exact manner in which the catalytic production of reducing acid takes place after the formation of the film of phosphide must for the present be left an open question. It will probably not be solved until more reliable data are available dealing with the metallic oxysalts of phosphorus, and especially with the properties of the metallic phosphides.

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* Journ. Chem. Soc., 1879, vol. 35, 253.

Art. XLVII.—*A Plea for the Scientific Study of Maori Names.*

By H. W. Williams, M.A., Archdeacon of Waiapu.

[*Read before the Wanganui Philosophical Society, 12th August, 1912.*]

The subject of Maori names is one that has been dealt with many times in the past; but, so far as I know, no systematic or thorough inquiry has ever been made into the principles which guided the Maoris in their nomenclature.

In speaking of Maori names I have in view chiefly place-names; but for the purposes of investigation it will be necessary to say something also about personal names, names of trees, birds, and fish, and a little about the names of some ordinary objects.

Before coming to the names themselves, it may be well to make a remark about the structure of the language. It is well known that the Maori alphabet contains but ten consonants and five vowels, and that all syllables are open—that is, all end with a vowel; or, in other words, two consonants cannot come together. This means that the Maoris have only fifty-five possible syllables, by the permutations of which all words have to be formed. The full effect of this fact is often lost sight of, and it is not readily appreciated till a comparison is made with the English language. Assuming, for the sake of argument, that we have in English only five vowels, we have a far wider range of consonants; we admit combinations of these consonants in twos, and even in threes, and, further, allow syllables to end with a consonant or combination of consonants. This wealth of material provides us with no less than three hundred open syllables and twenty-eight thousand closed syllables, which would make ample provision for an entirely monosyllabic language far beyond the range of vocabulary found necessary for most ordinary speakers of English. And these numbers will be largely increased if account be taken of the full number of vowel-sounds actually existing in English.

Returning, then, to Maori, with its fifty-five syllables (of which in practice four are never used), we can see that the very frequent recurrence of the syllables produces that sense of similiarity in Maori names which is so confusing to the English ear, and we can understand that variety in the names may require the use of a number of syllables which seems unnecessary to the hurrying civilization of Europeans.

The advent of the white man brought into the world of the Maori a number of new objects for which names had to be found. In some cases he took the name he heard applied to an object, and made such alteration as his defective alphabet demanded; but where left to himself he varied from the strict transliteration which would have been followed by a European. For instance, he made "horse" into *hoiho*, "carpenter" into *kamura*, "publichouse" into *paparakauta*, and "needle" into *ngira*. In the last case the initial "ng" is no doubt by way of compensation for the inability to reproduce the consonantal sound of "dl" in the second syllable. Some of the Maori transliterations are a pointed criticism of our slovenly methods of pronunciation: had we uttered pure vowel-sounds the Maori could hardly have made *tupeka* do duty for "tobacco," or *paera* for "boiler." But not infrequently the Maori ingeniously found an appellative with a thoroughly Native ring about it for some new acquirement. Iron he designates by *rino*, *maitai*, or *piauau*. The latter is also the name of a hard stone used formerly for making axe-heads. *Rino* might be supposed to be an anagram from "iron," but this origin must be dismissed. *Maitai* is a true Polynesian word, meaning "good." It was in use in the north of this Island a hundred years ago, and is still current in Tahiti and elsewhere. There can be very little doubt that Tupaea, Cook's Tahitian interpreter, in bartering nails with the Maoris, referred to them as *maitai* (good), and the Maoris, unfamiliar with the word, assumed that it was the name of this new treasure.

The potato has been thoroughly adopted by the Maori, who, while there was nothing to prevent him from pronouncing "potato," has preferred to designate the same by *parete*, *parareka*, *riwai*, *hiwai*, *taewa*, *kapana*, or *popoia*. The first of these is no doubt "praty"; the second may have a reference to the *para* tuber formerly eaten by the Maoris; but the rest seem to have been simply inventions to meet the necessity.* These are general names for potatoes; and when the question of varieties is entered upon, the Maori tongue is as prolific of names as a seedsman's catalogue.

The names applied to the local flora and fauna afford illustrations of the methods adopted by the Maori in fixing his nomenclature. It is not surprising to find many instances of words generic in their scope which the Maori uses in common with other Polynesian dialects. But numerous examples might be given where specific names with a range over a large part of Polynesia are still current in New Zealand. It will be found that the Maori colonist acted very much as later European ones have done, and applied names generally to similar or allied plants and birds, but was not tied by any strict rules, and so occasionally transferred the name to something widely different from that to which it had been applied in the past. A few names in each group must suffice us. The *karaka* is stated in some of the ancient legends to have been brought here by the Maoris when they came; but it is not found outside New Zealand and the Chatham Islands, the name elsewhere being applied to a different tree. The hibiscus (*fau* or *hau* in the Pacific) supplied the name *whau* for the *Entelea arborescens*. The *kava* (*Piper methysticum*), well known throughout Polynesia, appears here as *kawakawa (Piper excelsum)*, another species of the same genus. *Kiekie* (the Maori name for *Freycinetia Banksii*) is in some of the islands the name for other species of the *Freycinetia*, and in some for the pandanus; while *fara* (the name for the pandanus in others of the islands) supplies the Maori name for the edible bracts of the *kiekie*, which are called *tawhara*. A large number of plants and trees have names which cannot be traced in other islands, but which must originally have had a signification which made them appropriate to the plants to which they have been applied.

It is somewhat difficult from the dictionaries available to identify the fishes which are mentioned. It will be sufficient, therefore, to record that a large number of the fish-names are easily recognizable as Polynesian in their origin, and that some of those are applied to fish which are identical with or similar to those in other parts of the Pacific.

With birds identification is much simpler. Some six hundred names have been recorded for the 120 birds we have here. The distribution of the names is very unequal. For some sea-birds no Maori name has been

* Some light may be thrown on *taewa* by a note in Kendall and Lee (p. 107), that Taiwa, or Stivers, was "a man who is said to have visited the Bay of Islands before Captain Cook."

obtained. A few names, like *toroa*, *torea*, and *titi*, are applied somewhat loosely to several different birds. One or two birds, like the *huia*, *kotare* (kingfisher), *kaka* (parrot), *kotuku* (white heron), and *weka* (woodhen), are everywhere known by those names, though they may have other appellatives of local application. On the other hand, the fantail rejoices in a choice of nineteen names, while the bell-bird has no less than twenty-six. But there is this difference between the two cases: the names of the fantail all bear close resemblance to one another and would probably be recognized anywhere, while those for the bell-bird differ very materially, and are many of them very local. Of the bird-names, some were certainly imported, some are onomatopoetic, and the origin of the majority must remain a matter of conjecture. Of the imported names, we may mention *kotare* (kingfisher), which is stated in the Tahitian dictionary to be a bird like a woodpecker. *Ruru* (the morepork) appears in many of the islands as *lulu*, some species of owl. *Matuku* (bittern, or sea-heron) and *kotuku* (white heron) are found as names for similar birds in not a few of the islands. *Toroa* (albatross) in some islands is applied to a species of duck. *Kohoperoa* and *koekoea* (names for the long-tailed cuckoo) are known in a number of the islands. *Peho* and *koukou* are supposed to represent the cry of the morepork; while *honga* and *honge* are applied to the *kokako*, as taken from its cry. Then, the nineteen names for the fantail (*hirairaka*, *pitakataka*, *tiwaiwaka*, with numerous variants of these) are said to denote the little bird's restless, fidgety habit. The name for the shining cuckoo (*pipiwharauroa*) offers an interesting opportunity for speculation. *Pipi* is a word applied to the young of birds; *wharau* is at present seldom, if ever, used in Maori apart from the term *whare-wharau*, a temporary booth or shelter of branches. The meaning of the word has been lost by the Maoris, but in a number of the Polynesian dialects it survives in the word *folau*, where it means a journey or voyage. *Roa*, of course, means "long." The question arises then, did the Maoris formerly recognize the *pipiwharauroa* as a migrant ("the bird of the long journey"), and preserve the fact in the name long after they had invented myths to account for the cuckoo's disappearance in the winter?

Before leaving the department of natural history it may be well to call attention to a peculiarity that will be observed in these names. The most superficial observer must be aware of the fondness of the Maoris for dissyllabic reduplication. In general this reduplication denotes some slight differentiation of the meaning—in verbs it may betoken frequency of action, in adjectives a lessening of intensity, and so on; but in the names with which we have been dealing reduplication may remove a name from the list of birds to that of fish, or even from the animal to the vegetable kingdom. For instance, *kotare* is a kingfisher, but *kotaretare* is a species of eel; *kotuku* is the celebrated and rare white heron, while *kotukutuku* is the native fuchsia. It is well to bear these facts in mind, as otherwise much confusion may result. It has, in fact, been stated in a work upon Maori names* that the name *makotuku* may perhaps be more correctly *makotukutuku*, meaning in both cases "the stream of the white heron"—an interpretation which can be given only to the former name. Then, too, the Maoris had other ways of varying their names which produced unexpected resemblances. The word *papauma* is the name of a fish and of a shrub; in the former case it is a contraction from *papaki-uma*, in the latter from *paraparauma*.

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* "Nomenclature," by W. Colenso.

Some such process as this may account for the large number of cases in which the same word has to do duty as a name in two or even three of the groups—birds, fishes, or plants.

When we turn to personal names we find an entirely different set of conditions operating. It is hardly necessary to remark that in the past the Maori had no surname, but considerations of convenience are causing the rapid spread of the system. If an additional name was required for the purposes of identification, the father's or husband's name would sometimes be added, but more frequently the exact relationship would be expressed in full. Now that they are adopting the surname, we sometimes detect a quaint ingenuity displayed in the process of evolution. I knew a young Maori by the name of *Wakana Kiniha*—a son of one *Hape Kiniha*—and was not a little amused to discover that the latter was the father's full baptismal name, being nothing more or less than the transliteration of Hopkins. *Kiniha* makes a quite serviceable surname if you once lose sight of the fact that it is only "kins." The younger Maori of the present day assumes the name of some well-known ancestor as his surname, and before another generation has passed the system will be thoroughly established. Sundry ceremonies attended the naming of a child, but the description of those ceremonies is outside our present subject. What concerns us is the principle which guided the parents in the selection of a name. In general, the name was to commemorate some event; and not infrequently the event commemorated seems to European minds wholly trivial, or at best but remotely connected with the person on whom the name is conferred. One of the most frequent sources of names was the death of a relative, or some disaster. And the most unlikely details in connection with the death might be pressed into the service to provide the name. A girl was named *Te Ao-mihia* (the day welcomed) in memory of her grandfather, because he had discussed and welcomed overnight the indications of a fine day for a fishing excursion, on which expedition he was murdered. The story of her brother's name is more complicated. One *Tu-moana-kotore* died, and was duly wrapped up, and carried off to be deposited in a *puriri* tree until his bones should be ready for the process of scraping, after which they would be laid in the family burial-cave. The two men detailed for the work were just returning from the tree when they heard a voice. They listened and recognized the voice of the dead chief calling from the tree; they at once removed the wrappings, and found that the old chief had recovered from the trance which they had mistaken for death. The boy who was born soon after was thereupon called *Tu-moana-kotore-i-whakairia-oratia*—that is, "*Tu-moana-kotore* was hung up in the tree while he was yet alive." This euphonious and handy name, my Maori informant naïvely tells me, was shortened in practice into *Tuwkakairiora*, which has been still further curtailed into *Tuwhaka*, which will by familiars be clipped into *Tu*. The Maori who told me this story, himself rejoiced in the name of *Te Karu-harare* (the sealing-wax eye), a name which came about as follows: Ngati-porou had made a raid into the Bay of Plenty, and suffered defeat at the picturesque *pa* of *Wharekura*, where a chief, *Te Pori*, was killed. Following the strict rules of etiquette, *Te Pori's* head was duly dried, and the sunken eye-sockets filled with sealing-wax, a commodity but lately acquired by the Maori. A short time after this, *Te Rangiipaea*, wife of the famous *Pomare*, came from the Bay of Plenty to visit her friends on the Waiapu River. My friend, a nameless infant almost able to crawl, was at once utilized as the recording tablet on which to register the indignity inflicted upon the head of the chief, and so received the name "The Sealing-wax Eye"—*Te Karu-harare.* In another instance two chiefs had gone into the bush pigeon-shooting, and were caught by bad weather, which necessitated a four days' lodging under a very flimsy shelter made from the fronds of the *wheki* tree-fern (*Dicksonia squarrosa*). A niece was born to one of them about the time, and duly received the name *Te-whare-wheki* (the *wheki* hut). Another young woman has the name *Nga-rangi-putiputi* (the flower days), a romantic-sounding name, the beauty of which is seriously marred when it transpires that the flowers referred to were those placed about the corpse of a dead relative, and the name is nothing more than a reminder of the death—a sort of verbal funeral card. I had for years speculated as to how one old friend of mine came by the name of *Wai-hopi* (soapy water), and at last screwed up my courage to ask him. A sister of his had died, and the corpse had been washed with soap and water, a combination which had been lately introduced. But once in a way a name has a touch of true romance, as when a woman calls her son *Tama-inu-po* (son of the draught by night), to commemorate the fact that she had been wooed at the brink of the well, whither she had gone one night for a drink. A curious custom of the Maoris was that of changing their own or their children's names to commemorate some important event—generally, again, a disaster. A moribund chief is placed in a tent, and dies there, whereupon a friend adopts the name of *Whare-taaka* (house of duck—duck for canvas). Several persons are drowned by the upsetting of a canoe, and a whole crop of names recalls the event: *Mate-moana* (sea disaster), *Waka-tahuri* (canoe overturned), and so on—a large proportion of these names displacing, or attempting to displace, names which have been borne for years. One old Maori used generally to refer to his son by the name of *Te-okanga* (the incision), a name which I knew was not the youth's baptismal name; inquiry elicited the information that the lad's sister had succumbed after an operation, hence the name. Any one acquainted with Bible history will be struck by the similarity of the Maori customs in respect of names to those recorded of the ancient Semitic race, the inference being not that the Maoris are Semitic by descent, but that such customs are appropriate to a primitive people at a certain stage of their development.

We are now in a position to make a few inquiries into place-names. Few races have been so prodigal in the bestowal of local names. Every peak, saddle, knoll, and spur; every bend, rapid, and pool in a stream; every creek and bay, beach and headland, had its name, as well as every mountain-range, river, and sea. Pas and camping-grounds, battlefields and cultivations, fishing-grounds and landing-places, sites of eel-weirs or of bird-snares—all were well known by their own particular names; and it is much to be regretted that the vast mass of these names has been allowed to pass into oblivion, and that those which have been preserved have in many cases been ridiculously mutilated, while not a few have been transferred to localities far removed from those to which they belong. The mutilation of names is, naturally perhaps, more rampant in the South Island than in the North. Here we have frequent confusion between "i" and "e," between "a" and "o"; and in this particular part of the North Island you have the example of the Natives in dropping an "h": it is no more correct to write and say "*Wanganui*" for "*Whanganui*" than it would be to write and say "Ampstead Eath" and plead the example there of the natives. But in the South Island violent changes have been made. *Temuka* represents the Maori name *Te-umu-kaha* (the fiercely heated oven), while *Tapanui* does duty for the native form *Te-tapuwae-o-Uenuku* (the footprint of *Uenuku*). In the case of *Waitati*, near Dunedin, a curious series of mistakes has operated: the real Maori name is *Wai-tete* (the two "e's" being long); the earliest settlers pronounced this somewhat loosely *Waitayty*, and wrote this in the form *Waitati;* later arrivals accepted this spelling, but, having a little knowledge of Maori orthography, pronounced it *Waitatty.*

But I am concerned in this paper with genuine Maori names. These names will fall into two main divisions—imported names, and names which have originated locally. But it must be laid down at the outset that it is not by any means easy to decide in every case in which category a name should be placed.

The imported names fall into five classes, which may in some cases have a not very clearly marked line of division. In the first class I would place names which are traditionally reported by the Maoris to have been brought with them. For example, we are told that as the party of new arrivals passed along the shores of the Bay of Plenty they gave names to striking spots, among others to the island of *Motiti*, which we are expressly told was after the *Motiti* in Hawaiki. Then, near the East Cape there is a place, *Te Kawakawa*, which might quite reasonably have been supposed to be a local name, were it not for the fact that the full name of the place is *Te-kawa-kawa-mai-tawhiti* (*Te Kawakawa* from abroad).* Farther down the coast, some sixteen miles from Gisborne, is the bay of *Whangara*, again in full *Whangara-mai-tawhiti.* The legend is that *Paikea*, travelling down the coast, was, on arriving here, so struck by the resemblance of the place to the *Whangara* that he knew that he named several features of the landscape after the similar ones in the original *Whangara:* among them *Pakarae*, a stream at the north of the bay; *Rangitoto*, a steep hill connected by a low saddle with a smaller hill, *Pukehapopo;* and *Waiomoko*, a stream immediately to the south. The only thing wrong, *Paikea* said, was that *Wai-o-moko* should have debouched to the north of *Pukehapopo*, presumably through the low saddle mentioned above. It is interesting to note, in connection with this incident, that *Whangara, Pukehapopo*, and several other names of the locality are still known as place-names in Rarotonga.

In the second class I would place names which occur in legends preserved by the Maoris of events prior to their coming over to New Zealand. As instances: *Hikurangi* occurs frequently in very early legends, reaching back to the period of myth, as the hill on which various persons have taken refuge from floods of excessive violence. One of the mythical ancestors of the Maoris, known variously as *Whena, Wheta*, or *Tawheta*, is said to have resided at *Porangahau*, a name which has been preserved on the coast of Hawke's Bay; and *Reporua*, a place a few miles south of the East Cape, is mentioned in legends dating from before the Maori immigration.

Again, we may find names in New Zealand which appear as place-names in other Polynesian islands in the Pacific. An instance of this has already been mentioned in the *Whangara* names; but there is still a large number of such names with regard to which the Maoris have preserved no tradition, or, perhaps more correctly, no tradition has been placed on record. For example, *Waimea* and *Maunaloa* are Hawaiian names, *Matawai* is Tahitian, and *Fangaloa* a Samoan name. All these names reappear in New Zealand, *Maunaloa* and *Fangaloa* becoming, of course, *Maungaroa* and *Whangaroa.*

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* The postal name of this place—which has been adopted to avoid confusion—is *Te Araroa* (the long path), a name given by the Maoris to the residence of the missionary, who had a long path with a hedge from his gate to his front door.

The presumption is that the names are some of those which the Maoris brought with them.

Yet another class is that of names which are found in many different localities in New Zealand. Many of these will be names to which a meaning can be assigned which does not in every case seem to be appropriate—such names as *Rangitoto*, of which I know at least six instances in the North Island; *Titirangi*, another favourite hill-name; *Wairoa*, which is by no means confined, as would seem appropriate, to long rivers; *Awanui*, which is generally supposed to mean "large river," but more probably refers, as a rule, to a channel in the rocks used as a landing-place for canoes. Another interesting example is *Rangihoua*, which was the name of the place in the Bay of Islands where the first missionaries settled: a *pa* of the same name stood on a hill at the south end of Poverty Bay, and another at Wairoa, in Hawke's Bay. Interchange was possible in the case of the last two, but most highly improbable between either of these districts and the members of the Ngapuhi Tribe in the north. *Takapau* is another very favourite name; but in a great number of cases the name was differentiated by the addition of another word, as, for example, *Takapau-arero*, in the Poverty Bay district. The most reasonable explanation of the frequent occurrence of these names is that they have been given by the different tribes in remembrance of some common prototype in far off Hawaiki.

The last group of these imported names is that which is illustrated by such names as *Maketu*, *Nuhaka*, and *Mohaka*. These names have quite a foreign ring about them when compared with indigenous names, and do not lend themselves to any interpretation, as do most of the more modern names. It may therefore be conjectured with some degree of certainty that they too have been imported.

This branch of the inquiry into Maori names is, if not the most interesting, certainly the most important. It is much to be desired that no time should be lost in placing on record as many of the Maori names as possible, that residents in the other Polynesian islands should be urged to do the same for their respective localities, and that all the lists should be carefully collated. Something of this sort has been done in the matter of genealogies, but, as far as I know, little or nothing has been done to extend the process, with any degree of thoroughness, to place-names.

We now come to the names which are, or appear to be, of local origin. A considerable number of these are taken from trees, as *Te Kowhai*, *Te Karaka*, *Puriri*, *Totara-roa*, *Te Rimu-roa*, and so on—names of this class supplying another group of repeated names, which does not, however, seem to point to the importation of the name. Then, an exceedingly large number are drawn from physical features in the landscape. To this group belong all those beginning with *Puke* (hill), *Manga* or *Ma* (stream), *Maunga* (mountain), *Roto* (lake), and the very large group with *Wai* as the leading syllable. The last-named would seem to monopolize more than its share of the Native nomenclature. The Post Office Guide may be taken as a fair indication of the proportion in which names occur, and I find there 150 names beginning with *Wai*. These names, of course, apply to both streams and lakes. Another very frequent initial factor in names is *Pa;* this would certainly be a feature in the landscape, as the *pa* was almost invariably well placed to command the surrounding country, but was not, of course, a natural feature.

Some of the names carried their meaning clearly in their form, as *Pohatu-roa* (the tall rock), a conspicuous hill near *Atiamuri;* *Waerenga-a-Hika*

(*Hika's* clearing); *Te Pahi-o-Te-Rangi-tuanui* (the camping-place of *Te Rangi-tuanui*); *Taumata-whakatangihanga-koanau-a-Tamatea-ki-tana-tahu* (the brow of the hill where *Tamatea* played the nose-flute to his lady love). But in the vast majority of cases, while it might be quite possible to translate the name, it would still remain inexplicable unless the circumstances were known in which the name was given; in fact, without that knowledge it is exceedingly unlikely that the translation given would be correct. As in the case of the personal names, the incidents commemorated will in many cases appear to us trivial or irrelevant. The *Kaingaroa* (long feeding) plains are said in Maori tradition to take their name from the fact that a body of travellers was delayed one morning in starting from the place by one of the party, a lady named *Haungaroa*, taking rather long over her breakfast. A place near the East Cape is called *Kamokamo* (winking) because a celebrated chief, *Porourangi*,* was murdered there, his companions adopting the highly original device of winking to one another as a signal that a suitable opportunity for setting upon him had occurred. *Tahu-tukua* (ridge-pole let down) marks the site of an old *whare-puni* in which during the great epidemic of *rewha-rewha* a century or more ago some thirty persons died in the night. Their friends, horror-stricken, chopped the main posts, and let the ridge-pole fall, carrying the roof with it, and that was their burial. We get a glimpse of the genial manners of the ancient Maori in some of the names. In the East Coast district, as not infrequently happened, there was a feud between a clan living on a hill and their neighbours in the valley below. In one of the skirmishes the latter were badly beaten, and a chief of the name of *Roia* slain. As it was a stiff climb homewards, *Roia* was quartered and served out to carriers, but, unfortunately, near the top one of the carriers let go a hind-quarter, which rolled down the hillside: the place was accordingly named *Te Takanga-o-te-huwha-o-Roia* (the place where *Roia's* thigh rolled down). A similar name comes from the Urewera country, where a party was returning home with the body of an enemy named *Piki*, and, wearying of the job, rolled him down a hill with a steep homeward grade. The hill is now *Te Whaka-takanga-o-Piki* (the place where *Piki* was rolled down).

A good many of these names have reference to the doings of mythical or semi-mythical heroes. *Paoa*, who came from the Waiapu district and thence moved to several other parts of the North Island, accounts for quite a number of these: more than one *Waipaoa*, or *Waipawa*, commemorates his name. Then there was a gentleman named *Rongokako* who left a number of footprints about—one near the Kidnappers, one at the Mahia, another near Gisborne, another some twelve miles farther on, and yet another near the East Cape. These are in some cases *Tapuwae* (footprints) and in others *Te Tapuwae-o-Rongokako* (*Rongokako's* footprint). Of course, it does not follow that he did not put his foot to the ground between these points; but we need not be surprised should we find that it was so when we are informed that a friend of his, wishing to set a trap (*tawhiti*) for him, placed the trap on the hill *Tawhiti*, at Waipiro Bay, and stuck the wand used as a spring (*whana*) for the trap in a mountain *Arowhana*, inland from Tokomaru Bay, some twenty-five miles distant as the crow flies.

There is another very large group of place-names—those beginning with "*O*"—which requires more investigation than has hitherto been given to it. I need hardly give instances of these names, as they are exceedingly

* The grandfather of *Te Ao-mihia* mentioned above.

common—in fact, in the Post Office Guide they occupy the same amount of space as the *Wai* names. It has in the past, I believe, generally been assumed that this " *O* " is simply the sign of the possessive case, and the remainder of the name in each instance a proper name, the meaning being that the place is So-and-so's *pa*, or place of residence. But there is quite a large proportion of these names to which this explanation will not apply. For example, we are told by the Maoris in their traditions that a place known as *Opura* was so called because *Tamatea* there got dust or some other irritant into his eye, the Maori word indicating this trouble being *pura*. Again, one of their heroes saw a bird flying, skirting a belt of trees (*taku-wao*), and accordingly the place was called *O-taku-wao*.

I have referred in several instances to the traditions of the Maoris with regard to the origin of names, and the question may be raised as to how far we can safely place any dependence upon these traditions. In some cases I would do so with diffidence, particularly if the account should take the form of a string of names each with its explanatory incident. And there are instances in which divergent accounts are given, in which case we may be safe in discarding one at any rate, or possibly both. One account of the origin of the *Manu-kau* is that the early Maoris saw there a " single bird " ; and another makes it mean that the " Tainui " canoe, which they dragged over the isthmus with much difficulty, at last " floated freely," which might be rendered by *Manukau ;* but, unfortunately, in this case the first " a " should be long, and not short as it actually is in the name. Again, when we are told that one of these old-time personages travelled along the coast, and left a name here and a name there—as one old fellow. with his dog, on the north coast of Hawke's Bay called one river *Wai-hua* (stream of the fish's roe) because his dog there ate a porcupine-fish, but left the roe ; and another *Wai-kari* (water of digging) because the dog dug in the sand—when we hear the story told thus we are not justified in assuming that he then and there dubbed the places in question *Waihua* and *Waikari*, but that he possibly had occasion later to refer to these places, and did so as " the stream where my dog did so-and-so," and in time the names became established, and probably much shortened in the process of establishment.

In not a few cases students of names are trapped into confidence in explaining a name, where a further investigation tends largely to undermine the confidence. Two examples will explain my meaning : We hear a great deal about *Waikare-moana* as a tourist resort, and much has been written about the " Sea of rippling waters " : but it must be borne in mind that, while this sounds like a quite satisfactory translation of the name, it is by no means above criticism. In point of fact, *Waikare* is first and foremost a name ; it may—probably does—mean " rippling water," but it is the name also of a raging torrent running out of the lake, to which " rippling water " is hardly appropriate—this is *Waikare-taheke ;* and yet further is applied to a district (*Waikare-whenua*), the last half of the name in each case being an explanatory term—lake, torrent, territory, as the case may be. Another instance of the same sort is that of *Tarawera*. After the disastrous eruption of 1886, people said, " Oh, yes, *Tara-wera*, of course—' burnt peak ' : that shows that the Maori had traditional knowledge of its volcanic nature." Which had not otherwise been at all evident. But in fact the name *Tarawera* applies equally to the lake and the river, and i is not at all certain to which it most properly belongs. They are respectively *Tarawera-maunga*, *-moana*, and *-awa*, if the distinction is desired.

I think I have made it clear from what has been said that the analysis of a Maori name cannot be assumed to be that which appears at first sight

—that, even when the elements have been correctly ascertained, we are not necessarily thereby in possession of the clue to the real meaning of the name. This warning is not a mere haphazard one, as will be seen by consulting the works of two gentlemen who had a very close acquaintance with the Maori language. The late Rev. W. Colenso published in 1883 a paper entitled "Nomenclature," which he had read before the Hawke's Bay Institute. In this he deals at some length with a few Maori names. I need not detail all the wild and astonishing speculations of that paper, but will refer to one or two. The hill *Kahu-ranaki*, in Hawke's Bay, he prefers to spell *Kahu-raanake*, writing *more suo* "aa" for a long "a"; he then divides the word *Ka-hura-anake*, which he interprets as "the great and only revealer," which we may assert with confidence that the name does not mean. *Kohinu-rakau*, he says, means "choice fat of the woods, including Maori game—birds and delicious wood-rats, fruits, and pure water," wilfully ignoring the fact that *rakau* is "wood" only in the sense of "timber," which destroys his whole theory. A little later in the paper, after making very merry over a speculation by the Rev. R. Taylor with regard to *Tongariro*, he goes on to explain the name as derived "from the snow often deposited by the south wind upon it, *tonga* being also commonly used by them for biting cold, hence for snow—the cause for the effect; and then owing to the heat arising from the crater the fallen snow remained but a very short time on the cone or peak, and thus became *riro* (gone). So different in this respect from the neighbouring crest, which also bears the highly appropriate name of *Para-te-tai-tonga** (dirt or dregs from the southern sea)."

John White, in his six volumes of "The Ancient History of the Maori," explains every name, as it occurs, by the simple process of chopping it into lengths and giving each piece a meaning. He makes *Pākarae* (*karae* being a bird-name) into *pāka-rae*, and translates it "dry headland," in defiance of Maori grammar (vol. iii, 34). He comes across *Pu-marangai* (from form and context obviously a wind-name) in its southern form *Pu-marakai*, and explains it—"*pu*, the great climax; *mara-kai*, plot of cultivated kumara" (i, 18): again doing violence to the language by substituting a long "a" in the first syllable of *mara* for the short "a" in the original. *Kahutia-te-rangi*, he says in one passage (i, 22), means "the heaven pulled up," and in another (iii, 9) "the garment of heaven." He twists *Takahia-pu-poka* into "how many cuts made" (i, 27); and *Rangi-whitiki-ora* into "day of life putting the belt on" (i, 31). But with regard to *Hawaiki* he surpasses himself, giving in one paragraph no less than four explanations: "*Ha-wai-ki*, 'water of breath filled'; *Hawa-i-ki*, 'chipped and filled'; *Ha-wai-ki* (*iti*), 'water of small breath'; *Hawa-iki* (*iti*), 'broken small'" (i, 174). All this—and hundreds of examples might be added—is just so much solemn fooling on the part of these learned gentlemen, and is, as a contribution to the investigation of Maori names, as valuable as the schoolboy's rendering of the name William into Latin by *Voluntas-ego-sum*.

It is not that inquiry into Maori names is futile—far from it; but it must be conducted on scientific lines. I have said that there is immediate need for the patient and diligent collecting and recording of Maori names. There is need, further, of obtaining, before it is too late, from living Maoris all that they know of the traditions relating to those names. Lastly, all the matter must be patiently and laboriously sifted. And then we may hope to know something of the subject. But in all this there is no room

* Two other forms of this name are current among the Maori—*Pare-te-tai-tonga* and *Pare-tai-tonga*.

for wild and fanciful theories as to the origin of the names, built up upon illegitimate and ridiculous guesses at their meaning. It is in matters of this sort that the branches of the New Zealand Institute have one of the most inviting outlets for their energies, and a fruitful opportunity of doing some really valuable work.

NOTE.—It is gratifying to learn that steps are being taken to deal with the names in and around Wellington. It is to be hoped that this may encourage others to do likewise in their own districts. Much mutual support will be obtained if investigators can get into touch with one another, and the Institute seems to offer the most suitable means for establishing the necessary communication.

ART. XLVIII.—*Life of the Ngati Kahu-ngunu Chief Nuku-Pewapewa.*

By T. W. DOWNES.

[*Read before the Wanganui Philosophical Society, 13th May, 1912.*]

LOOKING through a fine collection of manuscript *waiata* with the grey-headed Native owner, and noticing the frequently occurring name of Nuku, an inquiry concerning this (to me) unknown but great chief of the Ngati Kahu-ngunu brought to light the following history.

When Nuku was a little lad he developed an extraordinary gift for mimicry, which led him into many a scrape, for his fellows did not like to be mocked, and so young Nuku very often had to put up with bruised face and battered limbs; but the result of this jesting was that he quickly learned to protect himself, and became a great fighter as he developed size and strength. He gloried in his power, till at length none of his people could stand against him, for he was master every time. Even the big fellows and fighting-men had to yield to him, and he soon became the acknowledged leader of his people and captain of the war-parties.

Now he was a leader he wished to become a *tohunga* as well, but as this was forbidden him he gained by stealth what he could not obtain by power, for one evening, after dark, he crept quietly into the *whare-wananga* before the *tohunga* and their pupils came in, and endeavoured to hide himself in one of the dark corners of the building. Soon the priests came in and commenced reciting their genealogies and *karakia*, but the fire burned brightly, and before they had gone very far they discovered young Nuku crouching in the corner. It was no good asking him what he was doing there, for they could not turn him out after having heard and seen so much, so they gave him a position near the middle of the house apart from the chiefs' sons, and there he sat with his back against the *poutoko-manawa* (main pillar of the house). Night after night he returned to his seat, till one evening the seventy students who were under instruction got up one by one to repeat the *wananga*. However, they all failed to go right through without a mistake until Nuku tried, and lo! he was able to repeat every word. By this test he again added to his quickly growing fame, and went out a *tohunga* as well as the chief leader among his people.

When he had fully reached man's estate his first act was to build a *pa* strong enough to resist all attacks, and with this in view he chose a point on the Rua-mahanga River, Wairarapa (about two miles from Mr. Morrison's place, and opposite Mr. Wall's station). This naturally strong position, nearly encircled as it is by the river-cliffs, he carefully fenced all round with high protective works, and across the neck of the peninsula he ran two rows of palisading, about half a chain apart, with a deep moat between. But his crowning work was carrying an underground passage from the middle of the *pa* to the moat, and from thence inland. In this way he could send a messenger unseen from the moat down the cliffs by an *aka-tokai* vine, which was always kept handy; or, if pressed very hard, he and his company could escape unseen by way of the underground passage, the outlet of which was hidden by earth and vines in a dark bush. This *pa* was called Nga-mahanga (twins), because of the underground roads, and was large enough to contain some small *kumara* plantations, as well as all the stores, and a garrison of one hundred men. He kept one hundred picked men in the *pa*, because he could move quickly with a small company, and he did not need to make so much provision for *kai*. Occasionally he had a few more men, but he endeavouerd to keep his strength about one hundred. This *pa* was never taken.

His first experience of actual warfare was at the Maunga-raki *pa*, on the Wainuioru River, which place he took, though considered by all to be impregnable. There was no road down the cliff to the *pa*. There stood Nuku with his hundred men above, looking down. Ah! but he had to be satisfied with a look, for he could not get down. So thought the people of the *pa*, and slept with the thought of their usual security. But Nuku considered, and then he acted. He built a huge *raupo* kite, something in the shape of a bird with great extended wings, and during the darkness of night he fastened one of his men to this *manu* and floated him over the cliff by means of a long cord into the *pa* below. The man quietly opened the gates, and when all was ready, at a given signal, Nuku let down his men, four and five together, by means of a *tokai* vine, and before morning the *pa* was taken. The people of the *pa* were the Ngati Hau-moana, the Ngati Waitaha and the Ngati Tama-wahine, under the chiefs Toko-te-rangi and Haupapa-o-te-rangi, the latter being captured. When taken, the conqueror spread his mat on the ground and invited Hau-papa-o-te-rangi to sit upon it, which he did, thus saving his own life and upwards of four hundred of his people.

His next exploit was at the Oruhi *pa* (at the mouth of the Whareama River, near Castle Point). Two men of the Hamua (a subtribe of the Ngati Kahu-ngunu), named Hautuhi and Tohi-te-oru-rangi, were killed, and a great army of two thousand men gathered together to obtain *utu*.

They reached the Oruhi *pa*, but as the place was well fortified and protected they camped for several days, unable to effect an entrance. Then a chief named Te Hiha called out that he would challenge the people of the *pa* to combat; so he selected three hundred of his bravest men, and another chief called Rangi-hui-nuku selected two hundred more, making five hundred in all, and this party separated from the main body and advanced, in the hope that their challenge would be accepted. (Te Hiha, of the Ngati Ira Tribe, was a great warrior who did much fighting at Wairarapa; he was the author of the following saying:—

Ma te huruhuru te manu ka rere,
He ao te rangi ka uhia,
He rango te waka ka mania.

By feathers does the bird fly,
By clouds are the heavens covered,
By skids does the canoe slide along.

The modern meaning of which is, "Money is the sinews of war."

A rough idea of Te Hiha's period may be obtained from the following genealogical table:—

```
                         Te Hiha
                            |
                        Te Weranga
                            |
                       Hine-tarewa
                            |
         ----------------------------------------------
         |                                             |
Hine-ki-runga-o-te-rangi                Whanake = Tama-i-rangi*
         |                                       |
         |           ----
         |           |
      Tarewa = Te Kekerenga
                     |
               Te Miha-o-te-rangi
                     |
         -------------------------
         |                        |
      Ratuna              Meiha Keepa (named after Major Kemp)
         |
      Te Ruhi = Aporo te Kumeroa (about 55 years old, 1909).
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The two challenging chiefs were not disappointed. Tu-te-whakarua-a-nga-rangi, the leading chief in the *pa*, likewise selected five hundred of his best men, and formed up to meet the invaders. Not only did he meet them, but he beat them, and drove them into the river; indeed, if it had not been for the river they would all have been killed; as it was, many saved themselves by swimming across. Both the assaulting chiefs escaped, but Te Hiha was afterwards known as Te Hiha-moumou-tangata (Te Hiha, waster of mankind).

Now, although this portion of the army was badly beaten, there were still the fifteen hundred men under Nuku, who were very anxious to strike immediately, and so obtain *utu* for their late companions. But Nuku said, "No; wait. When night comes lay ambuscades in the flax on both sides of the track, and in the morning you will find *utu* enough and to spare." When night fell Nuku sent his companies up the hill, and placed them in various divisions in hiding on both sides of the road leading from the *pa* to the camp, which was about two miles distant, and when morning broke he sent another three hundred men with the apparent intention of attacking the *pa*.

Now, when Tu-te-whakarua saw the three hundred approaching he sent out six hundred of his best men to meet them, and as Nuku's men drew near the *pa* the companies met, and a general scramble took place. Then Nuku retreated towards his camp, as though defeated, and all the people of the *pa* rushed out to join in the pursuit and participate in the victory, for the people of Oruhi were hungry: they had been besieged for several days, and now they thought the opportunty to obtain provisions was before them. But they knew not of Nuku's men in hiding, who waited till the people of the *pa* were busy pursuing, and then they took them in the rear. Great was the killing. And now the fame of Nuku was established, and his name was spoken everywhere.

Soon the people in the north heard of his great *mana*, and they sent a message to him for help, as they were in a bad way. The Ure-wera, Whakatohea, and Ngai Tai people had attacked the Gisborne district, and its people were in bondage.

When this message reached the Ngati Kahu-ngunu in Hawke's Bay and Wairarapa, Nuku agreed to assist; so he and another chief, Pareihe, who

* The great chieftainess of Ngati Ira, killed near Kai-koura.

lived at Te Roto-a-Tara, travelled to Gisborne with one thousand men, and there they attacked a strong *pa* on the Waipawa River (near Gisborne), and, although the *pa* contained between six and seven thousand men, Nuku was victorious. (This battle was fought with Maori weapons, and took place about 1825.)

When the news of this great victory was spread abroad Te Kani-a-takirau, of the Ngati Porou Tribe, sent the chiefs Houkamau, Tama-nui-te-ra, and five others to ask Pareihe and Nuku, as leaders of the Ngati Kahu-ngunu, to help them take revenge against Whanau-a-apa-nui, who was living beyond Whare-kahika, for this latter tribe had beaten them three times in succession, so now Te Kani sought help from the Ngati Kahu-ngunu. Pareihe and Nuku started off to help, and when they reached Nukutaurua (on the east side of Te Mahia Peninsula, between Wairoa and Gisborne), Te Kani gave them a great war-canoe, which took forty men to paddle, twenty on each side, also a calabash full of red ochre, two mats, and one dogskin mat called Tapu-nui (the name of the dog whose skin supplied this mat was Tapu-nui, hence the name of the mat). When the present was laid before them Pareihe asked Nuku what his opinion was—should they go forward or return. Said Nuku, "Never turn back when the voice of war is sounding in your ears." A Nga Puhi chief called Te Wera-hauraki (who had settled at Nukutaurua and married a Ngati Kahu-ngunu woman) supported Nuku in his resolve, and so Pareihe was satisfied, and sent word to Kani-a-takirau to bring all the scattered people in from the back country, to establish camps along the road which they were to pass, also to have plenty of food, weapons, and *waka* ready, for the Ngati Kahu-ngunu war-party was hastening to their assistance.

Soon they came along, went right up to Toka-a-kuku, and there the fight took place, the Ngati Kahu-ngunu being victorious, four hundred of the enemy being slain. After the battle was over, a huge *whata*, or stage, was erected, long poles being lashed to upright supports, something like a great post-and-rail fence. Then the dead were tied together, one foot of each man, and in pairs they were thrown over the poles, making a solid wall of dead men, and because of this arrangement the battle was called Whata-tangata. Then all the captured slaves were placed under the *whata*, a captured chief called Te Koata-waho being placed on a mat in the centre of the group, but forward from them. This man was Te Kani's uncle, and when Te Kani saw him he called out and said, "My uncle, I cannot save you; because of the many chiefs of the Ngati Porou which you have killed, you must die." Then, turning round to the victorious war-party, Te Kani continued, "There is Te Koata-waho; you can do with him what you wish, for he is in your hands now." Then one of the brave fellows of Ngati Porou, called Takituangia, got up and said to Te Kani, "I'll take him and fight him man and man; we can't kill him there sitting on his mat." Then he handed him three weapons—a *taiaha*, a *tokotoko*, and a *patu paraoa*—and said, "Take your choice, for you must fight." Te Koata-waho replied, "Give me a *taiaha*; I die by a chief's weapon." They stood up, fought, and the brave Takituangia was killed. Directly Te Koata felled his adversary he flew off, but was caught after getting about three miles, was brought back, and duly added to the *whata-tangata*. After the feast Nuku and Pareihe returned home, with their names sounding to the very heavens.

Besides the one described, Nuku had another strongly fortified *pa*, called Pahikatea, and he was at this place when he heard Tu-whare was coming down the coast with his *pu*. When Nuku heard of the approach of the *taua* he shouted out, "Let them come; let them blow their *pu*; my men can blow *pu* also, and I will make more and greater *pu* than theirs, and meet them with their own weapons." So spake Nuku, and he straightway set his men to work fashioning trumpets and making *pu* of flax-leaves. Then when the *taua* appeared he ordered his two hundred men to take their positions on the high palisading surrounding the *pa*, and blow with all their might. But when he saw them falling all around, struck down by invisible means, with blood trickling from the wounded, he discovered that his *pu* were not a match for the *pu-atua* of the invaders, so he called to those of his men who remained to come down from their conspicuous positions and take refuge within the *pa*.

That night he placed one hundred of his men in hiding in one of the trenches of the *pa*, and next morning, when Nga Puhi came up to renew the attack, up jumped Nuku and his hundred men and quickly turned the tables, killing many, and capturing seven men, also three guns, which he named Pahikatea after the *pa*,* Waiohena after the creek where the capture took place, and Pu-atua (devil's gun), the name given by him to the new weapon. He also took some ammunition from the dead men, and kept the captured slaves alive to show him how to use the guns. After a week, or perhaps a fortnight, Nuku arranged with his captives to show him how to load and fire; but they, cute fellows as they were, drove the bullet home first, with the charge of powder on top, and when Nuku found he could not fire as they could the slaves declared the guns were *tapu*, and only made for killing men.

Nuku, only too anxious to try his new weapons, made war on the people of Moawhango (Wairarapa), and here, as at the practice, the guns would not go off, being loaded the wrong way. During the excitement of the fight the seven Nga Puhi men escaped and got clean away, carrying the guns with them, for Nuku, when he found his guns would not go off, quickly discarded them and fought with his old Native weapons.

It was after this that Nuku decided to take his people to Nukutaurua, to be nearer European trade, for whalers had commenced operations in that district, and, in exchange for maize, pigs, and flax, guns and ammunition were obtainable. This was three years after the Whata-tangata battle was fought in the north.

As soon as Nuku left the district the Ngati Toa, Ngati Awa, and Ngati Raukawa took possession of the Wairarapa lands, the Ngati Toa occupying round about where the town of Carterton now stands, the Ngati Awa taking Featherston, and the Ngati Raukawa the district round Masterton. When Nuku reached Napier he heard how these intruders had taken up their residence on his land, so he called together the chiefs of his party to talk the matter over. He himself was strongly of the opinion that they should turn back and chastise those tribes, but Tahae-ata got up and sang a song the subject of which was the folly of returning while the *pu-atua* were still blazing. However, as Nuku had decided to go, some of the subtribes of the Ngati Kahu-ngunu agreed to accompany him. The Ngati Tokoira, Ngati Kurakuru, Ngati Hinepare, and the Ngati Kore gave four hundred men, who, with his own two hundred, made in all an army of six hundred strong. They journeyed back without incident, and when they reached Munga-raki (Mr. Buchanan's property) they rested under a great

* This took place at Te Tarata. Pahikatea is about three miles north-east of Papawai.

rata-tree. They reached that place at midday, and after *kai* Hapuku asked Nuku and the other chiefs to climb a very high hill in order to survey the situation. From the top of this hill they could see from Masterton to the lake, as well as both the east and west sides of the Rua-mahanga River. They reached the top about sunset, when they saw the innumerable fires of the various interloping companies below, stretching right from the mouth of the lake to Masterton. After surveying the scene in silence for a time, Hapuku said to Nuku, " Where are we going to get enough water to put all these fires out ? " Nuku replied, " If you are frightened, return at once, and I'll put the fires out myself." Then a *korero* took place, and all the chiefs of the party advised Nuku to return, as the fire was too great to be extinguished ; but Nuku replied to every argument that he would see them put out or die on his own land.

Next morning the main body left Nuku with his two hundred fighting-men ; but a few hours later one of the chiefs, named Hoiroa, of the Ngati Upokoire, returned with twenty-five of his followers, saying, " As you are going to stay, I also will remain."

After two days had been spent digging fern-root and preparing food, Nuku and his party went to Puku-maki, from which place they again looked down on the fires. Then Nuku discovered that there was only one great fire, all the rest were small and insignificant, so he concluded that the most people were to be found where the great fire was burning. He started off that night, and came to Featherston, where there was a bush called Pikoke, and when he reached the shelter of this place he set his men to work and placed snares for rats all through the bush. Next morning the traps were visited and the rats cooked before daylight, and after *kai* they all went on to Tau-whare-rata, where the large camp-fire had been seen.

It was summer-time, in the early morning, and the occupants of the *pa* were all asleep. Nuku now arranged that twenty men should creep up to each of the nine houses composing the *pa*, and his instructions were that the principal men should be captured, and none killed, as he wished to make a peace after getting the chiefs into his power.

Accordingly the nine companies crept along in the dim light of the early morning, reached the houses, held the closed doors, and trapped the enemy. Out of that company only one man escaped—namely, the chief Whare-pouri—and he got away owing to the sides of his house not being driven into the ground and fixed like the rest of the *whare*. Nuku and two of his friends were watching the outcome of the attack, when they saw Whare-pouri creep under the side of his house, and flee. They watched him climb the bank, and they noticed by the dress he wore that he was a chief of note. Accordingly Nuku sent two of his fleetest men after the fugitive chief; but it was of no avail. When they at length caught up to him he saved himself by jumping over the cliff. In his descent he caught or was caught by a *pohue* vine, which saved his life by breaking the force of his fall, and eventually he got away to Pitone. When his pursuers came up they dared not venture the same feat, and had to return crestfallen and declare themselves beaten. In this exploit Nuku captured twenty-seven persons, including Te Ua-mai-rangi (the wife of Whare-pouri), also his eldest daughter (whose name was Te Kakape) ; and when he had got them together he launched the great canoe called Nga-toto, put all his captives on board, and took them to Otauira, sending most of his own people by land. Here he left the *waka* and went to Nga-mutu-awa (Bishop's reserve for college at Masterton), where Nuku said to Hoiroa and the rest of the people, "As Ngati Kahu-ngunu went back with fear because of the great fire on my land, and because I was thus weakened, I thought it the better plan to make peace, and that is the reason why I have saved these people from death." Then, turning to Ua-mai-rangi, he continued, "Go home to my friend Whare-pouri and ask him why he came all the way from Maunga-tautari* (at Waikato) to kill me and take away my land. I am now on my way to Nukutaurua, but will come back again when I am armed with the *pu-atua*."

When Te Ua-mai-rangi heard that speech she stood up and replied to Nuku, saying, "You have saved me; because of this I give you Te Whare-pouri's eldest daughter, Te Kakape, and, as you have made peace, I leave my daughter and return to Whare-pouri to tell him what you say." Then Nuku provided twenty of his people as an escort for her, and conducted her as far as Mataraua (the river near Carterton Station), where they parted, and she went on with her own people. At dark she reached the place where the Pencarrow Lighthouse now stands, and by the time she reached Pitone it was after midnight, and all the people in the *pa* at that place were asleep. Then she left her own people on the beach, and went in search for her husband, Whare-pouri. She listened at each house for her husband's heavy breathing, and when she discovered the house where he was sleeping she entered. The fire was burning dimly, but she detected her husband and, quietly walking up to him, she placed her hand on his head, at the same time bending down and whispering, "Here I am alone, saved by Nuku."

Hearing the sound of voices, the rest of the people woke up, and when they discovered it was Te Ua-mai-rangi who had come to them during the night they wished to *tangi;* but Whare-pouri said, "Wait till we hear the whole matter on the morrow." When morning came Whare-pouri blew the trumpets and gathered all the people together, and then Ua-mai-rangi told what had happened, what Nuku had said, and how she had given her daughter to Nuku. Then Whare-pouri got up and said, "I want all the Ngati Toa, the Ngati Awa, and Ngati Raukawa to leave this valley, for Nuku is right. Why did I come here? Was it not because Te Rauparaha and Rangi-haeata advised me that the land was idle? I want you now to give your consent, so that I may go to Nukutaurua and bring Nuku back to his own land, and I and my people will then go back to Maunga-tautari." Then all agreed to this proposition, with the exception of Taringa-kuri, of the Ngati Tama, who had come from Poutama, near Mokau, who said, "No; I shall not leave; I have lost some of my people here, and will never go back."

Wiwi-o-te-rangi, of Ngati Raukawa, spoke next, and he said to Whare-pouri, "I agree with you, and will order all my people out of the district." Rangi-hei-roa, chief of Ngati Toa (uncle to Wi-parata), also agreed with Whare-pouri's plan, and said, "My people will also leave this land, and go back to Waikato." When Whare-pouri saw the feeling of the chiefs he turned to Taringa-kuri and said, "We all go; you can remain to light Nuku's fire; stay as firewood for him." Taringa-kuri replied, "I'm green wood, and won't burn." Whare-pouri then said, "I shall go to Nukutaurua by ship; I want you, my people, to gather pigs and corn in abundance, so

* My informant has evidently made a mistake here, for Whare-pouri came from Nga Motu, New Plymouth, where he was the head chief of the Nga Motu hapu of Ati-awa.

that we may fill the ship in payment for taking us there." He afterwards found the captain of a ship who was agreeable to undertake the expedition, and he eventually set sail.

In the meantime Nuku was on his way back to his new home, and when he reached Wai-marama (a well-known block of land, recently sold by the Government) Te Hapuku came to meet Nuku, and after the greeting he said, " This young person you have with you is a fine girl ; I want her, and have come out to get her." Nuku replied, " This is the fire that you were frightened of, and could not put out; I put it out myself." Then Te Moana-nui asked Nuku for her; but again Nuku refused, saying, " She was given to me to make peace, and I wish to send her back to her father." He then called the Ngati Kahu-ngunu around him, and when they had gathered he said, " This lady is Whare-pouri's daughter, given me by Te Ua-mai-rangi in order to make peace between us. You now see her ; there she is. I want you to give her mats and greenstone, and send her back to her father." Then the people all shouted for joy, agreeing to Nuku's proposals, and they gave her fifteen mats and a celebrated greenstone called Kai-kanohi, and then raised an escort of thirty men to see her safe as far as the place where the Pencarrow Lighthouse now stands. When this place was reached twenty-eight of the escort were sent back, but the two leaders, Paranga-rehu and Te Aketu, still acted as her bodyguard, saying, " We will stay with you whether you are safe or not."

When the party reached the *pa* the girl called out, " Whare-pouri, where are you ? " and the father, recognizing his daughter's voice, said, " Surely it is my child ; I will go to meet her." As he went out the girl's two companions hung behind, until they were about 2 chains away, for they did not wish to intrude while the two met. When the father and his child were clasped in the usual *hongi*, Whare-pouri whispered, " Is this an errand of peace, or did you escape ? " and Te Kakape answered, " I came on a mission of peace, and Nuku's two men are just behind ; save them." Then Whare-pouri, in obedience to his daughter's words, *hongied* with the chiefs, and they were saved.

Before Nuku sent his escort south with Whare-pouri's daughter, one of the leading chiefs of Hawke's Bay, named Pareihe (previously mentioned). said to Nuku, " I find you are a brave man ; the way you challenged Ngati Toa, Ngati Raukawa, and Ngati Awa, and put out their great fire, proved that. Now there is a great fire at Roto-a-Tara (Te Aute), with smoke rising to the very sky. Te Heuheu (of the Ngati Tuwharetoa) has taken possession, and has started that fire. You asked my people to help you quench the great fire at Wairarapa, but they left you, frightened. Yet I come to you for help, for who else can put this fire out ? " Nuku replied, " Let us first go to Nukutaurua ; we must have *pu-atua* before we can fight Te Heuheu, for he has got them." As Pareihe was agreeable to wait, they went to Nukutaurua and spent two years breeding pigs and growing maize to give in exchange to the traders for *pu-atua*. At the end of that time an army of six hundred men left Nukutaurua, and travelled to Te Aute, where very many of the Waikato, Ngati Raukawa, and Ngati Tuwharetoa were killed, the great chief Te Momo* being among the number. Afterwards Te Heuheu came back to Hawke's Bay seeking revenge for his losses, but in the battle of Te Whiti-otu he was again defeated, and the chief Tanguru slain.

* See wars between north and south tribes, Poly. Soc. Journ.

Nuku had not long been settled in his new district when Ngati Porou sent Te Potae-aute, one of their chiefs, asking for aid to obtain *utu* from the Tolaga Bay people, Te Rere-horua having been killed at Toko-maru, on the East Coast. The answer he received was, "We never like to fight at the back of the house: outside, all right; but inside, never" (probably meaning, could not fight within Ngati Porou boundaries).

Being unsuccessful, Potae-aute went on to the Arawa people, and interviewed their chief Taraia. After considering the proposition, Taraia said, "You go on to the Waikato people: if they will help you I'll follow; if not, I won't go, as it is a risky business, and the distance is too far to walk." So Potae-aute went on to Waikato, where he met the chief Paiaka, and after having explained the object of his journey Paiaka said, "You require a very great war-party for this business, and the distance makes the thing bad; however, let us go on together to Taupo, and see what Te Heuheu has to say about it." They journeyed to Taupo, and when Te Heuheu heard of the affair he decided not to form an opinion till he had talked the matter over with Whata-nui, of the Ngati Raukawa, and Pehi-turoa, of Whanganui. So Te Heuheu sent for Whata-nui and Pehi-turoa, and when they met to consider the position Whata-nui said, "The Hawke's Bay and the Wairarapa people both killed my people at Roto-a-Tara (Te Aute), where we lost Te Momo (the great chief allied to Ngati Raukawa, Ngati Tuwharetoa, and Ngati Maniapoto); because of this I will join you." Te Heuheu said, "Because of the beating the Ngati Kahu-ngunu gave me at Te Whitiotu and Manga-toetoe (in the Hawke's Bay district), I'll consent to take revenge." On hearing this, Pehi Turoa also consented to join; so the three said to Potae-aute, "Go back; gather up your people; be ready. We will travel by the Mohaka road to Wairoa, then on to Nukutaurua, where we will take revenge on the Ngati Kahu-ngunu before we go to make good your loss."

So the war-party started off with a great army of a thousand men, and when they neared Nukutaurua the people heard of their approach and started off in canoes to meet them. Near Gisborne they met. There were the Rongo-whaka-ata, the Mahaki-ngai-tahupo, and the Aitanga-hauiti; but in the battle which ensued at the meeting of the two forces these tribes were beaten, their chief Te Heke-tua-te-rangi and his daughter both being taken as slaves, the latter being captured by Te Heuheu himself. When these two were taken Whata-nui said, "Let me kill Heke-tua-te-rangi and his daughter for the blood of Te Momo" (*utu*). But Te Heuheu replied, "You shall not slay a man whom I captured," and, turning round to the captive chief, he said, "Go home, and take your daughter with you." Then said Te Heke-tua-te-rangi, "Now I see that I am saved by you, keep my daughter; I will come back to bring her home."

He went home, and quickly returned with six slaves, a greenstone *mere*, and six mats. This present he handed over to Te Heuheu for saving their lives, saying, "Accept these slaves, mats, and *mere;* give me my daughter and I'll return, and may the sun shine between us for ever and ever." To this speech Te Heuheu replied, "My foot shall never step into this valley, and I will also warn my people lest they offend": and thus they established a friendship which was never broken.

After this Te Heuheu came to the *pa* where Nuku and Pareihe were dwelling, and called out, "Where are Nuku and Pareihe?" Then went Nuku and Pareihe outside the gate, and called back to Te Heuheu, "Here we are. What do you want?" Then said Te Heuheu, "When are you coming out to meet me in fight? I have heard a lot about your bravery in battle, and have followed you up with the intention of fighting, but there you are, sitting in your *pa* like owls in the supplejacks." Pareihe, answering, said, " Are you not satisfied with the great heap of dead men you have slain—enough to keep you and all your force in food for twelve months? What more do you want? Go, return to your own land." Te Heuheu replied, " When you see the clouds all red in the sky you will know that I have returned with all my party (a threat to burn all the *pa* as he returned), but the thunder of my footstep will I leave behind for you to hear." Pareihe again answered, " This is a foreign land, not my own home. Why do you wish to fight in a strange land? But listen: the thunder of your footstep will I follow, and may be you will then obtain the satisfaction of fighting me." Te Heuheu lifted his arm, so as to signify his acceptance of the challenge and terms.

When the harvest of *kumara* had been gathered in, Pareihe and Nuku went on to Taupo to redeem their promise — to follow the sound of Te Heuheu's footsteps. They conquered the Taupo people at a battle called Omakukara, on the west side of Taupo, where they killed four hundred, and piled them up in a great heap, presenting the pile to the daughter of (here the narrator's memory was at fault). Then on the war-party went to the southern end of the lake, in order to find Te Heuheu himself. Te Heuheu was at this time on an island in the lake (probably Motutaiko), and when he saw the great war-party at the side of the lake he said to his people, " Who can stand against that forest? It is not policy to throw our lives away when we see danger"; and turning to his daughter, Te Rohu, he said, " Go to the people of Ngati Kahu-ngunu, for my life must be saved through you." His daughter answered, " Why, would you give me up to be killed?" Te Heuheu replied, " Not so, my girl, for your mother is closely related to them." So he sent Te Rohu with six men; but before they went he caused to be tied round the forehead of each the symbol of peace (the broad part of the flax tied round in a circle for the head, and finished with a sort of bow in front).

Then the seven left the island and met the war-party at Tauranga-Taupo (a river on the eastern side of the lake), and, after the greeting was over, Te Heuheu said, " Come hither Pareihe, Nuku, and Te Wera; you have fulfilled your promise made at Nukutaurua, for you have followed me, and have made your mark in my lake. No other tribe has ever been able to establish such a mark, so now we will make peace for ever, for our daughter made peace, and a woman's peace is a lasting peace. Remember."

Pareihe, noticing a *kawau* (shag) sitting on a stump in the lake, said to Te Heuheu, " Is this true what you say?" Te Heuheu replied, " Yes." Then said Pareihe, " If I shoot that shag with this new weapon [he had a gun] it will certainly be a true peace." He raised the gun, and the shag fell.

After this the *taua* returned again to Nukutaurua, and shortly after they reached home they heard that two men and a woman had been killed by Rangi-tane. The names of those killed were Paia (Te Moana-nui's mother), Pae-rikiriki, and Te Hau-waho, and they were killed by Whatanui in revenge for Te Momo. When the news reached the peninsula Pareihe stood up and said to Nuku and his people, " I shall want your help, for we must obtain *utu* from Rangi-tane." So off they started for Hawke's Bay and other Rangi-tane lands, and as they went along victorious they captured the principal women of Rangi-tane as slaves, and killed many of their men, the principal slaughter taking place at Te Ruru, on the Manawa-tu River (near Dannevirke).

Then they returned, carrying the captive women with them. Among those taken were the two daughters of Kai-mokopuna. The chief Hapuku married one of these, and their son's name was Te Watini Hapuku. No revenge was ever obtained for these victories.

In the meantime Whare-pouri had been growing corn and preparing flax in order to pay for the passage by boat for himself and a number of his people, and they set out for the peninsula to seek Nuku.

While they were in the boat journeying up the coast it so happened that Nuku set out in a large canoe for the place where the town of Napier now stands, and when they were all out to sea a violent gale arose and the canoe was capsized. Eighteen persons were thus drowned, but Nuku and four others climbed on to the upturned canoe and waited for the tide to wash them on shore. Poor fellows, half-dead by cold and exposure, they vainly struggled, endeavouring to keep her prow straight on to the shore, as swiftly she was being driven to destruction. While Nuku was swimming at the prow, striving to bring her round, a strong wave drove the canoe right on him; he was struck on the head, and in a moment was dead.

When Whare-pouri landed from the boat on which he had journeyed north he found that the man he had come to seek was dead, so he inquired who was the nearest relation to the great chief. Tu-te-pakihi-rangi came, stood up and welcomed Whare-pouri with the customary salutation, and then asked why he had come. Whare-pouri replied, "I came hither to see my friend Nuku, and invite him back to his own place at Wairarapa, for I am heeding his message, and am leaving the land for my old home, taking my people, the Ngati Awa, with me. The Ngati Toa and the Ngati Raukawa are also removing; but Taringa-kuri and his people, the Ngati Tama, are still at Featherston, where I have left them as firewood for Nuku's fire. I find my friend Nuku is dead, but I still wish all you of the Ngati Kahungunu to go back."

Then Te Hapuku said to Whare-pouri, "I cannot allow my people to go back with you to Wairarapa, for when you get them there you may kill them in revenge for past fights." Whare-pouri stood up and said, "I am a chief by birth, and my word is the word of a chief. If you are frightened I am prepared to stay with you as a hostage while your people go; then if any of them are killed you can kill me."

Then Whare-pouri, with fifteen of his warriors, stayed at Nukutaurua, while Tu-te-pakihi-rangi and twenty Wairarapa chiefs (here my informant recited the twenty names) went on board the same boat that had brought Whare-pouri, and sailed back to Po-neke. When they landed at that place a great meeting was called, at which Tu-te-pakihi-rangi stood up and said, "We have now a new people amongst us, and they are armed with this new and strong weapon against which our weapons are useless. Because of this, I shall ask you to retire back to your own land, for who knows what lies before us? Listen: my boundaries will be from the Manawa-tu River to the Manga-toro Creek (a tributary) on the east side to its source, thence over the land to Rapu-ruru, and on to Aketiu, round the coast, back to the Manawa-tu River, where the boundaries meet. This land shall be mine, for me and my people. See the Tararua Mountains, which divide the land: let that range be our backbone, and all the rivers and creeks which rise in that backbone and flow west will be water for you to drink from; those flowing east will be for me and mine."

Then all the people agreed to these proposals, and they stayed and lived together in peace.

Note.

Nuku-pewapewa was so named because his face was tattooed with a pattern called *pewapewa*. It consisted of a single curve round the eye, a spiral on the nose, and three lines curving from the nose to the chin. A carved figure representing this chief, bearing his peculiar *moko*, is to be found on one of the corner-posts of the palisading at the Papa-wai *pa* near Greytown. He is credited with being a man of extraordinary height, and in a cave called Hui-te-rangiora, on the Nga-waka-a-Kupe Hill (about four miles east of Martinborough), there is or was to be seen his mark. Here the Native chiefs for many generations dipped a hand in *kokowai* and struck the wall as high as possible; Nuku's mark is a clear foot above all the rest. He was drowned about 1840, and at Te Whaka-ki, on the beach at Wairoa, where the accident took place, his canoe was carved and erected as a monument, "And" (said my informant) "it is still there, or was there when last I visited the spot."

Art. XLIX.—*The Manuaute, or Maori Kite.*

By Archdeacon Walsh.

[*Read before the Auckland Institute, 24th October, 1912.*]

Climb up, climb up
To the highest surface of heaven—
To all the sides of heaven.

Climb then to thy ancestor,
The sacred bird in the sky—
To thy ancestor Rehua,
In the heavens.

—*New Zealand Kite-song.*

Previous to their contact with European civilization the Maoris were a strenuous people. They were strenuous in war, strenuous in industry, strenuous in their sports. Their splendid physique, their perfect health, and the hardy condition in which they were kept by their arduous open-air life, joined to their buoyant and happy temperament, fitted them for every kind of undertaking that required strength, activity, and endurance.

Games and exercises of one sort or another would be going on among them all the year round whenever opportunity offered. There would be the *poi* and the dancing contests, the practice of the *haka* and the *tutungarahu*, as well as wrestling matches and spear-throwing, varied with the spinning of tops, the flying of kites, and many other sports too numerous to mention. Some of these were designed to while away the long evenings in the *whare tapere*, or house of amusement;* some as trials of strength and

* See Elsdon Best, Trans. N.Z. Inst., vol. 34, p. 34.

skill in the open air. But it was in the late summer or early autumn that the "great games," or tribal or intertribal tournaments, usually took place; for it was at this season—when the days were long and the weather generally fine, when the *kumara* plantation had been cleaned up and required no further attention until the harvest-time—it was then that the Maori was wont to give himself up to enjoyment, provided always that he was not engaged on the war-path. At this time the inhabitants of villages, or groups of villages, would turn out in parties—men, women, and children—and go on their hunting or fishing expeditions, or perhaps on a visit to some neighbouring *hapu* or friendly tribe; and whenever a number of people were assembled a great part of their time would be spent in whatever game happened to be the craze at the moment.

It was generally characteristic of Maori games that they engaged the strength of the whole number of available contestants. They had not yet reached that stage of civilization at which the game is played by a few trained athletes while the whole crowd sit round as spectators, as in a Spanish bull-fight or a colonial football match. Even if the games were such that only a few could play at a time, the rest were ready to take their turn; and very often, in the larger competitions, a *haka*, or posture dance, would form part of the programme, if it did not, as was often the case, form a sort of chorus to the game.

Of all the games in vogue amongst the Maoris that of kite-flying was one of the most ancient as well as one of the most popular. There is pretty frequent mention of the practice in several of the older writers on New Zealand, but the notices are fragmentary and incomplete. It seemed to me, therefore, that it would be a good thing to put them, along with such information as I have been able to obtain from other sources, into a connected form; and the result is the paper I have the honour of reading to you this evening.

It may seem strange that neither in the writings of Captain Cook nor in those of any of his companions do we find any mention of the kite; but when we consider the character of the Maoris, as well as the circumstances of the navigator's visit, we realize that there is nothing remarkable in the omission. The head of the primitive Maori could contain only one thing at a time—what he felt he felt most acutely, to the exclusion of everything else; and we can easily conceive that they would be so taken up with the *kaipuke* (ship), with the strange race of beings that it brought to their shores, with the wonders of the fire-arms, and the (to them) priceless value of the *taonga*, or goods, that for the moment such an every-day thing as the mere flying of a kite would have quite lost its interest. The same absence of mention of the kite is noticeable in Crozet, the historian of the ill-fated Marion expedition, which took place in 1772. Crozet was a very accurate observer, and his account of the primitive Maoris and their customs is one of the most exact and graphic that we possess. If he had seen the kite he would certainly have described it. But it must be remembered that his visit was confined to a very small part of the country — a hilly, forest-covered, and sparsely populated region on the coast of the Bay of Islands, where kite-flying would scarcely have been practised.

According to the universal Polynesian tradition, Maui, the hero-god, and the common ancestor of all the brown races of the Pacific, was himself a kite-flyer,* and wherever his adventurous descendants have settled they

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* See "Maui the Demi-god," by W. D. Westervelt, p. 114.

have brought the practice with them; while in most places they have introduced the material of which tradition states his kite was originally made—viz., the *aute* or paper-mulberry, which gives to the New Zealand kite its generic name—the term *manuaute* meaning "the bird (made of) the *aute*."

This plant, a small tree with rough trilobed leaves, known to botanists as the *Broussonetia papyrifera*, is common to most of the Pacific islands, where to this day its bark is used for the manufacture of *tapa*, or Native cloth. Together with the *kumara* or sweet potato, the *hue* or calabash, the *ti pore* or *Cordyline terminalis*, and probably the *karaka* or native laurel, it was introduced into New Zealand by the Maoris in some of their earlier migrations. Though specimens of the tree, as well as of the cloth which was made from it, were seen by Cook and others of the early navigators, it never seems to have been very abundant. Being a tropical plant, it would no doubt need a good deal of care in the cultivation; and as soon as the Maoris were able to obtain a supply of cotton and linen cloth it was neglected, and became the prey of wandering cattle, and gradually died out. Parkinson, on a visit to the Bay of Islands in 1844, heard of some plants still existing in Hokianga, and managed to get a few cuttings from the chief Patuone, which, however, he failed to propagate; and Colenso, writing in 1880, was of opinion that at that time not a single vestige of the *aute* tree was remaining in New Zealand.

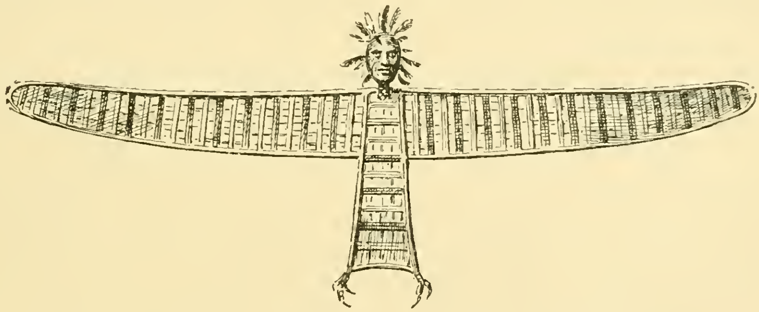

Fig. 1.—*Manuaute:* Sir George Grey's model in Auckland Museum.

It is probable that the first kites made in New Zealand were constructed on the Polynesian model, in which the *aute* was used in the form of *tapa*, or paper cloth, stretched on a frame; but the difficulty of obtaining a sufficient quantity of the bark, and perhaps the unsuitability of the climate for the manufacture of *tapa*, necessitated the adoption of another material, especially for the larger kites, and a substitute was found in the leaves of the *raupo* (a kind of giant sedge—*Typha latifolia*), a coarse tussock-grass named *upoko tangata*, or in the flower-stems of the *kakaho* (*Arundo conspicua*). Even after the plant had become scarce the connection with the *aute* was kept up, the heads of the kites being sometimes made of that material while the body and wings were commoner stuff.

All the larger kites consisted of a light frame of twigs or reeds to which were sewn the *raupo*, *upoko tangata*, or whatever other material might be used to hold the wind. Even when the *aute* was used it was employed—at least, in later times—in the form of strips of the inner bark; in any case, there is no record of its use in the form of *tapa* for this purpose in New Zealand.

The Maori kite was known under several names, and probably each name described some special variety, differing from the others in size, shape, or the material of which it was made. Thus there is the *manu* or bird, the *kaahu* or hawk, the *paakau* or wing, and the *manuwhara* or kite of the canoe-sail. Still, the term *manuaute* seems to have been retained as a general name, and might be used loosely for any variety.

There is a very fine model of a Maori kite in the Auckland Museum, which was made for Sir George Grey by some East Coast Natives. Its shape is roughly that of a hawk with wings outspread, and measuring about 10 ft. or 12 ft. from tip to tip. It is made of *raupo*, neatly sewn on to a light frame of *manuka* or tea-tree twigs, stained alternately red and black. The body of the bird is surmounted by the likeness of a human head, made of linen or calico, painted and decorated with hawk's feathers, the latter being shaved off from the quill so as to wave in the wind. This kite is of a very graceful form, and, allowing for the difference of material, probably represents as nearly as possible the original *manuaute.*

Mr. J. White, in his "Ancient History of the Maori," tells of a kite, used in the olden times, which was made to resemble a man, with head, body, and legs—the body being made of *kareao* (commonly known as supplejack), over which was put the bark of the *aute* tree.

A smaller variety of kite is also represented in the Auckland Museum by two specimens obtained through Mr. Elsdon Best. These are of a triangular shape, and are made of the stems of the *kakaho* (*Arundo conspicua*) lashed on to the flowering panicles of the same, no other material being used. These kites are about 2 ft. long, and are ornamented with bunches of hawk's feathers at the angles. This species seems to have survived all the others, and has often been seen by some of the older settlers.

So far as I have been able to gather, none of the New Zealand kites were furnished with tails, such as we understand by the term. It is true that Mr. Elsdon Best* mentions the "tail" of a kite, but the context shows that this was part of the solid structure, as he says that to this, as well as to the wings, were attached "long tails or streamers termed *puhihi*" *(puhipuhi ?).* These were probably light garlands of feathers such as were flown from the sternpost of a war-canoe, and were simply used for ornament, having nothing whatever to do with the balancing of the kite. The same author states* that "sometimes shells were attached to the kites, and when flying, should the cord be held [checked ?], the oscillation would cause the shells to rattle. . . . Shells of the *kakahi*, or fresh-water mussel, were used for this purpose, evidently on account of their lightness." And Mr. A. Hamilton, in "Maori Art" (p. 377), says that the head was sometimes hollow, and that the shells were put inside. This statement agrees with that of a Maori writer (Te Rangi, or William Marsh) whom I shall have to quote presently. Mr. Elsdon Best states that horns or points were attached to the head of the kite. These were probably in the shape of long antennae, formed of stalks of *toetoe* or *raupo*, covered with feathers, such as were used on a war-canoe.

Professor A. C. Haddon, in a most interesting and exhaustive essay on kites in general ("Study of Man," p. 246), states that the string (of the New Zealand kite) was most expeditiously formed and lengthened at pleasure, being merely the split leaves of the flax-plant (*Phormium tenax*). This may have been the case in regard to the little toy kites used by children, and perhaps to some of the degenerate kites of later days, but a string of knotted

* Trans. N.Z. Inst., vol. 34, p. 58.

flax-leaves would have been far too heavy as well as much too weak to raise some of the monster kites which in old times were flown at the "great games," when the string was often hundred of yards long. In fact, it is expressly stated in a minute and graphic description of the *manuaute*, in a Maori MS. by Te Rangi in the Auckland Public Library, kindly translated for me by Archdeacon Hawkins, that the string for such a kite as he describes was made of *muka*, or dressed flax—meaning, of course, that it was spun in the same way as a fishing-line or any other small cordage.

It appears to have been customary both in New Zealand and throughout Polynesia for the kite-flyer to chant a kind of song as the kite went up. These songs were a variety of the *karakia* called *turu manu*, or kite-charm, and were believed to make the kite fly properly. A number of these have been preserved. They are often full of poetic fancy; but the archaic language in which they are composed, while denoting their great antiquity, makes them extremely difficult of translation.

Mr. Colenso relates that, on arriving at a Maori village, he was surprised to find grown-up men engaged in flying kites and spinning tops. He seems to imply that there was something unmanly, if not childish, in such an occupation. But why kite-flying should be considered less manly than, say, bowling or golf it would be difficult to explain, especially if the kite-flyer was the manufacturer of his machine.

Mr. Elsdon Best gives a very graphic account of kite-flying in the olden days in a paper on Maori games read before the Auckland Institute in 1901.* Writing between inverted commas, probably repeating what was told him by some old Maori in Tuhoe-land, he says, "In the days of old our people would weave kites, and the wings and body thereof would be covered with *aute*. Hence the name '*manuaute*.' Horns or points would be fastened to the head of the kite. . . . When the wind rose the people would go a kite-flying (*whakaangi manu*), and many would gather to look on. An expert person would be selected to cast off the kite that it might rise, and, if a large kite, he would have to be careful lest the thing swoop down and he be struck by the points thereof. When the kite rose it would soar away like a bird, and the cord would be paid out as it ascended. Then the *karakia* [or kite-flying song] would be repeated. . . . Then a round object, a disc, would be sent up the cord, along which it would travel. It was to take water to the kite, and show that the kite had reached the heavens. And it would reach the kite, although the latter might be so distant as to be out of sight. Then the cord would be drawn in, and finally the kite would be recovered. And on being looked at it would be found quite wet. A peculiar wetness this that clings to the kite: it is not like the water which flows here below; it is like dew, or the misty wet which settles on the ranges."

But probably the finest account of the kites and kite-flying of the old days is that given by Te Rangi in the Maori MS. already referred to. The account is headed by a pen-and-ink drawing of a kite somewhat similar in shape and construction to Sir George Grey's model in the Auckland Museum —*i.e.*, of a bird with extended wings, each part of the kite being marked by a number referring to a schedule of names.

He commences with a description of the *manuaute*, which he says was a comparatively unimportant kite, but was nevertheless a very good flier, requiring from 150 to 200 yards of string of dressed flax (*muka*) for one of moderate size, and from 300 to 700 yards for a larger one.

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* Trans. N.Z. Inst., vol. 34, p. 58.

But this apparently was only a toy compared with the *manukaahu* (hawk-bird) and the *manuwhara* (sail-bird), on the description of which he waxes picturesque. Unfortunately, he does not give the dimensions, but they must have been immense machines, even allowing for exaggeration in the statement that it took " from five men to ten men, to twenty men to thirty men " to send them up, and, including the men holding the line—which might be anything to 1,200 yards, or even 2,200 yards in the case of an extra-large one—it took no less than seventy men to manipulate the kite. The head of the " man in the kite," as he terms it, was ornamented with feathers, " requiring perhaps the plucking of twenty pigeons." This includes, no doubt, the decoration of the horns which he mentions afterwards. There were also plumes from the albatross (*toroa*) on the head, as well as tufts of albatross-down attached to the ears. And " there were also young birds inside the head, to make a rattling or a rumbling noise as the kite was lifted up by the wind. About twelve was the number of these young ones, which were merely skeletons without any flesh."

It was a difficult as well as a dangerous thing to get the *manuwhara* launched in the air, on account of the straining of the huge wings under the pressure of the wind. For if a false start were made, and the kite struck a man as it swooped over the ground, the horns would pierce his body—" he would be driven into the earth ; he would never rise again." " This is what caused such fear," continues the writer, " when the *manuwhara* swooped about like a hawk skimmimg over the earth ; and that is why it required such a number of men to hold it."

The flying of such a kite was, of course, a great event, and would no doubt attract a large concourse of spectators, including probably the inhabitants of adjacent villages, and possibly parties of visitors from other tribes, many of whom would perhaps bring their own kites to join in a flying match. It is easy to picture the scene as the " great games " are being held on some breezy upland, or perhaps a broad beach, when the fine-weather wind is blowing in strong from the sea. There are the *kaumatuas*, or tribal elders, sitting with their more distinguished visitors on some rising ground whence they can obtain a good view of the proceedings. The chief women also, sitting in a body apart, with the general public in the background, and a host of children running all over the place. All are in animated discussion as to the respective merits of their favourite kites, or the potentiality of some new *manū* which is going to break the record, while a steamy haze in the distance reveals the presence of the *haangis*, or earth-ovens, where the food to be eaten when the play is over is in process of cooking.

Meanwhile the big kite is brought out, not without difficulty, and held up by a number of men facing the wind, while a party of young athletes, in their feathers and war-paint, are squatting down in a compact body at a convenient distance in front, ready to spring up and salute the kite with a *haka* as it starts on its flight.

And now the excitement rises to fever-heat. " The men who were holding up the kite," continues Te Rangi, " were as if they were mad, owing to the straining of the wings and the blowing of the wind as the men at the string were taking up their position." " It was not yet proper," he says, that these men should be more than 100 yards away "—doubtless so as to be able to keep the kite under control in case of a false start. " As they held it in their hands," he goes on to say, " a man came running forth from the front rank of the *haka*, quivering his hands," like the challenger of a war-party—doubtless with rolling eye-balls and protruding tongue and all the gestures proper on such occasions. At last the kite is let off. Soaring up like a giant hawk, it would take all the strength of the men to hold it as they pay out the line, and "as it went up from the hands of the holders," says Te Rangi again, "there was heard the rattling of the young ones" (that were shut up in the head). It was like the letting-go of the anchor of a ship.

So graphic is the description that we can almost see the body of young athletes jump to their feet with the shout as of one man, "*A-haha! Me te kete kainga e ringi ana ki te pari,*" and join in the maddening *haka,* as the great bird, with its human head festooned and feathered, sails away with waving antennae and its long streamers floating in the wind.

But the Maori kite was not always a mere plaything, even though it might be such a magnificent plaything as that described by Te Rangi. Kite-flying in the real old times had often a religious significance. Maui compelled the winds with his kite, and in the hands of a powerful *tohunga* the *manuaute* could do wonderful things. As an instrument of divination it could tell whether it would be wise for a war-party to attack a fortified position. "If the war-party," writes Mr. A. Hamilton in "Maori Art" (p. 377), "got within a reasonable distance of the *pa* without being molested

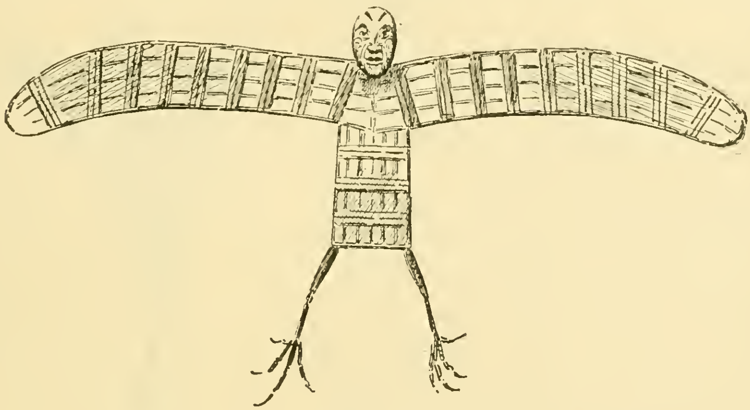

Fig. 2.—*Manuaute:* Specimen in the British Museum.

the priest would construct a kite made of *toe-toe whatu manu*, and fly it in the air; if the kite should fly lop-sided it is an evil omen, but if it flies well the priest will hold the line in his right hand (to hold it in his left would be an *aitua*, or unlucky), and, letting it out, he repeats his incantation. Still holding the kite, he sends a 'messenger' up the string: when it is half-way up he lets go the line, taking care to have the wind so that the kite will fly across the *pa*. If the kite catch on the palisade it is thought that the incantation of the priest, made during the performance, will produce such an overwhelming dread or panic in the inhabitants that they will be easily conquered." That is, of course, provided that a stronger incantation by the *tohunga* inside the *pa* is not able to keep the kite from alighting.

Another use of the kite as an instrument of divination is described in "The Migration of Kaha-hunu," translated by Mr. S. Percy Smith (p. 25). It appears that in very ancient times two twin brothers of high rank had been treacherously murdered by a certain chief, who was jealous of their growing importance in the tribe, and their bodies covered in a deep pit. The story goes on as follows: "Now, the children were absent from the morning even to noon: the morning food was cooked, but they appeared not. Then Kahutapere, their father, went about inquiring for his children at this village and that village, but they were not seen. He then went to the *pa* of Rakai-hiku-roa (the father of the murderer), and on inquiring was told that they had not seen them. Enough! The man was disheartened and anxious about his children, and returned to his *pa* and cried over them (believing them to be dead). Presently he decided on a course of action (by which they might be found): he weaved two kites, and named them Tara-ki-uta and Tara-ki-tai, after the twins. He then assembled all the priests to say the incantations over them. When they met he flew the kites, and as they ascended the incantations were recited. The kites ascended a great height, and hovered over the *pa*. . . . When at their extreme height they descended; then ascended a great height and hovered over the *pa*—that is, there were two ascents and two descents above the *pa*. It was sufficient; the lines were wound up, for it was now known that the people of the *pa* had killed the children."

What appears to have been a common and very ancient use of the Maori kite seems to have been its employment as a means for seeking for land for settlement. No less than four instances have come to my knowledge, and doubtless many more might be discovered on inquiry amongst the older Maoris. The first is related in an account, kindly furnished me by the Rev. Matiu Kapa, of Kaikohe, in connection with the spread of the Ngapuhi Tribe, of which he is a member.

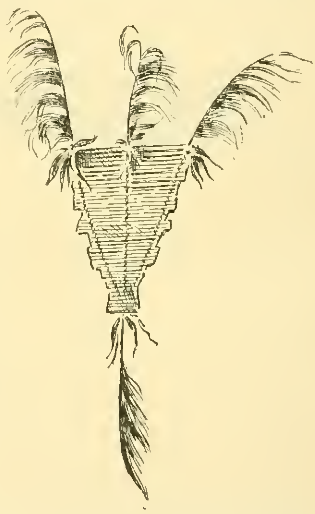

Fig. 3.—*Manuaute:* Modern specimen in the Dominion Museum, Wellington.

The Ngapuhi claim that their ancestors originally came to New Zealand, together with those of the Rarawa and the Aupouri, in a canoe named "Matawhaorua," about five and a half centuries ago. This was a sacred canoe which had belonged to Kupe the navigator, who had visited and explored the country some time previously. It was sacred because it held the *mana* of the tribes which was leading them to New Zealand. It was so sacred that it was not proper that any food should be carried in it, and it was therefore accompanied by another canoe, named the "Mamari," which carried the provisions for the crew.

On that first trip of Kupe's the women and children did not come to New Zealand, but stayed behind until a land could be found for them, and when Kupe discovered the land he returned to Hawaiki to bring the people. There was, however, a long delay before they were able to start, on account of dissensions among the tribes; and Kupe, who had grown very old, handed the expedition over to a chief named Nukutawhiti, together with the sacred canoe, at the same time giving him sailing directions which would land him across to Ocean of Kiwa.

The voyage was accomplished in safety, and the party landed at Hokianga—so called because it was the place of returning (*hokinga*)—*i.e.*, the place whence Kupe had returned to Hawaiki.

The people settled down near the place where they landed, but after some time the country became too small for them, and after a time a chief named Kaharau determined to go further out and seek land for his descendants. He flew a kite named Tuoronuku from Pakanae, near the mouth of the Hokianga River, and as it went forth the *turu manu*, or kite-song, was sung, as follows :—

Taku manu, ka turua atu nei,
He karipiripi, ke kaeaea ;
Turu taku manu,
Hoka taku manu,
Ki tua te haha-wai ;
Koia Atutahi, koia Rehua
Whakahoro tau tara,
Ki te kapua, Koia E !

[*Translation, by Mr. S. Percy Smith.*]

My bird, by power of charm ascending,
In the glance of an eye, like the sparrow-hawk,
By this charm shall my bird (arise).
My bird bestrides (the heavens)
Beyond the swirling waters,
Like the stars Atutahi and Rehua,*
And there spread out thy wings,
To the very clouds. Truly so.

As the string was let go the kite drifted along before the wind, and fell to the ground at Kaikohe, a distance of twenty-five miles from Pakanae—of course, conveying the *mana* of the tribe, and communicating it to the land on which it fell. The Maoris followed it up, and ever since the district of Kaikohe has been occupied by a branch of the Ngapuhi Tribe.

Another instance is related by Mr. J. White in his " Ancient History of the Maori " (vol. 5, p. 94). " In the days of old," he says, " the Nga-ti-koroki, of the Waikato tribes, put a kite up in the sky, and when it had gone far up the line broke, and the kite went in the direction of Here-taunga (Mercury Bay). The owners followed it, and found it in a place now known by the name of Whenua-kite (land found or discovered). Having found the kite, they gave the place the name it now bears, and the Ngati Koroki claim and hold possession of that land to this day."

The Ngatihaua, a Waikato tribe, also put up a kite at Maungatautari, when the string broke. They followed up the broken string, which they found resting along the tree-tops, and discovered the kite at Whitianga, also in Mercury Bay, and on that account the tribe afterwards laid claim to the land at Whitianga in the Native Land Court.

A similar device is said to account for the presence of a small detached body of the Ngapuhi Tribe at Koputauaki, near the township of Coromandel.

There was still another use found for the kite, described by Mr. J. White† as follows : " In the days of old an *aute* kite was the medium of communication between the various tribes who lived at a distance from each other. . . . The kite, when made, was kept till the wind blew from its owners towards the district in which the tribe lived for whom the message was intended. The kite was then taken and made to fly far up in the sky. Then the line that held it was allowed to go, and the kite was blown far away, and alighted at the home of those for whom the message was sent. These, when they had seen the kite, would divine the purport of the message, and the receiving tribe would at once go in a body to the place from which the kite had been sent."

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* Canopus and Antares.

† " Ancient History of the Maori," vol. 5, p. 94.

Dieffenbach says that the kite was a sign of peace when it was seen flying near a village. This may have been the case under ordinary circumstances, as it is obvious that kite-flying as a pastime would not have been practised in time of trouble; but I have it on the statement of Kapua, of Purangi, in Taranaki, a recognized authority on old Maori matters, that a kite was often flown over a *pa* when an enemy was on the war-path in the neighbourhood. This was no doubt a special kite, which would be recognized as a signal not only to give the alarm to the surrounding villages, but to summon the various fighting-parties to a central rallying-point.

I conclude with an anecdote relating how a kite was used as a signal, related to me by Mr. James Bedggood, an old settler in the Bay of Islands. Once upon a time a certain chief, who was already married, took to himself a second wife; but, as might be expected, the two women could not agree. Infatuated with his new wife, the chief took the old one secretly away in his canoe, and marooned her on an uninhabited island, where in process of time she gave birth to a son. She was very badly off for food, and for a while she had to subsist on anything she could pick up on the island. Walking along the shore one day, she happened on a kit of *kumara* which had been washed up by the tide. These she planted, and in due time harvested the crop, when her condition was a little better. Meanwhile her brothers, who had suspected all along that there was something crooked, had been searching for her everywhere, but so far without success. One day, however, they noticed a smoke rising from the island. They got out their kite, and managed to fly it so as it would drop near the fire. The woman recognized the kite, and made a bigger smoke as a sign that she had seen and understood, when the brothers crossed over and rescued the mother and child. Her husband wanted her to come back to him, saying that, after all, he preferred her to the young wife; but her brothers would not consent to this tardy settlement, and took her away to live with themselves.

The Maori kite has long been a thing of the past. Probably no Maori now living has ever seen a real *manuaute*, and when Sir George Grey wanted to obtain one many years ago he was obliged to get one specially made.

In the evolution of modern Maori life there is no room for the *manuaute*. Its place has been filled by other things. There is no occasion to send up a kite to take a message to a neighbouring county when the post-office or the telephone will do the business with much more ease and certainty. Neither would it be worth while to take the matter out of the hands of the police and hunt round with a kite for the body of a missing relative. As an instrument for the acquisition of new lands it would be hardly required, as the Maori of to-day is more anxious to dispose of the land he already possesses than to exert himself to acquire any more. And the "great games": is not their place taken by the horse-race and the football match and other *pakeha* diversions that delight the modern Maori? Some day—on the occasion of a Royal visit, perhaps—kite-flying may be revived once more, like the *haka* and the *poi* dance; but the revival, if it ever does occur, will be but a temporary makeshift, a shadow of the past, for the string is broken and the *manuaute* has long ago sailed away into oblivion.

Haere ra, manuaute!

(Farewell, Maori kite!)

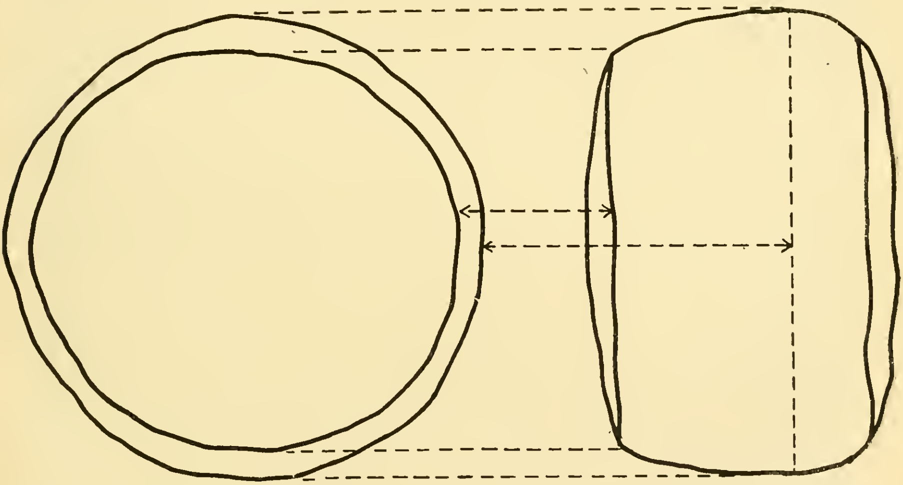
ART. L.—*Concerning certain Ancient Maori Stone Implements found at Tauranga.*

By C. A. SEMADENI.

[*Read before the Auckland Institute, 11th December, 1912.*]

ABOUT ten years ago, while I was living in Tauranga, I commenced to make a collection of ancient Maori "curios," and during the next few years I spent a good deal of my leisure time fossicking in the neighbourhood of old and long-since-abandoned Native settlements, particularly near Mount Maunganui, at the south-eastern entrance of the Tauranga Harbour. This place must at one time have had a fairly dense population, and frequently during a heavy westerly gale the sand was removed from the sites of old dwellings near the beach.

Here most of my finds were made. Among them are certain peculiar implements of stone, rather roughly finished, and in the form of discs. Their size and weight vary considerably. I suppose I found a dozen or thereabouts in all, and perhaps as many more were picked up by others. They



ROUGH SKETCH OF STONE BOWL. (About half-size. Weight, 4½ lb.)

were sometimes called, among some of my friends, "cheese-stones," and this name is apt enough, for many of them do resemble small cheeses in appearance.

Although I often tried to find out what their possible use could have been, I could find no one who had ever seen such implements used by the Maoris, and some of the friends I consulted had had dealings with the Natives for as long as fifty years before. It was pretty evident, then, that these implements could not have been in use for a very considerable time. The late Major Mair examined them, and so did Mr. Waite and Mr. Cheeseman, and several old residents (both Maori and pakeha) of the Bay of Plenty.

On one occasion a friend and I found one of these stones, and as we strolled along the hard sand at low water my companion bowled it along in front of us. We noticed that it ran with a wide and regular curve, and my friend jokingly remarked that "the ancient Maori must have played the ancient game of bowls." The incident is probably forgotten by my companion, but I have often recalled it, and wondered if this were really the explanation of the matter. I often thought it might be, but I was afraid to put forward the theory seriously, because at first the idea of the fierce cannibals of old amusing themselves in this manner appears somewhat ludicrous. Recently, however, I was reading again an old friend—Captain Cook's Voyages—and in his account of the Sandwich Islands Natives I found this passage: "They play at bowls with pieces of whetstone, mentioned before, of about a pound weight, shaped somewhat *like a small cheese*, but rounded at the sides and edges, which are very nicely polished; and they have other bowls of the same sort, made of a heavy reddish-brown clay, neatly glazed over with a composition of the same colour, or of a coarse dark-grey slate."

After reading this I made a careful re-examination of the stones (nine in all) still in my possession, and tested them pretty thoroughly, with the result that I have come to the conclusion that they are really and truly "bowls," and that the sport of bowling must have been indulged in long, long ago by the Maoris in the vicinity of Tauranga. Further, the game was most likely played on the hard level sand at low water. Cook does not mention the kind of ground on which the Sandwich Islanders played, but it would probably be the beach. I tried the bowls on a lawn, which just then was rather "heavy," as it had not been cut or rolled for a couple of weeks, and, although the bowls ran fairly well, the work of sending them across the green was too hard for pleasure; but on an asphalt court they ran well and easily, and even a couple which seemed to the eye to have no "bias" (or bevel on the circumference) curved quite 5 ft. from a straight line in travelling 20 yards. Hard, wet sand would form a splendid bowling-surface for them, and if it became "cut up" after a few games there would be no trouble in shifting to another "rink."

Mr. Cheeseman tells me that there are some of the Sandwich Islands bowls in the British Museum, and that a drawing of one which he has kindly examined might very well be taken for a sketch of one of those which I handed to him. It seems possible that Cook underestimated the weight, as the one in question is $3\frac{1}{2}$ in. across, and one of mine but slightly larger ($4\frac{1}{4}$ in.) weighs more than $4\frac{1}{2}$ lb. The lightest I have weighs $3\frac{1}{2}$ lb. The largest weighs $6\frac{1}{4}$ lb., and is nearly 6 in. in diameter. It runs beautifully—but I must not be carried away by a bowler's enthusiasm. The average weight of those I have is 4 lb. 9 oz.; the average diameter about $5\frac{1}{4}$ in.; and the average thickness nearly 3 in.

The drawing mentioned above, Mr. Cheeseman informs me, is in Heape and Partington's work on "Polynesian Ethnography," which makes a reference to the extract from Cook's Voyages which I have quoted, and also mentions that this Sandwich Islands game is described in Byron's Voyages and in Ellis's Journey through Hawaii.

As to the reason for the fact that these discs have been found only at Tauranga, and apparently nowhere else in the Dominion, I think, on the whole, that I had better leave it to be explained by more competent writers. I might, however, hazard a prophecy that if this little paper calls attention to the matter similar stones may yet be discovered in other parts.

In conclusion, I should like to state that if any bowler or collector wishes to examine them I shall be very pleased to afford him an opportunity.

ART. LI.—*New Zealand Bird-song: Further Notes.*

By JOHANNES C. ANDERSEN.

[*Read before the Philosophical Institute of Canterbury, 4th December, 1912.*]

THE figures accompanying this article contain the new notes observed since publication of the paper in the Transactions of 1910 (Trans. N.Z. Inst., vol. 43, p. 656). For convenience of reference the variations in the notes of each species of bird have been numbered consecutively from (1) onwards, the earlier numbers appearing in the Transactions of 1908 and 1910: reference is at times made to these earlier numbered variations. When notes were heard on one day only, the date on which they were heard follows the number.

THE TUI.

The notes of (25) have the sound of the tinkling of a distant sheep-bell. They varied from four to six in number, and also varied slightly in pitch on different days. They were uttered a good deal faster than the bell notes of (1), their time being about five to the second. The notes of (26), similar in quality to (25), were not always followed by the drop to *c*, and were still more seldom followed by the expletive *clit*; this latter was, indeed, only heard with these notes on the 31st December, 1911. On this day, too, two clear anvil notes preceded, and the guttural *aurr* followed (27). The sheep-bells took the place of the previous year's vesper bells. In (29) the last two notes (*d*) had a reedy quality, broader and more blatant than the note of a clarionet, yet musical. In (28) the sheep-bells were preceded by a cry like that of a goose, plaintive and melodious; the drop on *d* was staccato, and the cry would sometimes take *kraw krurr* after it in place of the sheep-bell. The cry when uttered only once was more drawn out and melodious than when uttered several times, as in (30). Here the notes were connected, but not slurred. Other than the goose cry, I could think of no similar sound excepting the hypothetical sound of a bell through a kazoo, suddenly muted as it struck the *e*. It might approximately be vocalized *vii-ü vii-ü*. This was the sound-effect it first had upon me; later it did not seem to be followed by the drop to *e*, but by *gaurr* only. It might be likened to the cry of a goose with a cold; less musical than (28). Later in the day it was more distinctly *e* only (31), and the sound was like that of a vibrating membrane having a resonant chamber to give it body; or like the vibrating of a reed to which adhered a loose thin strip of metal, adding a rattle to the reed. These five notes were sounded in about 2 seconds. They varied in number from one to seven, never more than seven, and usually four or five.* A long-drawn, high, sweet, very soft note, two octaves higher, sometimes preceded the reedy cry, which, too, was sometimes succeeded by *aurr*, making the full theme of (32). When the bird made this reedy cry it stretched out its neck, opened its beak very wide, and beat downwards with its head at each note, as though its head were a hammer, and that action produced the note on the air anvil. The high soft note was one of the "bubbling" song. There was a catch at the end of each reedy note on the day (32) was taken down, vocalized by *ke-oo ke-oo*—with a swell on the *e*, whose sound was

* On the 29th December, 1912, and on the 2nd January, 1913, the notes had the sound of a deep clarionet, very resonant, vocalized *eoo eoo eoo*.

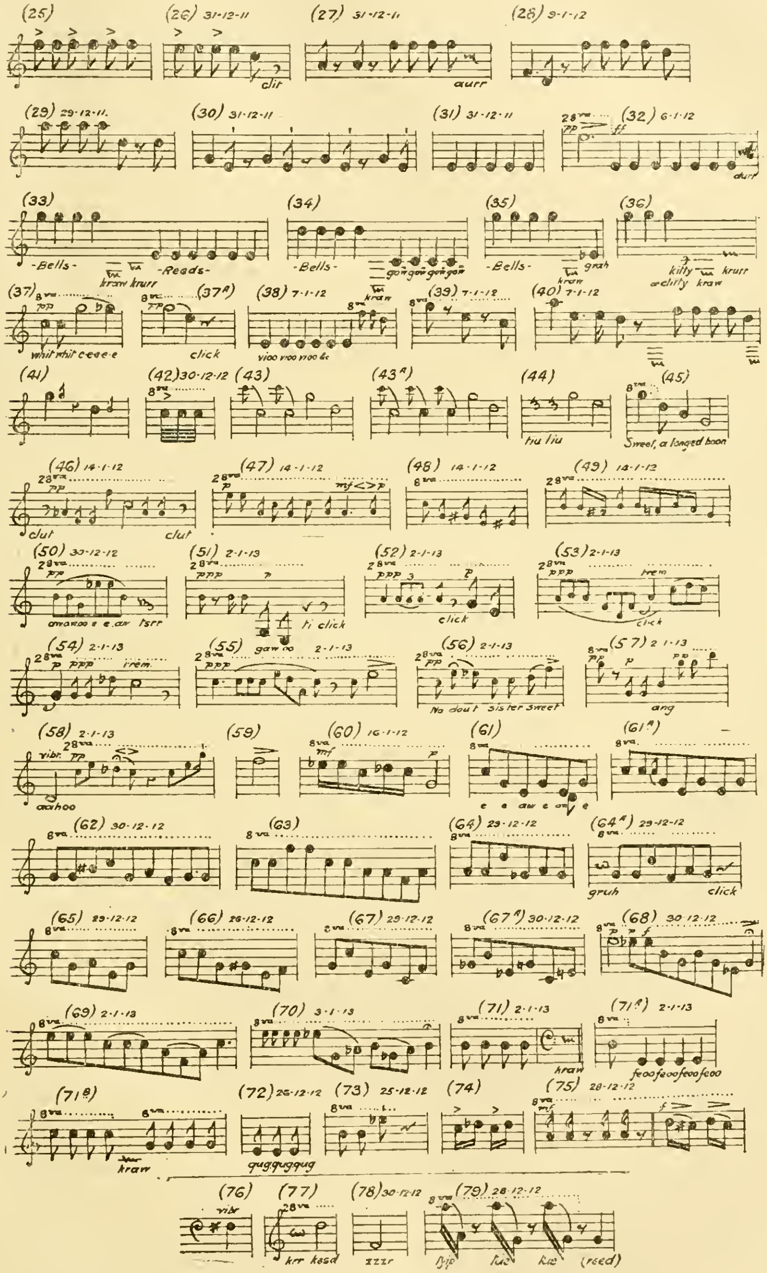
short, as in " net " : the catch was the *oo*, audible only when close at hand. The *oo* had less of the reedy tone, and the catch was evidently caused by a sudden change in the shape of the aperture through which the sound was produced ; at times this gave the impression that the *oo* was an octave lower than the *ke ;* but I think the difference was in the quality and not in the pitch. At times the *ke-oo* had the sound of *howw*, the pause on the *w* bringing back the *oo*.

The sound of the note changed during a fortnight from a clear anvil ring to the reedy sound in an acute form, with a rattle, mellowing again towards an anvil sound. People in the locality, life-long dwellers by the bush, declared it to be a new cry—an assertion warranted by its variability : one likened it to the sound of a cracked anvil, another to the knocking of rusty iron pipes. There were not more than three or four birds in the bush that gave utterance to the cry ; one particularly noticeable sat on the same totara day after day, well in view. Bell notes and reedy notes were at times played off one against another, as in (33), so it is evident that the new note was produced of the bird's own volition. On the 7th January, 1912, the sound was distinctly like the twang of a jews' harp, the shape of the open lips being altered for the *e-oo* whilst breathing on the twanging metal tongue. Other variations are given in (34), (35), and (36), the relative pitch of the expletives being also shown. The *kitty* or *clitty* of (36) was the same as the *clit* of (26), with a short sharp after-sound added. The bird from which these variants were obtained flew off with a sustained vibratory note that made it sound as though the bird were a flying aeolian harp. Other expletives, heard at various times, are shown in (37) and (37A). The reedy notes of (38)—vocalized *vioo vioo*—were on one day followed by three notes more like a clear whistle than the usual bell notes ; those of (39) were in quality between bell and whistle. The full theme (40) was heard only on one day ; at times the first half would be sung alone, and at times the second ; occasionally only, the full song.

In (41) two full bell notes were followed by faint after-notes, as though the hammer of a chiming bell had just touched again on the rebound ; the division between the note and its quasi-echo was barely discernible. A short note with double rebound, making a very rapid triplet, is shown in (42) ; this sometimes preceded the reedy note, sometimes succeeded it, but was usually heard alone : it had an open, vibrato, clarionet sound.

The full notes of (43) were uttered about two in a second ; the short sharp initial notes reminded me of a swinging creaking sign-board—if the creak could be sublimated into music. The last two notes of (43) and its variant (43A), preceded by two very sharp and abrupt sounds *tiu tiu*, were sung once as a duet, the two birds singing alternately or together (44). Often the *g* was vibrato, as though the bell were struck very quickly and lightly with a wooden mallet. The duet was very pleasant to listen to ; but far sweeter was a love-song, preluded by the exquisite theme of (45). The vocalization instantly took the words " Sweet, a longed boon." The bird sat high in the sunlight of a giant totara ; I sat in the shadow at its foot. When not singing the delicious theme of (45) the tui was song-bubbling to himself in an inarticulate and barely audible ecstasy. His subdued throat-rapture was so soft and so varied, and the notes so rapid, and broken in interval, and again so runningly blended in whistles, sighs, clucks, and constricted sounds, that nothing could be noted definitely, and it could only be likened to a light and liquid fall of music from the bell of a convolvulus.

On the 14th January, 1912, the bubbling song was often heard, and was extremely beautiful. Unless quite near the bird, and not always then, the



intervals could not be distinguished sufficiently for noting by me. The song (46) opened and closed with a sharp *clut,* a sound like the opening and closing of the mechanism of a musical box. This song lasted little over a second; (47), almost like a quick jangle of bells, took under 2 seconds: the sequence of the notes constantly varied. The theme of (48) was rather a bell-jangle than a bubbling song: the latter songs are an octave above the former—so highly pitched, indeed, and so softly uttered as to be inaudible to many human ears; folk may see the bird throbbing in song, but hear no sound. When heard, it is of extraordinary beauty. The song (49) was sung during flight. Whilst the notes constantly varied, there is probably a definite number of themes; for (48) was noted several times, and other combinations became familiar; indeed, it was only after hearing a theme repeated that it acquired sufficient definiteness to be recorded. As beautiful as the theme (45) was another, (50), whose sounds were easily vocalized *Og naar hun er naer os* (And when she is near us), at which point the *tsrr* switched off the secret, the song being continued even more softly, allowing but an echo of its sweetness to be heard.

A bright sunny day on the 2nd January, 1913, warmed the tuis into singing many charming bubbling songs. The bird that sang (51) sat with his neck outstretched, moving his head from side to side: the sweet bubble of the first three notes broadened to a most mellow soft bell sound on the *g* and *e*; the bubbling continued after the *click*, but I could not catch the sequence. In (52) the last two notes, whilst bell-like, had a more nasal sound, and the bird leaned forward, using more energy whilst giving utterance to them. In the beautiful (53) there was a curious *click* up to the tremolo *a*, and a similar upward *click* opened (54). In (55) the last note sweetened and dwindled away into silence. One bird repeated (56) many times, it being at times considerably louder than the bubbling song, especially as regards the first three notes, vocalized *No doubt*, dwelling on the double vowel. The drop to *e* flat was a slur, as was the final rise to *f*. There was yet more of (57), but it was sung so lightly that I could not distinguish the intervals. The last note of (58) was touched very lightly, and was most staccato in effect. The opening note was extremely peculiar, and was heard only on this day. It was like *aah oo*, breathed only, with a vibrating uvula—exactly like a gargle, in fact, so that the bird's gargle sweetened its throat for the song following. The beauty of the song was greater than the beauty of the simile—so far as beauty is greater than truth. These bubbling songs almost seemed beyond the bird's volition; they were like an escape, a running-over, from a full treasury of sound-jewels. They were often followed by a sweet long-drawn cry on *f* (59). The commonest songs were bell jangles and runnels: one would suppose the bird to be "preparing" for singing, for he emitted more *clicks*, *clacks*, and *gurrs* than musical notes, sounding like the snapping and intermittent whirring of clockwork, as though his musical box had been undergoing seasonal repairs, and was being tested as to its mechanism.

The jangle (60) was usually heard just after the tui had settled from a flight; it was often confused from a beautiful jangle to an elfin juggle of bells, when it was difficult to distinguish either pitch or interval, though the last note was usually definite, often remarkably sweet, as containing the concentrated essence of all preceding. The jangle (61) was very commonly heard, the whole phrase lasting little over a second, all the notes being very mellow and bell-like, the two lowest, on *e*, being more open and sweet; the second *e* was often *d*. The jangle was often confused by the introduction of one or more light notes, as in (61A); there were others introduced, but I could not fix them with certainty. The jangle (62) lasted nearly 2 seconds.

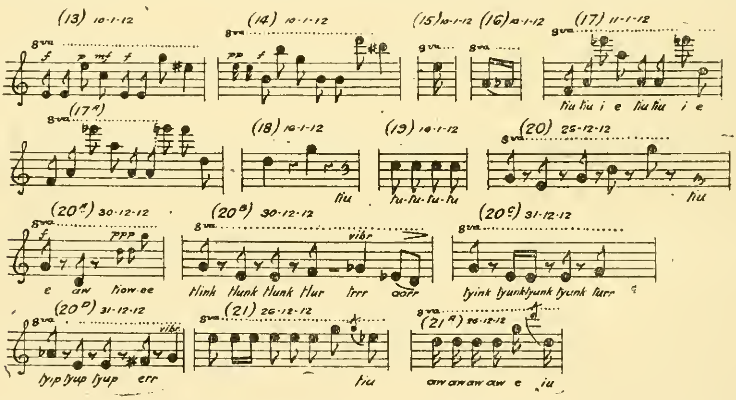
The pairs of (63) were not absolutely definite, but the effect was as written: they glided smoothly across the intervals, but were not slurred; as in (61), the lower notes were more open. This jangle also was uttered in less than 2 seconds. Jangle (64) took barely a second; (64A) was a slight variation, enclosed between expletives; (65), occupying about three-quarters of a second, opened with a barbaric twang on the *c*—whilst a jangle, it was smoothly legato.

These jangles sounded as though the bird merely set free the mechanism, and then the bells producing the notes swung freely in no determined order —though many jangles were many times repeated. There was an allied series, however—bell cascades or runnels—where the bird seemed to exercise more control over the notes, each runnel being distinct, clear, and orderly. The cascade (66) occupied about a second; the sound was as a mellow bell —almost flute-like, with broad nasal opening. A very clear runnel was heard in (67): the notes, whilst not staccato, were well divided. (67A) was a curious variant: each occupied about a second. The runnel (68) was preceded by a long light note on *e*, and succeeded by a diminishing note on *a*, the whole occupying a second and a half. The trebling of the notes of the sequence of (69) gave this runnel a distinctive charm. The opening and close of (70) related that runnel to (68), but the runnel itself, a common one, was quite different. It may be noted that the jangles and runnels were generally sung during flight, or immediately before or after. The notes of (71) were clear whistles, followed by *kraw;* or one whistle might precede four reedy notes, as (71A); or four whistles might be separated from four anvil notes by a *kraw*, as in (71B). The three low notes of (72) were not bell, nor whistle, nor reed, but a thick muffled sound like *qug qug qug;* at times they were sounded singly, at times followed by *kraw*. In (73) two bell notes were followed by a staccato whistle, the whole followed sometimes by a *click;* once there was a still further addition to the *click* of *kraw krurr*.

One tui pursued by another cried the notes of (74), up to five pairs, the ten notes occupying a second and a half. A different cry was (75): here the pursuer uttered the first part, repeating the couple on *a* many times in quick succession; the pursued bird similarly repeated the slurred note from *d* to *c* sharp. The sound of the tui's flight is on the note of (76): a mackintosh shaken quickly and vigorously will give the quality of the sound. Once it could be vocalized *furr-a-ea—fuff fuff fuff*. At times, through this *fuff fuff* of the wings, one could plainly hear a sharp *krr*, followed by a long-drawn, soft, highly pitched, but rather sweet note (77)—as though the mechanism of the wings grated occasionally and creaked during motion. The sound of (78) was also produced during flight; it was like one of the horn-sounds of the multifarious-voiced motor-car. In (79), a very characteristic phrase heard very frequently on one day, the reed note was at times omitted; at times the full phrase was repeated several times in succession.

THE BELL-BIRD.

Whilst not so plentiful as the tui, the bell-bird was seen often in 1911–12, sometimes at very close range. One came flying into a tree with the cry *tiu tiu tiu*—a cry it has in common with the tui—and at once began prying busily under the leaves, hopping quickly from twig to twig. It would pause for a moment to give utterance to the common theme of (13), then on again searching for prey. The pitch again constantly varied, and it was very difficult to catch the intervals, the note giving the most difficulty being the high *e*, which is touched much more lightly than the others. The whole phrase took little over a second in utterance, and was very clear and bright. Occasionally a light note or two preceded the phrase, as in (14); these light notes appeared to take the place of the notes producing the *tiu* of (7). A bird would often sit in a tree repeating a single note, *tiu*, at approximate intervals of 3 seconds. It was a short, sharp, clear note—a hiccuped drop of song that one could imagine as falling from the bird with a bell-like pat into some resonant receptacle: the bird ejected the note almost as one would spit a hair from the lips. I saw one bird in a shrub of *Pseudopanax*, 15 ft. distant, uttering the note. The bill was opened fairly wide, the throat swelled quickly and contracted, once to each note; the phrase (13) sometimes followed. In the shrub there seemed to be an answer to the *tiu*—a plaintive slurred *a* to *a* flat (16). Only one bird was seen, however, so it may have been indulging in soliloquy. In the variant (17) there were two exceedingly highly pitched notes, as in (11); in (17A) the natural *g* was dropped an octave. The quality of the notes appeared to vary the pitch, those of different pitch being susceptible of different vocalizations. The

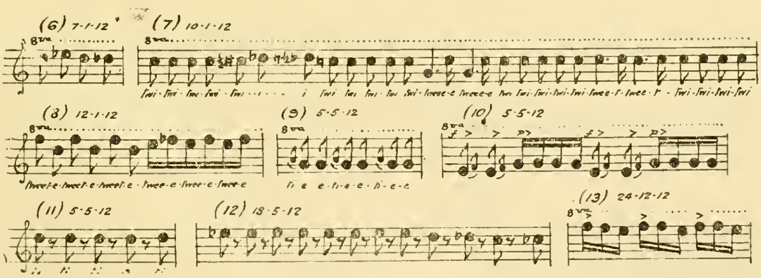


opening varied—sometimes *tiu* as in (7), sometimes as in (14), or (13), or (17). Once two clear sharp notes (18) preceded the *tiu*. The notes of (19) have the sound of *tu* (the *u* as in "but"), and the ordinary song was occasionally preceded by *tu*, or *tu tu*, or *tu tu tu*.

A variant of (3) was heard in (20). This theme was not always sung in full—often only the first two notes, and often the first five; if only the first two, the second note was lengthened to a crotchet. On one occasion, being directly below the bird when the two notes were sung, I repeatedly heard the faint light notes of (20A) following the bell notes; they were very light and softly uttered, through a restricted aperture. Whilst the opening of (20B) was the same, the notes were entirely different in quality. They were most distinctly vocalized *tlink, tlunk, tlunk, tlur,* without breathing on the terminal of the *k*; the aperture evidently varied with each note of different pitch. When the vowel or open part of the note sounded—that is, I take it, when the aperture had been formed—there was a distinct clear bell note, the bell giving the pitch; the consonantal sounds were evidently, so to speak, the gearing-up and slackening of the vocal organs for the emission of the bell note. In the majority of instances the first two notes only were sung; often the first four; sometimes, again, the fifth followed—a most entrancing vibrating bell note on *g* flat, like a bell struck four or five times with a small wooden mallet very quickly and very lightly. The effect of this note was extraordinarily sweet and plaintive, the whole theme of five notes coming like the rich voice of a contralto singing whilst on the point of tears. Sometimes the place of this fifth note was taken by a note slurred from *e* flat to *d*—a note without the bell sound, but with one more approaching that of the unwinding of a sharply jerked fishing-reel. I heard only one bird sing these notes; it sat but 6 ft. or 8 ft. above me, singing parts or the whole of the theme for some considerable time. Each pair of notes took about a second. The bird was of beautiful bright-green colour, much brighter than the duller olive of the other bell-birds seen—more of a parrakeet green. The plumage along its sides was rather raggled and ruffled. Its entire body seemed to enter into the production of the notes, contracting all along the sides on the emission of each one, the neck being stretched out and the beak slightly open. It turned from side to side, singing one note to the left, one to the front, one to the right irregularly, turning through a semicircle, as though before an audience, unseen by me, of Haku-turi or Nuku-mai-tore. It raised the body with each note, as though to eject them with a jerk in the case of the first four, and to *pour* out the sound of the fifth, the vibrating bell. An ordinarily coloured and smaller bell-bird appeared to be its companion during part of the time I saw it. I saw it again on the following day, when the vocalization of the notes was as in (20c) and (20d); again, as before, the final closed consonants were not breathed on. The theme was even more musical than on the day before, the *turr* of (20c) being entirely bell-like. The quality of this bird's song was quite different from that of any other bell-bird ever heard by me, and its beauty impressed me much more than even that of the sweetest tui song. In (21) the notes were a sharp incisive whistle, and so of its variant (21a), which occupied less than a second in utterance. The second of the first four notes in (21a) was sometimes replaced by a rest of equal duration, and sometimes the first four were preceded by a click.

The Fantail.

Five fantails, three black and two pied, came to call, tweeting and flirting and displaying their beauties, all practically within touch; the phrase (6), sung quickly several times in succession, was the one most often used. In (7) the *twi* was the constricted sound—the *i* short as in "hit"—but



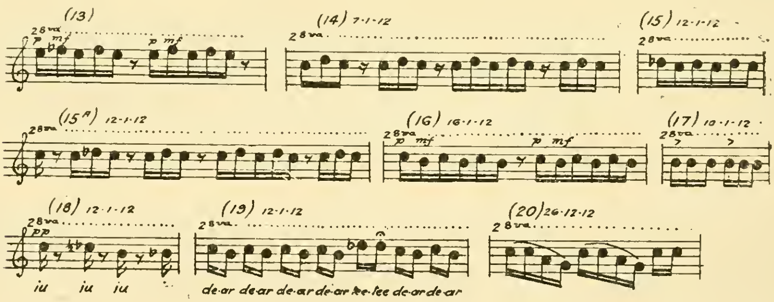
the *twee* of the *g* was more open and sweet. This song was continued for half a minute without break; not always in the order of the notes given, but in various combinations of those sounds. The bird still flirted about whilst singing, hopping restlessly here and there.

On the 10th January 1912, a fantail came to call whose body above and below was a beautiful dark brown, wing and tail feathers black. It was in company with a little pied paragon that constantly displayed to the full its white tail with central black longitudinal bar, spreading its wings at the same time, flitting about very daintily, and tweeting with bright-eyed insouciant exuberance. In (9) and (11) the *i* of the *ti* has the sound in "tit," the *e* the sound in "net"; (11) was repeated many times in succession at twilight. The song (10) was very vigorous, constricted *e* sounds followed by whistles on *g* much softer in tone; their different quality caused them to sound an octave above their real pitch. The triplets of (13) were repeated five or six times.

I am not sure that it is altogether friendliness that makes the fantail so tame, or whether it is not rather sheer curiosity and pugnacity; for on two occasions when I spoke or called fantails sitting close by me they uttered their rapid *tweet tweet* with mouth agape as they jerked from side to side whilst facing me. The mouth is not usually agape when the note is uttered; and, moreover, it will be remembered that when the sea-birds came in their great flock to attack the land-birds the fantail was the first to fly to the assault on the invading host, and, being put into a "towering rage," flew forward crying *ti ti, ti ti*, presenting his spear to left and right.

The Grey Warbler.

This bird had lost all shyness in 1911–12, and was repeatedly seen close at hand, often two together, and generally singing. They were also plentiful in 1912–13. Three years ago the notes of (13) were taken down and queried as a warbler's; again, in January, 1912, (14) was noted as a warbler



song, though the quality of the notes differed from the usual song, and the same of (15) and (15A). I often followed the sound, but it was elusive as Wheke, goddess of song—often heard, but never seen. One day, however, whilst seated under a totara, I saw a warbler whilst actually singing the doubtful theme, followed by the ordinary song. No. (16) was repeated six or eight times, each set of six notes and rest occupying about a second. I was able to compare the quality of the two sounds: (16) was cheery and bright; the usual song is much softer, more plaintive, and in comparison slightly ventriloquous, so that the two songs appeared to sound from two different places, the ordinary song being the farther removed. I now noted, too, that the first note of the six was always fainter; at a distance it would be so subdued as to be inaudible, and the listener would hear odd instead of even numbers, as in (13), (14), and (15A). An ordinary song was once opened with (17)—a quiet little chuckling guggle of notes, much softer than the song itself, and repeated in two or more sets of three notes. I saw two warblers guggling and singing within 6 ft. of where I stood. One discovered an unhappy insect under a leaf; after the titbit he sat on a twig in the sunlight, and, with bill partly open and tail quivering, sang his sweet, plaintive, minor melody. It may have been a thank-offering, it may have been a requiem —both appropriate; but, considering the minor quality of the song and the apparent gentleness of the bird, it was most probably the latter.

Two days afterwards, on the 12th January, 1912, I again saw two feeding. They kept close together, flitting quickly from place to place. Once one of them, as it were, kissed the other—very quickly, just a peck; probably a *bonne bouche* was offered and taken—a grubby affectionate kiss. Now and again a very soft, barely audible, exchange of notes took place, like monosyllabic endearments. I could not detect if they were uttered by one bird only or if both took part; it was as though they were saying *You! You! You! You!* (18). Two were heard uttering the cry and reply of (12); and when they came and settled above me, busily peering, one continually repeated quickly the notes of (19). In the vocalization the *d* sounded as when one speaks the word "dear" without letting the tongue quite touch the palate. The first five couple of notes took little over a second in utterance; the *tee tee* was nearer a whistle. The theme of (20) was very softly sung; it was almost a bird-whisper, with a sound somewhat like the rubbing of a wet finger on glass; each group of eight notes was uttered in a second.

It looked very pretty to see the warblers searching for prey amongst the misty-foliaged *Coprosmas* that here and there grew in glimmering thickets under the taller trees. The birds would try to settle on the thin springy twigs, sometimes opening and closing the tail very quickly; and sometimes they would poise, fluttering, in one position, tail downwards and broadly spread, so that on the ventral side they showed a bar of white along the tips of the tail-feathers. When fluttering amongst the green leaves where the branch-tips were too delicate for foothold, the waft from their wings made the surrounding green quiver like mist blown by a faint wind.

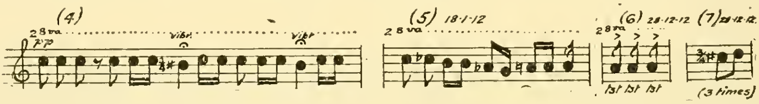
THE WREN.

The faint chirp of (3) was uttered whilst the bird was running up a branch, constantly flitting its wings. No. (4) is practically a variant of (1).

The notes of (5) and (6) were considerably faster than the throbbing chirp of a cricket, but no louder, if as loud, and certainly not so penetrating; the slur *e* to *c* in (5) was at times *a* to *f*, as indicated. One wren, answering to another, ran down in a vibrato of quarter-tones as in (7); there would be ten or eleven notes in the drop, which only occupied about a second. No. (8) is the cry of a young wren, which came to call. It settled on a twig immediately before my face, and each time I called it stretched towards me with extended fluttering wings, uttering the long vibrato with mouth agape. The real mother bird soon came, sat beside her extravagant offspring, and coaxed it away. The notes of (1) and (2) might be vocalized *titit* or *tutut*, in combinations of two, three, or more notes. A wren sounded this *tutut* whilst ascending a vine in its quick, jerky fashion ; it was *tutut* and a jerk upwards, *tutut* and another jerk, as though the bird had to wind itself up for each movement, and one heard the snapping of the tiny pawls of its lilliputian winding-gear. When the note was strengthened, as in the middle part of (9), the aperture was evidently widened, from the *i* of *it* to the *u* of *tut*, and the note dropped a semitone.

The Yellow-breasted Tit.

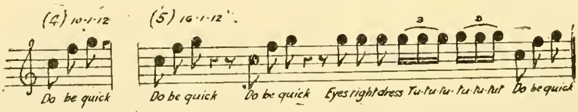
The cascade song (1) was continued in the strain (4). The vibrato, dropping a quarter-tone, was so rapid that it was almost a burr or throb. The whole was sung almost as softly as the chirping song of the wren ; the bird sat still, and the tail quivered in sympathy with the vibrato. On the 16th January, 1912, the cascade song dropped from *b* to *g* by five steps, so



that the intervals would appear to have been slightly less than quarter-tones. No. (5) was noted in Kennedy's Bush on the 18th January, 1912, and was sung several times. The notes of (6) were sharp whistles ; the bird usually announced his sudden appearance with these, as though they gave the warning call of the watchman of the wood-fairies. In reply to the call (7) in a series of three pairs, another bird answered with the cascade song of (1) six or eight times in succession.

The Parrakeet.

The common cry of (1) was different both in pitch and vocalization in (4). A curious combination of sounds was heard in (5) : it was as though a squad of raw recruits were being drilled by an irascible officer.



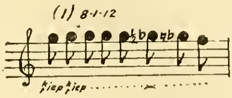
The Long-tailed Cuckoo.

Several variants of the cry of (1) are given. The *tiueet* of (6) was repeated alone a dozen times or more at intervals of 3 or 4 seconds,

interspersed with *tsiuu* of (7). Whilst two birds were circling over the trees, *wheet wheet wheet* was repeated quickly, four times a second, many times at intervals.

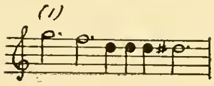
THE HAWK (HARRIER).

No. (1) was a whistling cry, sharp and quick, repeated at intervals whilst the hawk circled, fairly high up, on a misty day. The shrill cry of (2) was uttered whilst flying across the bush.



THE CROW (Blue-wattled Crow ; Kokako ; *Glaucopis wilsoni*).

This theme was whistled to me by a North Island surveyor, who said the crow's song was one of the sweetest he had heard.



THE HUIA (*Heteralocha acutirostris*).

The same gentleman also gave me the huia's cry (1). The phrase, sounded legato, repeated many times, was, he said, the cry of distress. It sounded like the words *Who are you?* pronounced in the colloquial fashion

Who er yer?—and it is not a far cry from these words to the native name *huia.* The Maori call when attracting the bird was (2), repeated many times.

The whole of the above songs and notes were heard in Boleyn's Bush, on Banks Peninsula, except those given as heard elsewhere, and excluding the fantail's (9) to (12), which were heard in Christchurch.

Art. LII.—*The Physical and Chemical State and Probable Role of Water in Rock-magmas.*

By P. G. Morgan, M.A., Director, New Zealand Geological Survey.

[*Read before the Wellington Philosophical Society, 25th September, 1912.*]

Introduction.

During recent years there has accumulated much evidence showing that an abundance of water is present in some or all rock-magmas, and may play a prominent part in their formation and subsequent consolidation. Thus a theory of so-called aqueo-igneous fusion has been evolved, more especially with respect to plutonic and hypabyssal rocks of acidic composition. Though there is a considerable amount of vagueness in the accessible literature dealing with the function of water in aqueo-igneous fusion, apparently many geologists and others distinctly hold the belief that the water present acts as a flux or solvent of silica, silicates, and other minerals not only when it is in the liquid state, but also when it is in the gaseous state. Moreover, some writers seem to assume that there is no practical limit imposed by temperature conditions on the solvent action of water. On the other hand, there are those who tacitly or explicitly make the assumption that the presence or absence of water and other "mineralizers" is a matter of secondary importance. For instance, Harker (6,* pp. 288 *et seq.*) certainly does not overemphasize the function of water as a solvent and mineralizing agent. Such a standpoint seems to be supported by the data obtained by Albert Brun, of Geneva, and published in his recent work entitled "Recherches sur l'Exhalaison Volcanique" (9). Brun maintains (pp. 254–55) that water is not present in lavas during extrusion, and, in fact, is wholly absent during ordinary volcanic activity. These conclusions are of doubtful validity, but if admitted would appear to lead to the corollary that water is not present in ordinary rock-magmas. It will, however, generally be granted that, notwithstanding Brun's new data, water is by far the most abundant of the volatile substances present in rock-magmas, and therefore that its role is relatively much more important than that of other "mineralizers," such as fluorine, chlorine, &c. Hence in this discussion the latter are more or less neglected. They seem, indeed, to be of importance only in connection with the presence of certain minerals in veins genetically related to granitic intrusions.

Physical State of Water.

If water is to be regarded as a solvent for silicates and other constituents of rock-magmas, the question of its physical state whilst so acting deserves consideration. The critical temperature of pure water being 365° C., and the critical pressure 200·5 atmospheres, some, if not most, writers assume that at higher temperatures, whatever the pressure, the water in a magma is necessarily in the gaseous state. As evidence of this the following quotation may be made: "He [Arrhenius] considers a magma as a complex solution containing various silicates, &c., and also gases, the latter, of course, including in the first place water, which above its critical temperature of about 365° must be ranked as a gaseous body" (6, p. 295). Again, with

* This and other numbers enclosed in brackets refer to list of literature at end.

reference to so-called pneumatolytic action, Vogt quotes Arrhenius as saying, "The solution in aqueous gas now gradually cools, and one substance after another gradually separates from it. By reason of the great mobility of the solution, and its consequent strong capability of diffusion, the minerals (provided the cooling be not too rapid) are segregated in large crystals, such as characterize a so-called pegmatitic structure. Gradually also the constituents which longest retain a gaseous form—such as water and carbonic acid—escape" (1, p. 644).

If we consider the water in a magma to be chemically combined, no difficulty arises as to its physical state until the temperature is sufficiently high to destroy the combination. The more general view is to assume that the water is in solution. Again, there need be no discussion as to its physical state so long as the water or aqueous gas is truly in solution; but the temperature may become so great that steam separates from the magma in the form of bubbles. In this latter condition it can no longer be regarded as acting the part of a solvent for the containing magma. There is certainly need both for a more exact terminology in order to prevent confusion of thought, and for experimental work in order to furnish a better foundation for magmatic hypotheses.

The difficulties involved in the assumptions made by some writers are thus stated from a chemist's point of view by Dr. James Moir: "All sorts of geological authorities accept the belief that water can be made red-hot and yet preserve its solvent properties. Now, every chemist and physicist knows that above the critical point water can only exist as steam, entirely devoid of solvent powers except for other vapours; and this however high the pressure. . . . As rock-magmas are certainly not vapours, there is no possibility of anything except an uncombined emulsion of rock and steam" (7, p. 4). Dr. Moir relies upon the experimental work of Andreas Smits and J. P. Wuite (5, abstracts, ii, p. 985), who found that the solubility of sodium sulphate in water became zero at 365° C. This result, however, cannot reasonably be extended to silicate solutions without experimental proof. We know that the boiling-point of water containing dissolved solids is above 100° C. at ordinary atmospheric pressure, and also that water at temperatures above 200° C. exerts a strong dissolving power on silicates. In the light of these facts it appears probable that an aqueous solution of silica or a silicate will not necessarily cease to exist as such at 365° C. Moreover, there is some doubt as to whether the so-called critical temperatures of water and other volatile bodies are really constants irrespective of pressures exceeding the critical pressures (2, pp. 460–61), and therefore it is to be hoped that experimental data showing the solubility of silicates in water at temperatures above 300° C. will soon be forthcoming.

The whole matter may be regarded from another point of view. The most enthusiastic supporter of aqueo-igneous fusion would not ask for the presence of more than 10 per cent. of water in any magma. Is there any real objection to regarding this amount of water as chemically combined with the silica and silicates of the rock-magma? The immense pressures prevailing in magmas may bring about a real chemical combination such as would be impossible at atmospheric pressure.

HYPOTHETICAL CLASSES OF MAGMA.

A clear definition of the difference between water acting as a solvent and water chemically combined in magmas must be left to the physical chemist. In the following statements a return is made to the nomenclature appropriate to the phenomena of solution. The well-known experiments of C. Barus show that at 185° C. and upwards water has a strong solvent action on soft glass. Lemberg shows that at 210° C. water slowly dissolves anhydrous powdered silicates (1, pp. 308, 643, 770). If the solubility of silicates does not materially diminish as 365° C. is approached, then, provided the pressure is adequate, a silicate solution will probably continue to exist as a solution at higher temperatures. We may assume, for example, a solution of silicic acid and hydrous silicates in an excess of water above that chemically combined, the whole at a temperature of 400° C., or even 500° C. Such a solution may correspond to some aqueo-igneous magmas. If the temperature of this hypothetical solution be raised it will reach such a point that the water not chemically combined becomes potentially gaseous—that is to say, it ceases to act as a solvent, and tends to separate itself from the magma, but is held (more or less) in solution by the prevailing pressure. Viscosity of the magma will also tend to prevent mechanical separation. There may now be an inclination for the water combined with silicates to break away from this union, but probably much or all as yet remains chemically combined, and the hydrous silicates still mutually dissolve one another, notwithstanding that the temperature is lower than that required for the ordinary fusion of anhydrous silicates. If the temperature still rises, presumably in the end the combinations with water are broken up. Since micas and amphiboles containing water form in both plutonic and volcanic rocks, and since analcite and, it is believed, calcite occur as primary minerals in various igneous rocks, there seems to be no difficulty in supposing that the ordinary magma contains dissolved or combined water at temperatures reaching or exceeding 1000° C. "Dissolved water" in such a magma is really dissolved steam, but the solution is a liquid, not "an uncombined emulsion of rock and steam." At a temperature of, say, 1200° to 1500° C. chemical combination of water with silicates, as indicated above, may cease. Some steam will still be held in solution by pressure, but some probably separates in the form of gaseous bubbles. Magma at a high temperature ("superheated magma" of Daly) may be unable to dissolve more than a trace of steam, and, if so, bubbles of aqueous gas or steam will rise in the magma until either they reach a cooler portion where they can be redissolved, or are stopped by the solid rock that forms the upper boundary or roof of the liquid mass. Here the gaseous water and other volatile substances present may act on the roof rock, thus forming new magma. This magma will necessarily contain water.

From such considerations as those just stated it follows that there is probably a continuous passage from so-called aqueo-igneous magmas at temperatures not far above 365° C. to high-temperature magmas not requiring the presence of water as a flux. The writer, with considerable hesitation, divides magmas into three classes:—

I. Aqueo-igneous magmas, in which much water is present, some chemically combined, some in solution, and acting energetically as a solvent. Temperature range, say, 350° C. to 700° C.

II. Igneo-aqueous magmas, in which the water present is mainly chemically combined. Any water not chemically combined is a gas held in solution by pressure, but probably not appreciably aiding in the fluxing of the silicates forming the main part of the magma. Temperature range, say, 700° C. to 1000° C., or more.

III. Fusion magmas, which maintain a liquid form without the assistance of water. Any water present is potentially gaseous, uncombined with silicates, and held in solution by pressure alone.

If in rock-magma a distinction between solution and chemical combination cannot be made then classes I and II must be merged. In any case, there cannot well be any hard-and-fast lines between the three classes. Transition temperatures will depend to some extent upon conditions of pressure and of chemical composition.

Hypothetical Distribution of Magma in the Earth's Crust.

If the influence of pressure, which is practically constant for a given depth and that of chemical composition, which is of minor importance in the present discussion, be discarded, the presence or absence of liquid rock at a stated depth in the earth's crust depends within certain limits both upon the temperature and upon the presence or absence of water. Provided sufficient water (or other "mineralizer" or flux) is present, we may have aqueo-igneous magma at quite moderate depths. Below this comes igneo-aqueous magma, followed by fusion magma. Assuming that temperature continues to increase towards the centre of the earth, and that ordinary physical laws are not essentially modified by immense pressure, we may suppose, with Arrhenius, that the fusion magma ultimately becomes gaseous.* Into this zone, however, there is no present need to venture. With a patchy and limited distribution of water in the earth's crust we may have at relatively shallow depths disconnected reservoirs of aqueo-igneous or igneo-aqueous magma surrounded by solid rock, with fusion magma at some greater depth. Where water is absent we shall have fusion magma only, confined by a solid roof of considerable thickness. It is quite possible, and, indeed, probable, that the influence of increasing pressure is sufficient to prevent the formation of fusion magma, except in those parts of the earth's crust where the temperature gradient is somewhat above the average.

Hypothetical Formation of Magmas.

In order to narrow discussion, let us consider a segment of the earth's crust assumed originally to have a temperature gradient of 1° C. in 200 ft., and to contain appreciable amounts of water to a depth of ten or fifteen miles, but little or no water at greater depth. Such a segment will be solid to a depth of forty miles, below which may be ordinary fusion (universal) magma. If now, through earth-movements or other cause, the temperature of the segment rises, the fusion magma, owing to melting of the overlying rock, will extend upwards. Even though the arguments in favour of a solid earth be considered valid, yet it will doubtless be admitted that a sufficient rise of the temperature gradient will cause melting in places, and this is all that is here postulated. Sooner or later aqueo-igneous magma will begin to form at a depth of, say, fifteen miles, and will gradually work its way upward. Two cases, dependent on amount of heat supplied, are conceivable. In the less important of these, the temperature gradient failing to reach, say, 1° per 100 ft., the fusion magma does not eat its way upward into contact with the aqueo-igneous magma. The latter in this case will probably cease its upward movement six or seven miles below the surface. On the

* There are, of course, well-known astronomical reasons for believing that the earth as a whole is rigid, and in discussion upon this paper Mr. G. Hogben pointed out that the transmission of earthquake-waves through the earth seems to preclude the possibility of a liquid or gaseous interior, at least to a depth of eight hundred miles. Hence appears an evident weakness in the above assumptions.

other hand, if the temperature gradient becomes relatively steep the lower magma will ultimately junction with the upper. In view of the fact that the lower magma may reasonably be expected to contain at least a small amount of water and other mineralizers, either as gas or contained in an aqueo-igneous differentiate, such junction means transference of water and heat to the aqueo-igneous magma. Lateral extension of the fusion magma will enable it to maintain a supply of water in gaseous form to the aqueo-igneous magma. The latter, therefore, will work (or, in Daly's phrase, "stope") its way upward at an accelerated pace. So the action will go on until either thermal equilibrium is established or some new condition connected with approach towards the earth's surface comes into play.

Most geologists will probably concede that in some such way as that indicated above solid rocks comparatively near the earth's surface may pass into the liquid condition. The prominent role here assigned to water will, however, be disputed, and doubtless strong arguments can be marshalled against statements resting on so hypothetical a basis.

Magmatic Differentiation.

Under the assumptions made in this paper a magma during formation will necessarily differentiate into two, or perhaps three, parts, distinguished by differences in water-content. The preference displayed by water for silica and alkaline silicates leads to the belief that the aqueo-igneous portion of the magma will be relatively light and acidic, whilst the fusion magma will be heavy, basic, and non-aqueous. The igneo-aqueous portion, intermediate in position, will probably be intermediate also in chemical composition, but may incline to acidity. Further differentiation, it is easy to imagine, will result through the cooling of portions of the magma to the point at which crystallization begins. The opening of a passage to the earth's surface, whereby part of the magma may be extruded, will also give rise to differentiation, which under some conditions may be of a varied nature. The absence of water probably limits differentiation very considerably; and if it be possible for a differentiated magma to rise as a whole to a temperature above that required for an ordinary fusion magma, then it may be assumed that convection currents will check differentiation, and tend to bring about an approximately uniform composition.

Formation of Granite.

An aqueo-igneous magma will in general have the composition of a granite or an acid diorite. Ultimate consolidation of a granitic magma is largely influenced not only by cooling, but also by conditions permitting the escape of water, such as obtain when a rising magma approaches the surface of the earth. The consolidation temperature of granite may be between 575° C. and 800° C.* (8, p. 342), but, according to some geologists of the French school, a lower temperature is more probable. It may be observed that under the assumptions made in this paper some granites probably represent more ancient re-fused granites, gneisses, and rocks of sedimentary origin, and thus their formation completes a cycle of change.

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* The quartz of granite shows by its etch figures that it was once β quartz, into which ordinary α quartz passes at 575° C. (552° C. according to Brun). The upper limit is 800° C., because at that temperature quartz inverts to tridymite. It may be suggested, however, that extreme pressure would modify these data.

Pegmatites, etc.

Highly heated water escaping into fissures from a solidifying granite will naturally carry silica and silicates with it in solution. These will ultimately crystallize as pegmatite veins (6, pp. 294–96). The consolidation temperature may be below 365° C., and is with tolerable certainty below 575° C. (8, p. 342). No difficulty need be experienced in accounting for the various rare or peculiar minerals found in some pegmatite veins. These are generally due to the presence of volatile bodies rejected with water from the consolidating granite. Any special pneumatolytic hypothesis seems unnecessary. In New Zealand pegmatitic veins, as a whole, are remarkably poor in accessory minerals, tourmaline being the only one at all frequently observed. Hence arises one reason why the writer lays stress on water, and not on other volatile substances, as a "mineralizing agent."

Syenites.

Syenitic rocks are quantitatively of no great importance, but present a great variety of types. Since they are usually found on the outskirts of granitic masses, it may be assumed that, as a rule, they represent differentiates from consolidating granite magmas. Their variety is perhaps due to varying conditions of temperature and of assimilation of solid rock, and more especially to variation in water and other mineralizers present. Some syenites may be derived from igneo-aqueous magmas.

Diorites.

Diorites, more especially the acid types, may in part be due to differentiation from a granitic magma. Some diorites may represent consolidated igneo-aqueous magmas, whilst others may be derived from fusion magmas.

Acid Hypabyssal Rocks.

The acid intrusives may be regarded as apophyses from granitic magmas. Water probably plays a prominent part in their formation, its presence reducing viscosity and preventing premature consolidation. Quartz-porphyry is said to consolidate, like granite, at temperatures above 575° C. (8, p. 342).

Formation of Schists.

Where schistose rocks occur in highly folded mountain-chains, and, moreover, are associated with granitic masses, it is easy to account for their formation by invoking a theory of dynamo-thermo-metamorphism. Gently folded schists extending over a wide area, such as the quartz-mica-schists of Central Otago, present a more difficult problem. It has been suggested that the Otago schists are due to thermal metamorphism, induced by underlying granite. Such a theory implies the formation of igneous rock beneath a wide area. In Central Otago evidence in favour of such a view is afforded by the occurrence in the schists of quartz veins carrying the tungsten mineral scheelite.

Volcanic Action.

It is commonly held that steam-pressure has much to do with volcanic eruptions (4, pp. 42, 45). Other imprisoned gases assist, and Harker suggests that gravitational pressure alone may cause fissure eruptions. Arrhenius supposes that sea-water may penetrate by means of fissures to a magma near the earth's surface. The magma eagerly absorbs the water, and in consequence swells and becomes more fluid. The resulting pressure, which is analogous to osmotic pressure, forces the magma outwards, and thus volcanic eruption begins (4, p. 18).

According to the assumptions made in this paper, a fusion magma has little or no inclination to absorb water, and, if so, the hypothesis advocated by Arrhenius fails to hold good. Moreover, it is not easily understandable how large quantities of sea water could find their way into a magma against enormous opposing pressure.

An aqueo-igneous magma stoping its way upward during folding movements of the earth's crust may find a plane of weakness leading to the surface. In this case the probability is that water and other volatile substances will escape, whilst the magma, or those portions losing water, will consolidate.

It may happen that heat has accumulated in part of an originally aqueo-igneous magma to such an extent that the temperature of this portion is raised well above 1000° C., and all or nearly all its water is free from combination. The opening of communication with the surface will relieve the pressure that keeps the aqueous and other gases confined, or holds them in solution. The result will be a series of violent explosions in the volcanic vent, analogous to geyser eruptions, which will scatter volcanic ash, pumice, &c., far and wide. When the gases have nearly exhausted themselves there may follow effusions of acidic lava. The cooling of the magma as it rises in the volcanic conduit, together with the loss of water and the extrusion of lava, promotes part crystallization and differentiation. If to these changes we add the influence of magma drawn laterally to the volcanic vent or vents from regions outside the original disturbance, we shall have hypothetical data quite adequate to account for all the phenomena of vulcanism.

Volcanic action may originate through a fusion magma, nearly devoid of water, finding its way to the surface. Such an occurrence is rare, or perhaps impossible.

Hot Springs and Geysers.

Hot springs and geysers are usually attributed to expiring volcanic action. Since the early stages of vulcanism may afford escape for all or most of the water in a magma, a magmatic source for the heated waters of the final stage can be postulated only with difficulty. If, however, an aqueo-igneous or other magma containing water approach the surface it may give rise to boiling springs, the water of which (in part at least) will be of magmatic origin. Thus hot springs may indicate rise of magma, and precede as well as follow a period of igneous activity.

Summary and Conclusions.

The physical or chemico-physical state of water in rock-magmas is not a matter of indifference. By making assumptions that are consistent with known facts, but have not as yet been experimentally proved or disproved, the following conclusions may be reached:—

1. It is possible for an aqueo-igneous magma to form at temperatures not far above 365° C. In this magma there may be uncombined water acting as a solvent and physically in the liquid state. At somewhat higher temperatures uncombined water no longer acts as a solvent, and may be regarded as physically a gas, held in solution only by pressure. At still higher temperatures no combined water can exist in the magma and all

water present is physically a gas, either held in solution by pressure alone or actually segregated in the form of gas-bubbles.

2. The presence of water induces or aids the differentiation of a magma into two or more layers differing in chemical composition.

3. The presence or absence of water has much to do with the distribution and formation of magma in the upper layers of the earth's crust.

4. The escape of water, as well as cooling, is a determining cause in the consolidation of aqueo-igneous magmas.

5. Some plutonic rocks, more especially granites, may represent sedimentary rocks fused by aqueo-igneous action.

6. Differentiation in consolidating aqueo-igneous magma is partly explained.

7. A fairly efficient hypothesis of volcanic action and magmatic differentiation in connection therewith can be evolved.

8. Hot springs may precede as well as follow a period of volcanic activity. In the latter case their water is probably not magmatic.

By varying the permissible assumptions in connection with water in rock-magmas a great variety of hypothetical results may be obtained. The necessity for eliminating false assumptions by such experimental research as is possible therefore becomes obvious. Though experimental work in geo-physics is difficult and expensive, and in some respects can never be conclusive, much may be done in a properly equipped laboratory. Hence there is reason for hoping that in a few years' time our knowledge of the earth's interior may be greatly increased, and placed on a much more satisfactory basis.

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PROCEEDINGS.

PROCEEDINGS

OF THE

NEW ZEALAND INSTITUTE.

1912.

TENTH ANNUAL MEETING.

Wellington, 29th January, 1913.

The annual meeting of the Board of Governors of the New Zealand Institute was held in the Dominion Museum Library on Wednesday, the 29th January, 1913.

Present: Mr. T. F. Cheeseman, President, in the chair, Mr. M. Chapman, Hon. H. D. Bell (Minister of Internal Affairs), Mr. A. Hamilton, Mr. G. M. Thomson, Dr. Cockayne, Mr. D. Petrie, Mr. J. Stewart, Mr. R. Speight, Professors H. B. Kirk, P. Marshall, C. C. Farr, Mr. John Young, Mr. K. Wilson, Mr. A. H. Turnbull, and Mr. H. W. Hesse.

Changes in the Representation.—The Secretary announced that the only changes in the *personnel* of the Board were the replacement of the Government nominee, Mr. Tregear, by Mr. A. H. Turnbull, and of Dr. Hilgendorf, who had resigned, by Professor C. C. Farr.

Roll.—The Secretary then called the roll.

Apologies for Non-attendance.—The President read apologies from Mr. C. A. Ewen, Hon. Treasurer, and Mr. H. Hill, who were unable to attend.

The President called upon Mr. G. M. Thomson to report what had been done in regard to two motions standing in his name which were carried at the last annual meeting.

Scientific Board of Advice.—Mr. Thomson read the following report and the order of reference (printed in parliamentary paper I.–7) of the Museum and Scientific Departments Committee (of which he was Chairman):—

The Museum and Scientific Departments Committee has the honour to report that, in accordance with the order of reference, it has met to consider the matters submitted to it, and has taken evidence in connection therewith. It now begs to submit the following recommendations, which have been agreed to unanimously:—

(1.) That a Scientific Board of Advice be set up to which the publication of all scientific and historical work undertaken by Government Departments should be referred.

(2.) That the Board consist of the Minister of Internal Affairs (*ex officio*), three members to be nominated by the Governor, and three members to be elected annually by the Board of Governors of the New Zealand Institute.

(3.) That the scientific and historical publications include the "Transactions and Proceedings of the New Zealand Institute," the Bulletins of the Geological Survey, the annual reports of all the scientific branches of the Government Departments, and such scientific and historical works as the Government may, on the recommendation of the Board from time to time, order to be printed.

(4.) That these publications be brought out in certain uniform sizes to be agreed upon by the Board.

(5.) That the Dominion Museum continue under the Minister of Internal Affairs.

(6.) That the proposed national gallery of art be a department of the Museum.

(7.) That there be established in connection with the Museum a national library of scientific works, within which should be gathered all scientific literature available now belonging to Government Departments, and also, if possible, that of the New Zealand Institute.

(8.) That a Board of Advice and Control be established for the combined institution, of which the Minister of Internal Affairs should be the President, and upon which nine other members should be appointed, including the Mayor of Wellington, the President of the New Zealand Institute, and such other persons as may be nominated by the Governor. All resolutions of the Board to be subject to the veto of the Minister, who shall be responsible to Parliament for the administration.

(9.) That the Government be requested to promote legislation (if necessary) to give effect to the above recommendations.

(10.) That the Committee regards the erection of a new Museum as a matter of great urgency.

Mr. Thomson moved, and Mr. Speight seconded, That this meeting respectfully requests the Government to give effect to the recommendations 1–4, inclusive, of the report of the Museum and Scientific Departments Committee of the House of Representatives, presented to the House 10th September, 1912, with the exception of the words in paragraph 3, "the 'Transactions and Proceedings of the New Zealand Institute.'"—Carried.

It was proposed by Professor P. Marshall, seconded by Mr. Hesse, That paragraphs 5–10, inclusive, of the report of the Museum and Scientific Departments Committee, with the substitution of the words "the library of the Board of Governors" in place of the word "that," in the second line of paragraph 7, be adopted, except that in paragraph 8, line 4, after the word "President," and before the words "of the New Zealand Institue," there be inserted the words "and two representatives."—Carried.

Mr. Thomson read letters from the Prime Minister (dated 23rd December, 1912) saying that the matter of the proposed Scientific Board of Advice would be considered by Cabinet at an early date; and from the Hon. the Minister of Internal Affairs (24th January, 1913) stating that the preparation of a Bill making provision for the conduct and control of the Dominion Museum, and separately for the control of the scientific publications published under authority in New Zealand, was contemplated.

Fishes of New Zealand.—With reference to the proposed catalogue of fishes, Mr. Thomson reported that on the 4th August, 1912, he asked the following question in the House of Representatives:—

Mr. G. M. Thomson asked the Minister of Marine, Whether he will take the requisite steps to have a full and illustrated catalogue of the fishes of New Zealand prepared and printed? (Note.—The knowledge of this important group of the fauna of New Zealand is in a very imperfect and scattered condition, while the Dominion possesses in Mr. Waite, Curator of the Canterbury Museum, the most competent ichthyologist in the Southern Hemisphere.)

The Hon. Mr. FISHER replied: Mr. E. Waite, Curator of the Museum at Christchurch, who accompanied the trawler "Nora Niven" when that vessel was carrying out experimental trawling for the Marine Department, prepared drawings of New Zealand fish, which were published in book form, the cost of publication, amounting to £195 5s. 6d., being paid by the Department. The preparation and publication of a full and illustrated catalogue of the fishes of New Zealand would cost between £600 and £700. Such a catalogue would be valuable, but in view of the fact that a considerable sum of money is being expended in the introduction into the Dominion of food fishes, and that the money available for fishery purposes is limited, it is suggested that the preparation and publication of a catalogue is a matter that might stand over for the present.

Mr. Thomson stated that he would bring up the matter again in the House next session.

Finances of the Institute.—Mr. Thomson reported that an additional £450 was promised by Mr. Allen, Minister of Finance, but only £250 had been voted. He moved, That this meeting respectfully recommends to the Government that section 10 of the New Zealand Institute Act be amended in the direction of omitting the words "five hundred pounds," with the object of substituting the words "seven hundred and fifty pounds."

Mr. Speight seconded the motion, which was carried.

The Hon. H. D. Bell here stated that some remission of the Government Printer's account against the Institute might yet be made.

The Hon. the Minister later addressed the meeting as follows: With regard to the increase of the grant, he had no doubt that would be dealt with next session of Parliament. So far as his memory went, it was not necessary to limit the allowance for last year to £250, because there was a sum due to the Government that might be the subject of further representations. The matter of immediate exigencies of finance, however, could, he thought, be disposed of to the satisfaction of the Board and the Government. The control of the Museum was distinct from the construction of the building and the establishment of the Museum in a suitable home. The Government was in unison with the Governors of the Institute and the Committee of Parliament, and he did not doubt that a measure would be introduced next session that would be satisfactory to the Institute. He was not satisfied, personally, with the Board of Control proposed by the Committee of the House. There could be no doubt that the Scientific Board of Advice for Government publications would be attended to. Numbers of matters would require the consideration of all Departments of State in order that a satisfactory decision might be arrived at. The size of the volume at present published by the Institute might not suit all Government Departments. He hoped that an agreement between the Departments might be arrived at. He should like to ask the Judges of the Supreme Court to elect one of their number to sit on the Scientific Board of Advice, and also on the Board of Control of the Museum. He was now collecting information with a view to having a measure drafted to put before the House next session.

President's Address.—The President then delivered his annual address. (See page 420.)

Incorporated Societies' Reports.—The report for the last financial year of each Society was laid on the table.

Standing Committee's Report.—The following annual report of the Standing Committee was received:—

Four meetings have been held during the past year, the attendance being as follows: Mr. Cheeseman, 2; Mr. Ewen, 3; Mr. Petrie, 1; Mr. Young, 3; Mr. G. M. Thomson, 2; Mr. Hamilton, 3; Professor Kirk, 3; Mr. Chapman, 1.

Hector Memorial Award.—The presentation of the award to Dr. Cockayne was made at the celebration of the Jubilee of the Philosophical Institute of Canterbury, on the 30th August, 1912. A supply of ten medals has been received from Messrs. Wyon, and one, suitably inscribed, has been forwarded to the first recipient of the prize.

Award for 1913.—The Committee of Award—Professors Orme-Masson, F. D. Brown, Evans, and Mr. G. M. Thomson, M.P. (convener)—have forwarded their recommendation in a sealed envelope, to be opened at the annual meeting on the 29th January, 1914. The Hector Memorial Declaration of Trust has been duly executed by the Institute and the Public Trustee, and deposited with the latter.

Hutton Memorial Fund.—The last award was made in 1911, and, unless under exceptional circumstances, the medal may not be awarded oftener than once in every three years. The next award may therefore be made in 1914, the Committee appointed to recommend a recipient being Professors David and Benham and Mr. Maiden. No applications for grants from the fund have been received during the year.

Dr. Chilton reports that, following on his former report of the expenditure of a grant from the fund, he has had several additional drawings prepared, some of which have been used in papers already published; that he has been working out some Antarctic *Amphipoda*, and, as a result, has been able to clear up several points in regard to New Zealand species.

Publications of the Institute.—Copies of Vol. 44 of the Transactions for 1911 were laid on the tables of both Houses of Assembly on the 2nd July, 1912. The volume was posted to every member of the Institute entitled to it during the week ending 10th July, 1912. The Secretaries of incorporated Societies of the Institute are requested to see that the full postal addresses of members are supplied to the Secretary. The Institute cannot be expected to supply additional volumes of Transactions when the originals have been lost owing to faulty or incomplete addresses supplied.

Proceedings: At the last annual meeting it was resolved that the publication of the Proceedings should be discontinued in the event of the Government declining to increase the statutory grant. The receipt by the Institute of an additional grant for the year has necessitated that the matter shall be further considered. Mr. Hamilton has given notice to move, "That the publication of the Proceedings of the New Zealand Institute be continued in the annual volume, and not published separately, and the Editor be requested to severely edit the publication."

Finance.—The efforts of the Standing Committee, which have been ably seconded by Messrs. G. M. Thomson and A. Myers, Ms.P., to obtain an increase in the annual grant derived from the Government have been at last successful; an additional £250 was placed upon the supplementary estimates this year, and that sum has now been received by the Institute. It has been found impossible, in the present unsatisfactory condition of the library, to determine what books are owned by the Institute and what by the Museum and Wellington Philosophical Society. It is hence not possible to prepare a complete statement of assets. Any estimate of the value of the assets would, moreover, be of such a vague nature as to be practically valueless. A statement of liabilities will, however, be prepared in addition to the usual statement of receipts and expenditure.

The attention of the Standing Committee has been called by the Treasurer to the excessive cost of some papers in the Transactions. It was resolved, That after 1913 the Publication Committee submit to the Board of Governors at the annual meeting an estimate from the Government Printer of the cost of publishing each paper selected for the annual volume.

British Association Australasian Meeting, 1914.—The Institute's Committee was not reappointed at the last annual meeting, but the British Association Reception Committee, on which the Institute is well represented, is carrying on the work of organizing a visit to New Zealand by some of the British Association members at the Australasian meeting, as well as by a number of Canadian and American men of science. The meeting in New Zealand will, it is anticipated, be held in September, 1914.

Exchange List.—The Committee was not reappointed at the last annual meeting of the Board, but the Standing Committee has carried out the recommendations of the late Committee (Messrs. Hamilton and Easterfield), as follows: Sixty recipients of the Institute's Transactions on the B revised list of the Committee's report have been circularized, and informed that the Institute could not continue to send the annual volumes unless something was received in exchange. Of these sixty, some twenty have replied, and after discussion the Standing Committee adopted, with some alterations, the Librarian's recommendations, the result being that some forty-five names will be removed from the list of those who now receive the volume.

Formulation of Rules and Regulations.—The Committee was not reappointed at the last annual meeting of the Board. It was not found possible to carry out the wish of the Board to gazette the new seal of the Institute.

Decisions of the Standing Committee.—The only further decision of any importance which requires the sanction of the Board is that concerning the Hawke's Bay Philosophical Society, "That the Hawke's Bay Society be supplied with as many copies of Vol. 44 of the Transactions as the subscriptions for the year represent guineas." This arose out of the action of the Hawke's Bay Society in reducing its subscription to 10s. 6d. per annum. On communicating the Committee's decision a strong protest was received from the Society, and the matter was temporarily adjusted to the mutual satisfaction of the Standing Committee and of the Society. The same difficulty will, however, arise when Vol. 45 is distributed. The matter is therefore referred to the annual meeting of the Board.

Another decision, of less importance, was to the effect that all outside orders for the Institute's publications coming from the Northern Hemisphere should be supplied through the London agents (Messrs. W. Wesley and Son, 28 Essex Street, Strand, W.C.).

Certificates of Incorporation.—The following form of certificate was adopted on the advice of the Board's solicitors, Messrs. Chapman, Skerrett, and Wylie :—

In the matter of the New Zealand Institute Act, 1908, and the Regulations made thereunder.

No.

CERTIFICATE OF INCORPORATION.

THIS is to certify that is this day incorporated with the New Zealand Institute, subject to the provisions of the said Act and the regulations made thereunder.

Dated this day of , 19 .

The Seal of the New Zealand Institute was affixed in the presence of .

Certificates of incorporation were issued on the 18th November, 1912, to the Manawatu Philosophical Society (No. 1), incorporated 6th January, 1905; and to the Wanganui Philosophical Society (No. 2), incorporated 2nd December, 1911.

Annual Reports of Societies.—The reports and balance-sheets of the following Societies have been received: Manawatu Philosophical Society, for year ending 31st October, 1912; Wanganui Philosophical Society, for year ending 30th September, 1912; Auckland Institute, for year ending 21st February, 1912; Otago Institute, for year ending 29th November, 1912; Philosophical Institute of Canterbury, for year ending 31st October, 1912; Hawke's Bay Philosophical Institute, for year ending 13th October, 1912; Nelson Institute, for year ending 31st December, 1912.

Southland and Westland Societies.—From inquiries made it would seem that there is no hope of resuscitating these Societies, the names of which, according to the Board's decision, will cease to appear as incorporated Societies one month after the next annual meeting (29th January, 1913).

Separate Publication of the Proceedings.—It was resolved to discontinue the separate publication of the Proceedings, Mr. G. M. Thomson recording his dissent.

Estimates from Government Printer.—The proposal, "That after 1913 the Publication Committee submit to the Board of Governors at the annual meeting an estimate from the Government Printer as to the cost of publishing each paper selected for the annual volume" was not adopted.

More frequent Publication of Transactions.—On motion of Mr. Speight, seconded by Professor Kirk, it was resolved, That as soon as possible the volume of Transactions be issued at more frequent intervals.

Hawke's Bay Society.—Proposed by Mr. Petrie, and seconded by Professor Farr, That the Hawke's Bay Philosophical Society be supplied with as many copies of the annual volume of the Transactions as their subscriptions for the year, as shown in their annual balance-sheet, represent guineas.—Carried.

Finance.—The following statement of receipts and expenditure, liabilities and assets, certified to by the Hon. Treasurer and audited by the Auditor-General, was adopted :—

Statement of Receipts and Expenditure for the Year ending 31st December, 1912.

Receipts.	£	s.	d.	*Expenditure.*	£	s.	d.
Balance in Bank of New Zealand	389	18	8	Travelling-expenses ..	60	9	4
Government grant for year ending 31st March, 1913	500	0	0	Secretary's salary to 31st December, 1912 ..	35	8	4
Supplementary Government grant	250	0	0	Museum Custodian's services	5	0	0
Sale of "Maori Art" ..	23	3	4	Bank charge	0	10	0
Sale of Transactions ..	30	6	0	Compiling catalogue scientific literature	10	0	0
Sale of Index to forty volumes	7	16	11	Insurance of library, premium	9	0	0
Sale of Brown's Manual ..	2	7	8	Law-expenses, Hector Trust	4	19	6
Postage refunded	25	12	7	Customs duty on Hector Medal	1	2	0
				Typing	10	0	0
				Petty cash: Secretary, £33; Editor, £3	36	0	0
				Purchase of books for library	1	9	7
				Cases for Transactions ..	5	12	6
				Government Printer—			
				Vol. 43	648	12	6
				Vol. 44	250	0	0
				Balance in Bank of New Zealand	151	1	5
	£1,229	5	2		£1,229	5	2

Statement of Liabilities and Assets at 31st December, 1912.

Liabilities.	£	s.	d.	*Assets.*	£	s.	d.
Balance due Government Printer on account of Vol. 44	292	1	0	Balance in Bank of New Zealand	151	1	5
				Cash in hand	3	0	8
				Amount due—			
				Minnesota University ..	15	0	0
				Friedlander	0	16	10
				Auckland Institute* ..	4	10	10
				Authors' reprints ..	2	18	3
				Sundry small accounts ..	0	10	6
				Deficiency†	114	2	6
	£292	1	0		£292	1	0

* Since paid. † Against this deficiency the Institute has a large stock of Transactions for sale and a very valuable library.

Carter Bequest.—Statement of Accounts, 31st December, 1911, to 31st December, 1912.

Cr.	£	s.	d.	*Dr.*	£	s.	d.
Balance at 31st December, 1911	3,123	19	11	Public Trust Office commission	0	0	3
Interest, N.Z. Loan and Mercantile Agency Company	0	10	0	Balance	3,264	8	7
Interest, Public Trust Office	139	18	11				
	£3,264	8	10		£3,264	8	10

HUTTON MEMORIAL RESEARCH FUND.—Statement of Accounts, 31st December, 1911, to 31st December, 1912.

Cr.	£ s. d.	*Dr.*	£ s. d.
Balance as at 31st December, 1911	660 10 10	Balance	690 4 10
Interest, Public Trust Office	29 14 0		
	£690 4 10		£690 4 10

HECTOR MEMORIAL FUND.—Statement of Accounts, 31st December, 1911, to 31st December, 1912.

Cr.	£ s. d.	*Dr.*	£ s. d.
Balance at 31st December, 1911	1,130 12 1	Beneficiary's Account, New Zealand Institute ..	150 0 0
Interest, Public Trust Office	50 3 0	Balance	1,030 15 1
	£1,180 15 1		£1,180 15 1

Hector Memorial Award.—Mr. G. M. Thomson, convener of the Award Committee, reported that it was the unanimous opinion of the Committee that the award of the Hector Medal for 1913 should be to Professor Easterfield, of Victoria College, Wellington, for his distinguished work in chemical research, especially in connection with New Zealand products.

He said this work had a direct as well as an indirect bearing on the scientific knowledge, the health, and the prosperity of the community. He read a letter from Professor Evans, expressing the opinion that the original intention of the Trust was to make the award for work done in New Zealand, whether it had a bearing upon New Zealand or not. Professor Orme-Masson agreed with this.

The recommendation of the Hector Award Committee was adopted.

Hector Deed of Trust.—It was proposed by Dr. Cockayne, seconded by the Hon. H. D. Bell, That the opinion of counsel be obtained as to—(1) Whether the deed of trust, which is drawn in contravention of the report of the Hector Memorial Committee, advocated by the Board of Governors, can be altered so as to accord therewith; (2) if not, whether the deed or the resolution of the Board of Governors prevails as defining the objects of the award.—Carried.

Publication Committee Report.—The following annual report of the Publication Committee was received:—

The Publication Committee begs to submit the following report for the year:—

Fifty-five papers were forwarded for consideration; of these, forty were printed in the Transactions, eight were printed in the Proceedings along with abstracts of three others, two were held over, and two others were definitely declined. The authors of some of the papers were requested to shorten them considerably, and this was done without any serious detraction from their merit.

A long paper by Major Broun on the New Zealand *Coleoptera* was divided into two parts, and the first part alone printed, while the second part was reserved for next year's volume, this step being taken owing to the great length of the paper and the somewhat straitened finances of the Institute. The second half is now in the hands of the printer. The Committee recommends that another long paper by Major Broun on the same subject, already in hand, as well as others to follow, should be issued in bulletin form.

Mr. H. N. Dixon, of Northampton, has been revising the moss material collected by the late Robert Brown, and deposited in the Canterbury Museum. The first part of this work has been forwarded, and the Committee recommends that this also should be published in bulletin form, and that subsequent parts, as they are finished, should be issued in like manner, and paged in sequence, so that when the work is complete the bulletins may be bound together, and thus be practically equivalent to a moss flora for the Dominion. Mr. Dixon is doing the work of revising Brown's collection without payment, and the country is very fortunate in thus securing a valuable monograph by an eminent specialist for the mere cost of publication.

Included in the Appendix to Vol. 44 (1912) of the Transactions is a list of earthquakes recorded in New Zealand for the years 1906–11. This list was accepted under a misapprehension, and without knowledge that there was on record a resolution of the Board disapproving of their inclusion in the Transactions. An arrangement was therefore made with Mr. Hogben whereby the Education Department bore the cost of printing the list. The Committee is of opinion that the Board might well reconsider its decision as to publishing these lists. They are certainly the results of original investigation, which should find a place in a publication which aims at giving a record of the scientific work done in the Dominion, providing that they are not published elsewhere.

It has been customary up to the present to publish photographs in the Transactions without any indication on the print as to its author. Your Committee thinks that it would be of advantage to give the author's name, if he does not expressly object. It increases the value of certain photographs if the author has either taken or supervised the taking of the picture, or if it has been taken by a person of experience in the subject under consideration, and it also allows of a simple means of acknowledgment if the author is indebted to another for the print.

There appears in the minds of some an uncertainty as to what year should be cited in reference to back numbers of the Transactions of the Institute; the difficulty arises from the fact that the year printed on the title-page of the volume is that of the year in which the papers are read, and not the date of publication. It should be clearly understood that the latter date is, according to convention, the only correct one, and it would save the Editor and the Printing Office much trouble if this convention were generally observed by all authors. It has been suggested that this mistake might be prevented by omitting the date from the title-page.

It has been further suggested that the authors who desire their papers to be illustrated by a larger number of blocks than the state of the finances allows should be permitted to supply further illustrations on the payment of the additional cost, subject to the approval of the Editor for the time being. As this procedure introduces a principle foreign to the usual practice of the Institute, the Committee would be glad to receive from the Board an expression of opinion on the point.

Your Committee would also like to emphasize the necessity for authors eliminating from their manuscript all useless verbiage and irrelevant matter, and further to emphasize the uselessness of submitting for publication material which neither brings forward fresh scientific facts nor suggests new ways of looking at old ones. In this connection it might be as well to adopt rules for the guidance of referees to whom papers are submitted for report, and your Committee would suggest that the following instructions, as used by the Linnaean Society, be formally approved and adopted by this Institute: (1.) Is it desirable that the paper as it stands should be published by the Society as containing facts, or new views of the bearing of admitted facts, not already published? (2.) Is it desirable that any part of the paper should be omitted, altered, or abridged, as merely general observations, as unnecessarily controversial, as containing expressions liable to give just cause of offence by reason of their personality, or for any other reason? If so, you will please mark in pencil the parts which in your opinion may be so omitted, altered, or abridged. (3.) If illustrations accompany the paper, can any of them be dispensed with? (4.) Would an abstract only give all that is important in the paper, and would such abstract require any woodcut or other illustration, regard being had to previous publications?

R. Speight, for the Committee.

The following resolutions, arising out of the report, were carried:—

Moss Flora.—Mr. Speight moved, and Mr. Hamilton seconded, That Mr. Dixon's material on the New Zealand Mosses be published in bulletin form.—Carried.

Major Broun's Papers on Coleoptera.—Mr. Speight moved, and Mr. Petrie seconded, That the second half of Major Broun's paper be published in this year's Transactions, and that future papers be published in bulletin form as funds allow.—Carried.

Seismological Returns.—It was proposed by Mr. Petrie, seconded by Mr. G. M. Thomson, That lists of earthquakes recorded in New Zealand should be included in the annual Transactions of the Institute.—Carried.

Mr. Suter's Paper on Mollusca.—Mr. Petrie proposed, and Mr. G. M. Thomson seconded, That the incoming President be directed to communicate with the Geological Survey Department with a view to having the cost of printing Mr. Suter's paper on the Tertiary *Mollusca* paid for by that Department.—Carried.

Citation of the Transactions.—It was agreed that the Hon. Editor should insert a short instruction to authors showing how to correctly quote the volumes, and that the size of the letters showing the date of issue be increased.

Cost of Illustrations.—It was resolved to allow authors of papers to contribute towards the cost of publishing such illustrations as were approved by the Hon. Editor.

Instructions to Referees.—It was decided that the Linnean Society's instructions be adopted.

Librarian's Report.—The following report was read and received :—

I have the honour to report that the library remains much in the same condition as in my last report.

I think it is time that some decided steps were taken in regard to this important collection of books. It must be remembered that the exchanges of the "Transactions of the New Zealand Institute" have been received from various parts, and also a large number of what may be called complimentary presentations. During the whole of that time no competent person has been placed unreservedly in charge of the collection, and it has suffered accordingly. It certainly requires the whole time of a competent individual to put in order the works now in the library, and to ascertain how far they are complete, and to add with regularity the books that are received in exchange. I would draw the attention of the Board of Governors to the recommendations of the Committee which sat during the last session of Parliament, and which strongly recommended the formation in Wellington of a library of scientific books, under the care of the Government. I think that, so far as the Institute is concerned, they should do all in their power to push forward such a scheme, to have a proper library properly supervised and kept together. With regard to the actual property of the books themselves, I may draw your attention to the fact that the *Gazette* notice that restores the property of the Museum by the present Act of 1903 only gives a certain number over which the Institute are to have a claim as property. These, however, have never been set aside or distinguished from the others, which remain the property of the Government just as much as those which are not so included.

From another point of view, the library of the Institute is not arranged in an accessible manner, and cannot be under the present conditions. I may also point out for your consideration that the Institute have no other right than the permission of the Minister to use the room. I hope that some steps will be taken either to support the proposed scientific library or to take some steps as may be deemed desirable for the better arrangement and custody of the books.

The cards of the receipts have been carefully kept during the year, and the number received during the year is 982.

Separate copies of the Transactions have been forwarded to those on the exchange list.

A catalogue is in existence, printed in 1900, but it is of little use, because it does not indicate the completeness or otherwise of the items included.

A. Hamilton, Librarian.

Exchange List.—The report of the Librarian on the exchange list was adopted, as follows :—

The Exchange List Committee begs to recommend that of those institutions which have replied to the Committee's circular :—

A. The following be struck off the list of exchanges : The Geological Survey of Australasia, Queensland Branch ; Adelaide University ; Royal Asiatic Society.

London; School Library, Eton College; Institute of Jamaica; Entomological Society of London; Society of Natural Science, Batavia; National Library, Honolulu; College of Literature, Imperial University of Japan; Philippine Museum, Manila; Natural History Museum, Central Park, New York; American Museum of Natural History, New York; Società Africana d'Italia, Naples; Museo di Geologia e Paleontol. del R. Inst. di Studi, Fl.; Biblioteca ed Archivio Tecnico, Rome; Société de Géographie, Paris; Société Entomologique de France, Paris; Musée d'Histoire Naturelle de Bordeaux; Bibliothèque Nationale, Paris; Musée d'Histoire Naturelle de Genève; Redaktion des Biologischen Central-Blatts, Erlangen; University of Christiania; Public Library of Tasmania, Hobart; Victorian Institute of Surveyors; Gordon Technical College, Geelong; Royal Geographical Society of Australasia, New South Wales Branch; Public Library, Sydney; Botanic Gardens, Brisbane; South African Museum, Cape Town; South African Philosophical Society, Cape Town; Free Public Library, Cape Town; Ottawa Literary and Scientific Society, Ottawa; Literary and Historical Society of Quebec; Victoria College, Manchester; University Library, Edinburgh; School Library Committee, Rugby; Royal College of Physicians, Edinburgh; Philosophical Society of Leeds; Norfolk and Norwich Naturalist Society; Natural History Society, Marlborough College, England; Linnean Society, London; Leeds Geological Association; *Geological Magazine*, London; Clifton College, Bristol.

B. The Transactions be sent to the following institutions, notwithstanding that no direct return is received from them: Sydney University; Rautenstrauch-Joest Museum, Cöln, Germany; Bodleian Library, Oxford University; International Catalogue of Scientific Literature, 34 Southampton Street, Strand, London.

C. The following be added to the list, having promised to exchange: North of England Institute of Mining Engineers, Newcastle-upon-Tyne; Nederlandsche Entomologische Nereeniging, Rotterdam; Zoologisch Museum, Berlin; Geological Survey of Western Australia, Perth, Western Australia; University of Melbourne; Public Library and Museum of South Australia; Engineering Institute of New South Wales; Stazione Zoologica di Napoli, Naples.

D. The following be retained on the list: Royal Anthropological Institute of Great Britain, 50 Russell Street, W.C., London; Royal Geographical Society of London, 1 Savile Row West, London; Geological Society of London; Field Museum of Natural History, Chicago; American Philosophical Society, Philadelphia; Stanford University, California; Museo Paulista, Sao Paulo, Brazil; Royal Institution, Liverpool; University of Montana, Missoula, Montana, United States of America; Patent Office, 25 Southampton Buildings, W.C., London; *Nature*, London; Imperial Institute, London; Colonial Office, London; Norfolk and Norwich Naturalist Society, Norwich; High Commissioner for New Zealand, London.

E. That the following, suggested by Mr. Cotton, be communicated with and asked if they are agreeable to exchange: Geological Society of America, New York; Société Géologique de la France, Paris; Department of Geology, University of California; Deutsche Geologische Gesellschaft, Berlin; Geological Institute, University of Upsala, Sweden; Geological Survey of Scotland, Edinburgh; Geological Survey of Ireland, Dublin; Service de la Carte Géologique de la France; Service de la Carte Géologique de la Suisse; Royal Scottish Geographical Society, Edinburgh; National Geographic Society, Washington; Geographical Society of Philadelphia; Justus Perthes' Geographische Anstalt, Gotha; Carnegie Institute, Washington; American Academy of Arts and Sciences, Boston.

That all those who have not taken any notice of the communication be erased from the original B list in addition to the present A list.

A. Hamilton.

Correspondence.—Letters were read and received from the ex Minister of Internal Affairs, Mr. G. W. Russell, with reference to the offices for the New Zealand Institute; and from Dr. Hilgendorf, resigning his position on the Board.

Hector Medal.—The report of the Committee for obtaining the Hector Medal was received, as follows:—

On behalf of the Hector Medal Committee, I beg to report that nearly twelve months late Messrs. Wyon have duly forwarded the medal. The medal appears to be well executed, and the likeness is a fairly good rendering of the photograph supplied. We have to thank Professor Thorpe for generally supervising the design and attending generally to the matter. The medal awarded in January last has been engraved with the following inscription—"To Leonard Cockayne, Ph.D., F.R.S., for his researches in botanical ecology"—and forwarded to Dr. Cockayne. The award was formally presented to him on behalf of the Institute by Mr. G. M. Thomson on the occasion of the Canterbury Philosophical Society's Jubilee, on the 30th August, 1912.

The Custom officials insisted on the payment of duty on the value of the medals themselves, on the ground that the medal could have been produced in this Dominion. I think the Board of Governors may be congratulated upon having within their bestowal two such fine medals as the Hutton and Hector Medals.

A. HAMILTON.

Resolved, That Professor Thorpe be thanked for the trouble he had taken in connection with the medal.

On the motion of Professor Farr, seconded by Dr. Cockayne, it was resolved, That a refund of the amount charged by the Customs officials on the Hector Medal be applied for, on the ground that the medal could certainly not have been produced in New Zealand.

Notice of Motion.—Dr. Cockayne gave notice that at the next meeting he will move certain alterations in the Hutton Memorial Research Regulations.

British Association Reception Committee.—Professor Kirk detailed the steps taken when in Australia to further a visit from some members of the British Association to New Zealand.

Election of Officers.—President, Professor Chilton; Hon. Treasurer, Mr. C. A. Ewen; Hon. Editors, Mr. R. Speight and Dr. Chilton; Hon. Librarian, Mr. A. Hamilton; Publication Committee, Professors Benham, Chilton, and Farr, and Messrs. Speight and G. M. Thomson; Secretary, Mr. B. C. Aston. Hector Award Committee for 1914, Professor Baldwin Spencer, Melbourne; Mr. R. Etheridge, Sydney; and Mr. T. F. Cheeseman, of Auckland.

Secretary's Salary.—It was resolved that the Secretary's salary for the year be £30.

Honorary Members.—A ballot for the two vacancies on the list of honorary members caused by the deaths of Sir Joseph Hooker and H. W. Eve resulted in the election of W. B. Hemsley, of England, and Professor W. M. Davis, of Harvard University.

Travelling-expenses.—It was resolved that the travelling-expenses (including hotel expenses) of the Governors should be paid.

Votes of Thanks.—Votes of thanks to the Honorary Editors and Librarian, and to the Hon. Mr. Bell, Minister of Internal Affairs, for attending the meeting, were carried; and on the motion of Mr. G. M. Thomson, seconded by Professor Kirk, it was resolved that a hearty vote of thanks be passed to Mr. T. F. Cheeseman, retiring President, for the able manner in which he had conducted the business of the Institute during his term of office.

Date and Place of next Annual Meeting.—It was resolved that the next annual meeting be held at Wellington, on Friday, the 25th January, 1914.

T. F. CHEESEMAN, President.

Read and confirmed.
30th January, 1913.

PRESIDENTIAL ADDRESS.

The following is the presidential address delivered at the annual meeting of the Board of Governors of the New Zealand Institute at Wellington, 29th January, 1913, by Mr. T. F. Cheeseman, F.L.S., F.Z.S., Curator of the Auckland Museum:—

Gentlemen of the Board of Governors,—The expiry of another year has again made it necessary for me to prepare a short address dealing with the position of the Institute and the work which it has performed since we last met. And, as this is the last occasion on which I shall occupy this chair, I wish to thank you for the kindly support that has been awarded to me, and for the considerate indulgence shown to my many shortcomings.

In the address which I had the honour of placing before you last year I stated that the financial position of the Institute was causing great anxiety to those who had the management of its affairs; that it was no longer possible to print the Transactions for the amount of the annual grant of £500; and that the Institute was practically in debt to the Government Printer for a sum which I estimated at £155, but which proved to be nearer £250. The obvious cure for this unsatisfactory condition of affairs was to obtain a permanent increase of the statutory grant, but as this cannot be done without an amendment of the New Zealand Institute Act it was decided to apply to Parliament for a supplementary grant of £250. In support of this application a deputation waited upon the Premier, and fully explained the position of affairs. It was shown that the statutory grant still stood at the amount fixed on the formation of the Institute in 1868, when the circumstances of the Dominion were very different from what they are now, and when the total membership amounted to only 178, a number widely different from the present roll of nearly 1,000. It is satisfactory to state that the deputation was sympathetically received, and that the proposed sum was placed upon the supplementary estimates, and, having received the sanction of Parliament, has since been duly paid to our Treasurer. I trust that this welcome addition to our funds may be shortly followed by a permanent enlargement of the annual grant.

The financial statement, which has already been circulated among you, shows that the total receipts of the Institute, including the balance of £389 18s. 8d. in hand at the beginning of the year, have been £1,229 5s. 2d. The total expenditure has been £1,078 3s. 9d., the two chief items being a sum of £648 12s. 6d. in payment of the cost of Vol. 43 of the Transactions, and one of £250 on account of Vol. 44. The balance in hand is given at £151 1s. 5d., but against this has to be placed the amount of £292 1s. due to the Government Printer on account of Vol. 44 of the Transactions. The Institute is thus in debt to the amount of £140 19s. 7d. But on the 31st March the annual subsidy of £500 will be payable, extinguishing the debt, and leaving a surplus of about £350. If the Institute is successful in obtaining a permanent addition to the statutory grant, or if a special grant be procured of equivalent amount to that voted during the last session of Parliament, funds will be available for the issue of a volume of Transactions of average size; but without additional income there will still remain an indebtedness to the Government Printer.

Vol. 44 of the Transactions, which has been issued during the year, is considerably smaller than its predecessor, the reason being the necessity of reducing our printer's bill as much as possible. I find that the volume contains 594 pages, of which 460 belong to the Transactions and 134 to the Proceedings, including in this latter term all matter supplementary to the Transactions. The number of separate papers is forty, but seventeen short communications appear in the Proceedings, making a total of fifty-seven. In the index the number of plates is given as twenty-four, but many illustrations appear in the text which are not included in that total. The previous volume (43) contained 808 pages, of which 680 are referable to the Transaction and 128 to the Proceedings. The number of articles (including twenty-five notes or abstracts given in the Proceedings) amounted to eighty-two, and the plates numbered thirty-two. It will therefore be noticed that the reduction in the size of Vol. 44 is entirely confined to the Transactions, which contains 220 pages fewer than in Vol. 43. I think we all regret that the necessary economy in publication has been effected at the expense of the most important portion of the volume; but, in justice to the Editors, I must state that the reason for this is that the greater part of the Proceedings were in type before the financial position of the Institute was fully known. As for the total cost of the volume, the financial statement shows that the amount charged by the Government Printer has been £542 1s. So far as I can ascertain, this shows a saving of slightly over £100 on the cost of the volume for the previous year, which was £648 12s. 6d.

At the last meeting of this Board a motion was adopted to the effect that the separate publication of the Proceedings should be discontinued if the Government declined to increase the statutory grant. As no decision of the Government was available until the month of October, it was found impossible to issue any part of the Proceedings in advance of Vol. 45 of the Transactions, now being printed, and they will consequently appear together, as was the uniform practice until a few years ago. Personally, I trust that no attempt will be made to revive the plan of issuing the Proceedings in parts in advance of the Transactions proper, especially as it inevitably leads to greatly increased expenditure on the least important part of the Institute's publications. As I remarked in my address of last year, the greater part of the material printed therein is of ephemeral value. No particular interest and no scientific importance can be attached to the minutes of the meetings of the various incorporated Societies; and the abstracts given of scientific papers printed outside the Dominion need not be nearly so long as many of those which have been printed. In most cases the title of the memoir and the name of the publication in which it appears is all that is required. And any short papers which possess permanent value should form part of the Transactions proper, and should not be consigned to the comparative obscurity of the Proceedings. Almost a quarter of the last-issued volume is composed of the Proceedings, a proportion which appears to be extravagantly large. In my opinion, it would be far better to cease publishing the Proceedings altogether, and to apply the funds thus saved to the quarterly or half-yearly publication of the Transactions.

The report of the Publication Committee, which has been duly placed before you, contains several matters which require careful attention. I quite agree with the Committee in considering that the list of earthquakes recorded in New Zealand in each year should find a place in the Transactions, in which such lists were printed for many years in succession. Their absence from recent volumes has to my own knowledge caused inconvenience to several inquirers.

The suggestion made that Mr. H. N. Dixon's papers on the Mosses of the Dominion should be published in bulletin form will, I hope, be favourably entertained by the Board. The opportunity of having a practical review of our moss flora made by an acknowledged authority at no expense beyond the cost of publication is not one which should be allowed to pass by. The proposal to print Major Broun's papers in bulletin form stands in a precisely similar position. After the highly favourable report on the character of his work placed before the Board last year it is certainly desirable that his papers should be printed as rapidly as the funds of the Institute will allow.

The reference made to the uncertain practice of authors in citing the annual volumes of Transactions should be followed by some definite action. Why should not a clause drawing attention to the facts be inserted in the "Memorandum for Authors of Papers" which is now regularly prefixed to the Transactions? As matters are at present, the incorrect practice of quoting the year during which the paper is read, instead of the year of publication, causes much unnecessary trouble, and gives rise to wrong ideas on questions of priority.

Among the reports presented to you is one from Mr. Hamilton, as Librarian of the Institute. Now, I need say but little about the condition of the library. We all know that it is most inadequately housed and inconveniently arranged; that it is stored in a wooden building that might any day be destroyed by fire; that it requires the constant care and attention of some competent person. To my mind, the present state of the library is a disgrace to both the Government and the Institute, and should be rectified as soon as possible. Mr. Hamilton has suggested that the Institute should support the proposal made to Parliament in the report of the Museum and Scientific Departments Committee, where it is recommended that the whole of the scientific literature belonging to the Government, together with the library of the Institute, should be conjoined to form a general library of scientific works. There is much to be said in favour of such a scheme, for the Institute is without any funds from which it could erect a library building of its own; in fact, it cannot even provide for the proper superintendence of its library. The subject is a little complicated on account of the number of independent libraries which it is proposed to include in the scheme, and also from the uncertainty respecting the ownership of some of the books; but these are difficulties which tact and careful negotiation would probably remove. In any case, the subject has to be faced, and I commend the report to your earnest consideration.

I regret that I have no fresh information of my own respecting the proposed visit of the British Association in 1914. I understand, however, that two members of this Board who have recently visited Sydney have had an interview with the

Commonwealth Government on the subject, and that the matter has also been discussed at the meeting of the Australasian Association. I hope that these gentlemen may be able to furnish us with some idea of the shape that the proposed visit will eventually take. It is possible, however, that the final arrangements will not be made until the meeting of the British Association to be held in Birmingham next September.

In the report of the Standing Committee there is a reference to the excessive cost incurred in printing certain papers in Vol. 43 of the Transactions, and a suggestion is made that after this year the Publication Committee should submit to the annual meeting an estimate of the cost of publishing each paper selected for the annual volume. While not desirous of unduly hampering the actions of the Publication Committee, I am decidedly of opinion that it is the duty of this Board to exercise a closer superintendence over the expenditure on the annual volume. To make the reason for this clear, I will remark that Vol. 43 of the Transactions cost £648; that in the same year the printing of the general index to the first forty volumes cost £60; and that there was an additional payment of £28 for part of the Proceedings. In other words, the printer's bill for the year amounted to no less than £736, or £236 in excess of the annual subsidy. Now, I do not say that the printing represented by this large sum was not of advantage to the Institute, or that the material printed was unworthy of publication; but I do hold that no committee, without previous authority from the Board of Governors, should incur an expenditure so largely in excess of the revenue of the Institute. In making this statement I am anxious that it should be fully understood that I am quite sensible of the services that successive Publication Committees have rendered to the Institute, and that I am fully convinced that they have acted with a sincere desire to further its objects. But granting all that, there are so many objections which can be raised to unauthorized expenditure of the kind that I have mentioned that it appears highly desirable that the Board of Governors, at each of its annual meetings, should vote some specified sum, or in some way indicate what amount should be expended in the publication of the annual volume.

Another important reason can be urged in support of this conclusion. The annual meeting of the Board of Governors is the only meeting where the representatives of the whole of the incorporated Societies can unite in discussing the affairs of the Institute and take part in the management of its work. In the interval between the annual meetings the conduct of affairs is entrusted partly to the Publication Committee, which is usually—and, I think, quite unnecessarily—confined to members of two, or at the most three, Societies, and partly to the Standing Committee, which is even more limited in its composition, for it practically consists of Wellington residents. No doubt there are difficulties in providing any other form of management, but these difficulties make it highly desirable that as much as possible of the work of the Institute in all its departments should be arranged for and ordered at the annual meeting of the Board of Governors.

AUCKLAND INSTITUTE.

First Meeting: *4th June, 1912.*

Professor H. W. Segar, President, in the chair.

New Members.—R. S. Abel, L. Adams, A. Alison, E. W. Alison, J. Allen, L. W. D. Andrews, L. Arnoldson, C. Bagley, G. H. Baker, W. Ward Baker, Dr. Bamford, T. Bell, L. Benjamin, N. L. H. Biss, J. L. R. Bloomfield, W. Blomfield, Elon Bond, Erni Bond, S. Bradley, Alan Brown, E. A. Brown, John Brown, W. W. Bruce, C. F. Buddle, A. Burt, jun., J. P. Campbell, Maurice Casey, T. B. Clay, J. M. Clifford, J. W. Coleman, W. M. Commons, T. Cotter, J. G. Currie, Eliot R. Davis, Ernest Davis, J. Dennin, W. R. Ellingham, J. Endean, A. J. Entrican, R. Farrell, J. W. Frater, Hon. S. T. George, H. Gilfillan, J. C. Gleeson, P. Gleeson, G. Gribbin, J. B. Graham, A. Gray, J. G. Haddow, A. Hanna, J. C. Hardie, A. E. Harding, W. F. Harrop, W. A. Harvey, Archdeacon Hawkins, Douglas Hay, H. W. Heath, H. D. Heather, S. Hesketh, Colonel Holgate, E. Horton, F. Hull, G. R. Hutchinson, W. E. Hutchinson, J. H. Jackson, A. T. Jagger, Frank Jagger, J. W. James, H. A. Keesing, B. Kent, G. S. Kent, A. Keyes, R. S. Lamb, F. W. Lang, M.P., Dr. T. H. Lewis, W. B. Leyland, Cecil Leys, E. Mahoney, H. A. Marriner, J. M. Mennie, M. G. McGregor, Captain G. McKenzie, R. McVeagh, J. F. Montague, W. B. A. Morrison, A. R. Morrison, E. Morton, A. M. Mowlem, D. L. Nathan, F. Neve, J. W. Nichol, G. Nicol, G. B. Osmond, W. R. B. Oliver, W. J. Parker, C. J. Parr, A. Peak, A. Porter, Dr. A. C. Purchas, W. J. Ralph, S. Rawnsley, J. Robb, J. Robertson, F. Rotherham, H. M. Shepherd, G. Sinclair, Captain J. Smith, A. E. Skelton, W. C. Somers, Dr. Somerville, Percy Spencer, J. Stewart, H. C. Swan, W. Swanson, W. Taylor, J. Thornes, Hon. J. A. Tole, J. Trounson, C. J. Tunks, W. R. Walker, J. H. Walters, J. D. Webster, R. W. White, F. W. Wilson; H. Munro Wilson, J. M. Wilson, Liston Wilson, H. Winkelmann, F. B. Winstone, G. Winstone, R. Wright, F. J. Wrigley.

Address.—The President delivered the anniversary address, taking as his subject "The Dwindling Sovereign."

Second Meeting: *4th July, 1912.*

Professor H. W. Segar, President, in the chair.

New Members.—R. H. Abbott, — Armitage, P. S. Ardern, Miss Butler, E. Brooke-Smith, Rev. R. H. Cole, S. Cory-Wright, J. Dempsey, J. C. Dove, J. Fleming, A. M. Gould, M. D. Gray, Trevor Lloyd, Rev. G. MacMurray, B. C. Moody, W. H. Pountney, Dr. A. H. Porter, F. C. Rollett, F. Shaw, Rev. J. H. Simmonds, Hall Skelton, Rev. P. S. Smallfield, Wesley Spragg, J. F. Stewart, H. L. Wade, Professor Maxwell Walker, Rev. C. A. B. Watson, A. Wiseman, Martin Wilson, A. C. Woolcott.

Sir John Logan Campbell.—The President called the attention of the meeting to the recent death of Sir John Logan Campbell, and the announcement that had been made to the effect that the Auckland Institute and Museum would receive a bequest of £1,000 under his will. He moved the following resolution:—

The Auckland Institute and Museum is desirous of recording at the earliest possible opportunity its sincere and profound regret at the death of Sir John Logan Campbell, a member of the Institute since 1872, for several years one of its Council, and during the whole of his membership a liberal and consistent supporter of the aims and interests of the Society. The Institute is proud to have numbered among its members one who assisted in the foundation of this city and the establishment of its institutions, who during his lifetime contributed an unexampled series of varied and far-reaching benefactions, and who at his death has provided for so many large and important bequests, for one of which the sorrowful acknowledgments of the Institute are due. The Institute also desires to express to Lady Campbell its sincere and respectful condolence, and to assure her of its deep sympathy in her affliction.

The motion was seconded by the Vice-President (Mr. J. H. Upton), and was carried unanimously.

Lecture.—"A Gentleman of Athens," by Professor H. S. Dettmann, M.A.

The main object of the lecture was to show that there was much in the daily life of ancient Athens that came curiously close, even in points of detail, to our own. It is possible to find parallels for many of our modern customs and even for many of our modern jests.

Third Meeting: *1st August, 1912.*

Professor H. W. Segar, President, in the chair.

Lecture.—"The Methods and Aims of Science," by E. V. Miller.

Abstract.

The lecturer attempted to show what mental and physical operations are concerned in the processes of scientific observation, experiment, and inference, touching on the subjects of scientific instruments and mathematics, and illustrating by short accounts of scientific results. An account was given of the genesis and growth of scientific theories, and in what way the latter, changing as they do from time to time, are to be regarded in relation to experience and reality. The utilitarian and intellectual aims of science were discussed, and a plan put forward for the wider dissemination of the scientific habit of mind and mode of belief.

Fourth Meeting: *29th August, 1912.*

Professor H. W. Segar, President, in the chair.

Lecture.—"Coal: its Products and their Applications to the Needs of Modern Life," by Mr. H. H. Morgan, B.Sc.

Fifth Meeting: *26th September, 1912.*

Professor H. W. Segar, President, in the chair.

Lecture.—"The Child and the Race," by H. G. Cousins, M.A.

Sixth Meeting: *24th October, 1912.*

Professor H. W. Segar, President, in the chair.

Paper.—"The Manuaute, or Maori Kite," by Archdeacon P. Walsh.

Seventh Meeting: *7th November, 1912.*

Professor H. W. Segar, President, in the chair.

Lecture.—"The Problem of Tuberculosis," by Dr. E. H. B. Milsom.

Eighth Meeting: *14th November, 1912.*

Professor H. W. Segar, President, in the chair.

Lecture.—"A Descriptive Account of the Upper Congo, the Country and its People," by Mr. Joseph Steele.

The lecture was profusely illustrated by lantern-views and by a large collection of ethnographical specimens.

Ninth Meeting: *11th December, 1912.*

Professor H. W. Segar, President, in the chair.

New Member.—G. A. Hansard.

Papers.—1. "On the Motion of Cirrus Clouds," by H. B. Devereux, F.R.Met.Soc.

2. "Concerning certain Ancient Maori Stone Implements found at Tauranga," by C. A. Semadeni.

3. "The Kermadec Islands Avifauna," by Tom Iredale; communicated by W. R. B. Oliver.

4. "Further Notes on the Birds of the Kermadec Islands," by W. R. B. Oliver.

5. "Descriptions of New Specimens and Varieties of Native Phanerogams," by D. Petrie, M.A.

6. "Note on the Pollination of *Rhabdothamnus*," by D. Petrie, M.A.

7. "On some Additions to the Flora of Mangonui County," by H. Carse.

8. "New Species of Plants," by T. F. Cheeseman, F.L.S.

9. "Anatomy of some New Zealand Representatives of the Order *Araliaceae*," by Miss C. L. Beaumont.

10. "New Genera and Species of *Coleoptera*," by Major T. Broun.

Annual Meeting: *24th February, 1913.*

Professor H. W. Segar, President, in the chair.

Annual Report.—The annual report and audited financial statement was read to the meeting, and ordered to be printed and distributed among the members.

Abstract of Report.

Membership.—In several previous reports the Council have drawn attention to the fact that the members roll was by no means so large as should be the case in a city of the size and importance of Auckland. Early in the session an attempt was made to rectify this, and, mainly through the exertions of the Hon. E. Mitchelson and Mr. H. E. Vaile, no less than 162 have been elected. On the other hand, eleven names have been withdrawn from the roll, six of them from death. The total membership at the present time amounts to 386. Among the members removed by death are several who have been associated with the Institute for long periods. Notable among these is Sir John Logan Campbell, who for several years served as one of its Council, and who during the whole of his membership was one of its most liberal and consistent supporters. Members of the Institute are aware that among his numerous bequests is one of £1,000 in favour of the Institute. Two other names deserve special mention—those of Mr. John Webster and Major W. G. Mair. The latter, assisted by his brother, Captain Gilbert Mair, formed the valuable and extensive series which now form the basis of our Maori collection.

Finance.—The balance-sheets show that the total revenue credited to the Working Account, excluding the balance in hand at the commencement of the year, was £1,353 13s. 2d. Last year the receipts were £1,273 5s. 10d., so that there has been a total increase of £80 7s. 4d. It will also be found that the invested funds of the Costley Bequest have yielded £350 2s. 8d., as against £392 7s. 6d. for the previous year. The Museum Endowment has contributed £511 10s. 6d. The large addition made to the members roll has resulted in the amount received from members' subscriptions being increased to £358 1s. The total expenditure amounts to £1,465 5s. 10d. The increase is principally due to three items—the cost of certain repairs, &c., to the Museum buildings and the construction of some show-cases required in the Museum; an enlarged expenditure over the Museum itself, both in the purchase of additions and the necessary expense of their installation; and, finally, a more than usually large expenditure over the library. The balance in hand at the present time amounts to £108 1s.

In last year's report particulars were given of the special subscription fund, amounting to £621, which had been contributed by the citizens of Auckland for the purchase of ancient Maori carvings and other additions to the Museum, but which had been only partially expended at the time of the last annual meeting. Since then the balance of the fund has been applied to the purposes for which it was raised.

The capital funds of the Institute have been increased by £132 10s. during the year, the total amount now standing at £16,511 14s. 3d.

Early in the year the Council applied to the Government with the object of obtaining a parliamentary grant equivalent to the amount (£681) of the fund raised by the citizens of Auckland for the benefit of the Museum. After considerable negotiation a vote of £250 was promised, and has been duly approved by Parliament.

Meetings.—Eight meetings have been held during the year, at which the following lectures and papers were read :—

1. Presidential address, "The Dwindling Sovereign," by Professor H. W. Segar, M.A.
2. "A Gentleman of Athens," by Professor H W. Dettmann, M.A., B.C.L.
3. "The Methods and Aims of Science," by E. V. Miller.
4. "Coal : its Products and their Applications to the Needs of Modern Life," by H. H. Morgan, B.Sc., A.R.C.S.
5. "The Child and the Race," by H. G. Cousins, M.A.
6. "The Manuaute, or Maori Kite," by Archdeacon P. Walsh.
7. "The Problem of Tuberculosis," by E. H. B. Milsom, M.R.C.S., M.D.
8. "The Upper Congo : its Country and People," by J. Steele.
9. "On the Motion of Cirrus Clouds," by H. B. Devereux, F.R.Met.Soc.
10. "Concerning certain Ancient Maori Stone Implements found at Tauranga," by C. A. Semadeni.
11. "The Avifauna of the Kermadec Islands," by T. Iredale.
12. "Further Notes on the Birds of the Kermadec Islands," by W. R. B. Oliver.
13. "Descriptions of New Species and Varieties of Native Phanerogams," by D. Petrie, Ph.D.
14. "Note on the Pollination of *Rhabdothamnus*," by D. Petrie, Ph.D.
15. "On some Additions to the Flora of Mangonui County," by H. Carse.
16. "New Species of Plants," by T. F. Cheeseman, F.L.S., F.Z.S.
17. "New Genera and Species of *Coleoptera*," by Major T. Broun, F.E.S.
18. Anatomy of some New Zealand Representatives of the Order *Araliaceae*," by Miss C. L. Beaumont; communicated by Professor A. P. W. Thomas.

Museum.—The number of visitors to the Museum has largely increased during the year. The progress made in the Museum during the past year has been satisfactory. Several collecting trips have been made, and through the kindness of the Marine Department Mr. Griffiths was twice carried free on the periodical trips of the "Hinemoa" around the North Island, thus receiving many opportunities for collecting fishes and other marine animals. Specimens received from other sources have also been dealt with during the year. The most interesting addition to the Zoological portion of the collections is a special group illustrating the life-history of the common shag or cormorant (*Phalocrocorax varius*). Mention may also be made of a series of birds from Norfolk Island, obtained from Mr. Quintal; a fine cassowary, presented by Mr. Vivian; several animals from the Onehunga Zoo, from the owner, Mr. Boyd; and a valuable collection of New Zealand and English birds' eggs, presented by Mr. H. C. Clark.

The Council have pleasure in drawing attention to several noteworthy additions to the Maori collections. Chief among them are the small collections purchased from Mrs. Palmer. All these are known to have been taken to England about the year 1795, and are excellent specimens of the best period of Maori workmanship. From Mr. Spencer the Museum has acquired what is probably the finest known greenstone *matau;* a greenstone *manaia;* a peculiar *pekapeka;* several remarkably good greenstone ear-pendants and other ornaments in greenstone; a very peculiar carved box intended to receive the skull of a chief; and a remarkably fine carved coffin of an entirely different type from those already in the Museum. Mr. Berry, of the Upper Waipa, has presented the figurehead and sternpost of the celebrated war-canoe "Te Atairehia," which was owned by the first Maori King Potatau, and was used by him while residing at Ngaruawahia, before the Waikato War. Mr. G. Graham, so well known from his previous donations to the Museum, has contributed several further additions during the year. Mr. H. B. Devereux, Mr. S. M. Clark, Mr. B. Roberts, and Mr. W. Wintle have made noteworthy presentations. The Council are glad to state that Mr. Arthur Eady has deposited in the Museum for a considerable time his fine collection of Maori articles, containing sixty-one specimens in all.

Library.—The amount expended on the library this year is rather larger than usual, amounting to £236 2s. 9d. Two consignments of books, containing slightly over 100 volumes, have been received; and a third, numbering fifty-six volumes, is due to arrive within a fortnight. In addition to the purchase of books, a large expenditure has been incurred in binding scientific periodicals, the publication of societies, &c., nearly 100 volumes having been added to the library from that source alone.

The Council have pleasure in drawing special attention to two very extensive and acceptable presentations of scientific and geographical works made by Mr. Henry Shaw, who has been a frequent contributor to the library during past years, and by his brother, Mr. F. Shaw. These presentations include no less than 170 volumes, many of them being standard editions of well-known works. Mention should also be made of a complete set of Science Abstracts presented by Professor Brown.

Scott Expedition.—On motion of the Chairman, seconded by Mr. Bagnall, it was resolved, That the Auckland Institute desires to express its profound regret at the disastrous loss of Captain Scott and his party during their return from the South Pole. It also wishes to state its admiration of the unswerving heroism of the party, which has left an example of devotion to duty and loyalty to one another which will endure for all time. It further desires to record its sympathy with the relatives of the deceased in their bitter and irreparable loss.

Gift of Books.—A special vote of thanks was awarded to Mr. Henry Shaw and Mr. F. Shaw for their very welcome and acceptable gift of 170 volumes of books dealing with geographical and natural science.

Election of Officers for 1913.—*President*—C. J. Parr, Esq., Mayor of Auckland; *Vice-Presidents*—Professor H. W. Segar, J. H. Upton; *Council*—Professor F. D. Brown, Professor C. W. Egerton, E. V. Miller, E. Mitchelson, T. Peacock, J. A. Pond, J. Reid, D. Petrie, J. Stewart, Professor A. P. W. Thomas, H. E. Vaile; *Trustees*—Professor F. D. Brown, T. Peacock, J. Reid, J. Stewart, J. H. Upton; *Curator and Secretary*—T. F. Cheeseman; *Auditor*—S. Gray.

WELLINGTON PHILOSOPHICAL SOCIETY.

FIRST MEETING: *1st May, 1912.*

Present: Mr. G. V. Hudson, President, in the chair, and about forty members and friends.

The President referred to the improvements made in the lecture-room, and conveyed the thanks of the Society to the Director of the Museum, Mr. A. Hamilton, for his action in the matter.

New Member.—Mr. M. H. Browne.

Papers.—1. "The Axioms of Geometry," by Professor D. K. Picken.

2. "Notes on the Entomology of the Ohakune and Waiouru Districts," by G. V. Hudson, F.E.S.

3. "Description of a New Species of *Perla* (Stone-fly) in New Zealand," by G. V. Hudson, F.E.S.

4. "On Two Blepharocerids from New Zealand," by C. G. Lamb, M.A., B.Sc., Clare College, Cambridge; communicated by the President, Mr. G. V. Hudson.

5. "Remarks on the Domestic Depravity of a Queensland Ant," by G. V. Hudson.

6. "*Somatochlora braueri* in New Zealand," by A. Hamilton.

7. "Localities of *Lepidoptera* in New Zealand," by A. Hamilton.

8. "*Deinacrida rugosa* Buller," by A. Hamilton.

Exhibit.—Mr. A. Hamilton exhibited a number of wetas from the Museum collections.

SECOND MEETING: *29th May, 1912.*

Present: Mr. G. V. Hudson, President, in the chair, and about sixty members and their friends.

A copy of the report of the second International Congress of Entomologists was received from the Chairman of Committee for Australasia, and read by the President, a number of copies being afterwards laid on the table for use of members.

Address.—"Early Cook Strait Incidents," by the Hon. Robert McNab.

THIRD MEETING: *26th June, 1912.*

Present: Mr. G. V. Hudson, President, in the chair, and about seventy members and their friends.

The President announced that the Council had resolved to congratulate Dr. Cockayne on being elected a Fellow of the Royal Society, London.

Paper.—"The Heat-conductivity of Gases and Heat-insulators," by Professor T. H. Laby and Mr. M. Alexander.

Exhibit.—Professor Laby exhibited and gave a description of "Tables annuelles de Constantes et Données numériques de Chimie, de Physique, et de Technologie."

Kinematograph Views.—Kinematograph views of rapids, mountains, and glaciers of New Zealand, by Mr. J. Macdonald.

FOURTH MEETING: *31st July, 1912.*

Present: Mr. G. V. Hudson, President, in the chair, and about thirty members and their friends.

New Members.—Professor J. Adamson, W. H. Field, H. A. Goudie.

Exhibit.—Mr. A. Hamilton, Director of the Dominion Museum, gave an interesting account of and exhibited a number of valuable Hawaiian and Tahitian specimens presented to the Museum by Lord St. Oswald.

Papers.—1. "Notes on Flightless Females in certain Species of Moths, with an Attempted Explanation," by G. V. Hudson, F.E.S.

2. "On *Tipula heterogama*, a New Species of Crane-fly in New Zealand," by G. V. Hudson, F.E.S.

FIFTH MEETING: *28th August, 1912*

Present: Mr. G. V. Hudson, President, in the chair, and about sixty members and their friends.

New Members.—Dr. C. M. Begg, Mr. F. W. Furkert, Mr. J. C. Morrison.

Paper.—"Notes on Synthetic Rubber," with experiments, by Professor Easterfield and Mr. J. McDowall.

Lecture.—"Radiant Heat," with experiments, by Professor Laby.

Exhibit.—The printing chronograph, Gautier model, as made by the Société Genévoise; exhibited by Mr. C. E. Adams, Government Astronomer.

SIXTH MEETING: *25th September, 1912.*

Present: Mr. G. V. Hudson, President, in the chair, and about fifty members and their friends.

Papers.—1. "Wild Flowers of New Zealand," by Mr. J. Crosby Smith.

Mr. Smith exhibited and described a fine series of hand-painted lantern-slides of New Zealand wild flowers.

2. "The Physical State and Role of Water in Rock-magmas," by P. G. Morgan, M.A.

ANNUAL MEETING: *23rd October, 1912.*

Present: Mr. G. V. Hudson, President, in the chair, and about forty members and their friends.

Annual Report.—The annual report and balance-sheet were read and adopted. The report was as follows:—

ANNUAL REPORT.

A special meeting was held on the 1st November, 1911, when Chief Detective McIlveney and Mr. E. Dinnie, of the Police Department, gave an interesting lecture, illustrated by lantern-slides, on the finger-print system for the detection of criminals.

The 1912 session opened on the 1st May, 1912, and ended on the 23rd October, the number of regular meetings being increased from six to seven.

Of the thirty papers read before the Society, fifteen were entomological, three physical, four geological, one mathematical, one chemical, two astronomical, while four were of a popular nature.

Since the last annual meeting ten new members have been elected, eleven have resigned, and three have died. The total number on the roll is now 138, including one honorary member and six life members.

A statement of the receipts and payments for the year ending 30th September, duly audited, was presented with this report. Inclusive of the balance brought forward from last year (£63 14s. 2d.), the receipts amounted to £343 12s. 2d., and the total payments were £219 12s. 1d., leaving a credit balance of £124 0s. 1d.

The Life Subscription Fund has been increased by £20, and now stands at £41 15s. 8d., including interest.

The Research Fund, including interest, now amounts to £41 9s. 2d.

Both these funds are invested with the Public Trustee, and, together with the credit balance at the bank, amount to £207 4s. 11d.

The Library Committee recommended that a number of the scientific periodicals should be bound, and missing numbers obtained to complete the sets, and these recommendations are now being given effect to.

The Council disposed of the *Philosophical Magazine* to Victoria College, and placed orders for the *American Journal of Science* from 1870, and for the *Astrophysical Journal* from its commencement in 1895.

Arrangements have been made with Victoria College for any member of the Society to have the privilege of using the books in the College library, while the Council offers similar facilities to Victoria College to make use of the Society's library.

The report of the Librarian shows that the Society receives by purchase or donation twenty-one periodicals, which are available for the use of members.

Tongariro National Park.—At the suggestion of Mr. E. Phillips Turner, the Council communicated with the other Philosophical Societies as to the advisability of urging on the Government the importance—(1) Of having a photo-topographic survey made of the park; (2) of extending the boundaries of the park as proposed in the report by Dr. Cockayne and Mr. Phillips Turner; and (3) of taking steps to acquire the small area of Native land which includes the Ketetahi Hot Springs. In every case the Council's recommendation was strongly supported by the other Societies, and a favourable opportunity will be taken to place the subject before the Government.

The Council is much indebted to Mr. E. J. Ludford for a valuable donation of books, some forty-four in number, chiefly relating to New Zealand.

The Astronomical Section has erected an observatory at Kelburne, and has mounted equatorially a 5 in. Cooke refractor, which is now available for use.

Astronomical Section.—The annual report of the Astronomical Section was read by the Secretary, Mr. A. C. Gifford. The President congratulated the section on its work. The report was as follows:—

The chief work of the year has been the building of a small observatory at Kelburne. It consists of an ante-room 12 ft. square, and an instrument-room of the same size, the latter surmounted by a revolving dome. The plans of the observatory were prepared by Mr. J. Campbell, Government Architect, and the work carried out by Messrs. McLean and Gray. The 5 in. refractor is mounted equatorially on an iron pedestal cemented on to a very solid concrete pillar. The telescope was adjusted in time to allow members to make some good observations of Gale's comet.

It has been arranged to open the observatory, for the convenience of members, every Tuesday evening, if the weather is astronomically favourable. Any member approved by the Council may hire a private key, and have access to the observatory at any time.

Arrangements are being made to admit the public on certain evenings.

During the year the following lectures have been delivered: Thursday, 19th October, 1911—Mr. J. T. Ward, Director, Wanganui Observatory, gave a popular lecture, "Evenings with the Telescope," illustrated by a particularly fine collection of lantern-slides. Wednesday, 17th July, 1912—Mr. C. E. Adams, Government Astronomer, lectured on meridian work and meridian instruments. Thursday, 3rd October, 1912—The Very Rev. Dr. Kennedy gave a lecture in the observatory on the equatorial telescope and its use.

Officers for 1913.—The President announced that the following officers were suggested by the Council for the year 1913: *President*—Professor T. H. Easterfield; *Vice-Presidents*—Mr. Thomas King, F.R.A.S., and Professor H. B. Kirk; *Council*—Mr. A. Hamilton, Mr. Martin Chapman, K.C., Mr. F. G. A. Stuckey, M.A., Professor D. K. Picken, Mr. P. G. Morgan, M.A., Dr. C. Munro Hector, Mr. G. V. Hudson, F.E.S.; *Secretary and Treasurer*—Mr. C. E. Adams, M.Sc., F.R.A.S.; *Librarian*—Miss J. A. Wilson; *Auditor*—Mr. E. R. Dymock, A.I.A.N.Z.

On motion of Dr. A. Thomson, seconded by Mr. A. C. Gifford, these officers were declared elected.

New Members.—Captain Hayward and Mr. J. Mackay.

Papers.—1. "On an Instance of Protective Mimicry in New Zealand Moths," by Alfred Philpott; communicated by G. V. Hudson.

Abstract.

The genus *Declana* contains some of the most beautiful of New Zealand moths. They are not, however, generally decked in gaudy or vivid colours, but owe their attractiveness to a pleasing arrangement of white or brown and grey. When resting on tree-trunks amongst lichen and moss they would be quite inconspicuous, and, as they are chiefly forest-frequenting forms, their colouring is probably highly protective. Being nocturnal insects, they are not liable to much persecution from birds, though when found in the daytime they are eaten with relish. One member of the genus, however—*D. glacialis* Huds.—differs altogether from the others, and is, I believe, an example—the only one known at present among our native moths—of protective mimicry.

D. glacialis, unlike any of its congeners, is brightly coloured, orange and red predominating. It is, I have no doubt, mimetic of the genus *Metacrias*. Of this genus we have three forms. They are all black and orange or black and red. They fly by day in the hottest sunshine, and when on the wing they appear to be bright yellow or reddish insects. They are, I believe, nauseous in taste; birds do not appear to attack them, and I have seen them untouched in spiders' webs. *Declanae* in general are quite opposite in appearance and habit to *Metacrias*, yet we find that *D. glacialis* has acquired a singular resemblance to the latter genus. It flies by day: Mr. Hudson found it flying commonly in bright sunshine at Mount Cook, and Messrs. Oliver and Pasco met with it under similar circumstances on Ben Lomond, Wakatipu. On the wing the markings will not be noticeable, and it will appear of the same reddish type as *Metacrias*. So unlike a typical *Declana* and so superficially like a *Metacrias* is the species that its describer, Mr. G. V. Hudson, had placed it in the latter genus, and only discovered the error by an examination of the wing-nervures, which are quite different in the two genera. There is, I think, a very strong presumption that *Declana glacialis* is mimetic of the genus *Metacrias*, though not perhaps of any particular species of that genus.

2. "On an Instance of the Effects of Natural Selection and Isolation in reducing the Wing-expanse of a Moth," by Alfred Philpott; communicated by G. V. Hudson.

Abstract.

The moth in question (*Notoreas synclinalis* Huds.) was discovered at Seaward Moss in January, 1900 (Trans. N.Z. Inst., vol. 35, p. 244). The locality is an extensive mossy bog lying along the coast from the Bluff to near Fortrose, and stretch-

ing inland for several miles. It is covered in places with rather stunted manuka (*Leptospermum scoparium*), and in some of the lower portions *Cassinia Vauvilliersii* flourishes to some extent. An interesting and peculiar community of lowly plants covers the spongy surface, those of a "cushion" habit of growth being noticeable.

Until 1911 this was the only known locality for *N. synclinalis*, but in March of that year it was discovered on some flat hilltops near Preservation Inlet. These bare hilltops are of much the same character as Seaward Moss, but the coating of peaty soil appears to be shallow, as the granite shows through in several places. The height above sea-level is about 1,000 ft., and the open spaces are of small extent, being surrounded by dense bush. The distance between the two localities is about eighty miles—that is, taking a straight line from point to point, which will run for the greater part of its length over the waters of Foveaux Strait. Following round the coast, the most direct line will give a distance of about 120 miles.

On comparing the moth from Preservation with specimens from Seaward Moss it was at once apparent that a constant variation existed. The Preservation form is distinctly shorter and narrower winged, the difference being on the average about a millimetre. There is also a very slight difference in coloration and marking, and, though the features are hardly definable, they become noticeable when series are placed side by side.

3. "On the Physiography of the Tararua Ranges," by G. L. Adkin.

4. "Notes on the Habitats of New Zealand *Lepidoptera*," by A. Hamilton.

5. "The Tuamarina Valley," by C. A. Cotton.

6. "On Two New Echinoderms," by H. Farquhar; communicated by Professor Kirk.

7. "Igneous Intrusions of Mount Tapuaenuka," by J. A. Thomson.

8. "Harmonic Tidal Constants of New Zealand Ports," by C. E. Adams.

9. "Descriptions of New Zealand *Lepidoptera*," by E. Meyrick; communicated by G. V. Hudson.

10. "A Revision of New Zealand *Pyralidina*," by E. Meyrick; communicated by G. V. Hudson.

PHILOSOPHICAL INSTITUTE OF CANTERBURY.

Special Meeting: *27th March, 1912.*

Present: Dr. L. Cockayne, F.R.S., President, in the chair, and twenty-seven others.

Address.—"Heredity in Relation to Practical Stock-breeding," by Mr. A. Grant-Watson.

A hearty vote of thanks was accorded the lecturer.

First Meeting: *1st May, 1912.*

Present: Dr. L. Cockayne, F.R.S., President, in the chair, and thirty others.

Congratulations.—The congratulations of the Institute were accorded to Dr. Cockayne on the award to him of the Hector Medal, and also on his election as a Fellow of the Royal Society.

Address—Mr. A. M. Wright, the retiring President, then delivered his ex-presidential address on "The Chemist and the Community."

Special Meeting: *15th May, 1912.*

Present: Dr. L. Cockayne, F.R.S., President, in the chair, and seventy others.

Address.—"Sleeping Sickness," by Dr. P. H. Ross, Bacteriologist to the British East African Protectorate.

A hearty vote of thanks was accorded the lecturer.

Second Meeting: *5th June, 1912.*

Present: Dr. L. Cockayne, F.R.S., President, in the chair, and thirty others.

New Members.—Messrs. Maurice Richmond, F. L. Mouldey, and S. Fry.

Papers.—1. "The Chemistry of Flesh Foods," by A. M. Wright.
2. Psychic Aspects of Evolution," by Johannes C. Andersen.

THIRD MEETING: *3rd July, 1912.*

Present: Dr. L. Cockayne, F.R.S., President, in the chair, and twenty five others.

New Members.—Messrs. H. E. Marsh, A. H. R. Aness.

Papers.—1. "On *Gunnera* and its Fresh-water Alga," by G. E. Archey.
2. "Botanical Observations in Marlborough," by C. E. Foweraker.
3. "The Crab-beds of Pareora," by M. C. Gudex.
4. "Radium in Rocks," by D. B. Macleod.

FOURTH MEETING: *7th August, 1912*

Present: Dr. L. Cockayne, F.R.S., President, in the chair, and thirty others.

Address.—"The Oscillograph," by Mr. P. H. Powell.

Exhibit.—A specimen of *Euonymus*, showing fasciated growth, by Mr. R. Nairn.

JUBILEE MEETING: *30th August, 1912.*

Present: Dr. L. Cockayne, F.R.S., President, in the chair, and about 350 members and guests, including Mr. H. Holland (Mayor of Christchurch), Mr. G. M. Thomson, M.P. (representing the Government), Mr. George Hogben (representing the Senate of the New Zealand University and the Education Department), Messrs. A. Hamilton and B. C. Aston (representing the New Zealand Institute), and Professor Picken (representing Victoria College).

Presidential Address.—Dr. L. Cockayne addressed the meeting with reference to the work carried out by the Institute during the past fifty years, and outlined some of the work for future investigation.

Congratulations.—His Worship the Mayor of Christchurch and Messrs. G. M. Thomson, George Hogben, and A. Hamilton briefly addressed the meeting, conveying congratulations from the bodies which they represented.

Hector Medal.—On behalf of the New Zealand Institute, Mr. G. M. Thomson presented to Dr. L. Cockayne the Hector Medal for botany.

FIFTH MEETING: *11th September, 1912.*

Present: Dr. L. Cockayne, F.R.S., President, in the chair, and thirty others.

Congratulations.—The congratulations of the Institute were accorded Dr. Charles Chilton on the award to him of the honorary degree of Doctor of Laws by the Aberdeen University.

Address.—"The Lighting of Picture-galleries and Museums," by Mr. S. Hurst Seager.

Sixth Meeting: *2nd October, 1912.*

Present: Dr. F. W. Hilgendorf, in the chair, and sixty others.

New Members.—Miss Tabart, Rev. J. Holloway, Messrs. H. M. Budd and E. V. Barrett.

Address.—"The Cost of Living, with Special Reference to its Connection with the Gold-supply and the General Level of Prices," by Dr. J. Hight.

Seventh Meeting: *6th November, 1912.*

Present: Mr. A. M. Wright, Vice-President, in the chair, and twenty-five others.

Papers.—1. "The Physiography of Norfolk Island," by R. M. Laing.

2. "On a Collection of Rocks from Norfolk Island," by R. Speight.

3. "On *Dicranoloma*," by Mr. H. N. Dixon; communicated by Dr. L. Cockayne.

4. "Report on the Examination of some Tertary *Mollusca* in the Collection of the New Zealand Geological Survey," by H. Suter.

5. "On some Folk Stories from Epi, New Hebrides," by Rev. T. E. Riddle; communicated by R. M. Laing.

This paper is printed in the "Journal of the Polynesian Society."

6. "Further Observations on the Artesian Wells in the Christchurch District," by Dr. F. W. Hilgendorf.

Annual Meeting: *4th December, 1912.*

Present: Dr. L. Cockayne, F.R.S., President, in the chair, and twenty-five others.

New Member.—Mr. Orton Bradley.

Annual Report.—The annual report and balance-sheet for the year were adopted.

Abstract.

The membership of the Institute has further increased during the year, and the finances are in a satisfactory state.

Jubilee.—On the 30th August the Institute celebrated the fiftieth anniversary of its foundation, and on this date a special meeting was held, to which all members were invited, as well as representatives of various scientific, educational, and political bodies throughout the Dominion.

Meeting of the Board of Governors of the New Zealand Institute.—The annual meeting of the Board of Governors of the New Zealand Institute was held this year in Christchurch, and the Philosophical Institute of Canterbury had much pleasure in welcoming for the first time the members of the governing body of the parent Institute. After the formal business of the meeting had been concluded an enjoyable excursion was made to Lincoln College, the return to Christchurch being by way of Tai Tapu, Gebbie's Pass, and Governor's Bay. The Council is greatly indebted for the kind hospitality shown to its members and to their guests by Mr. E. Alexander, Director of Lincoln College, and by the Hon. R. Heaton Rhodes, M.P., who conducted the visitors over his beautiful garden and explained his extensive collection of plants.

Library.—The library has been kept up to date, and the Council is pleased to report that members of the British Antarctic Expedition have found it most useful in their biological researches. Numerous additions have been made to the Antarctic section during the year.

Meetings of the Institute.—Nine meetings of the Institute have been held during the year, at which the following addresses have been delivered: "Heredity Community" (ex-presidential address), by Mr. A. M. Wright; "Sleeping Sick-in Relation to Stock-breeding," by Mr. A. Grant-Watson; "The Chemist and the ness," by Dr. P. H. Ross, Bacteriologist to the East African Protectorate; "The Oscillograph," by Mr. P. H. Powell; "Picture-galleries and Museums, their Lighting and Arrangement," by Mr. S. Hurst Seager, F.R.I.B.A.; "The Cost of Living, with Special Reference to the Gold-supply and the General Level of Prices," by Dr. J. Hight. In addition to these, twenty-three papers of more technical character have been submitted. These may be classified as follows: Chemistry, 3; geology, 8; physics, 1; mathematics, 1; zoology, 1; botany, 4; miscellaneous, 3.

Membership.—During the year twelve members have been elected and ten have either resigned or been struck off, so that the number on the roll of the Institute now stands at 185.

Balance-sheet.—The balance-sheet shows a credit on the Institute's ordinary account of £33 17s. 8d., and on the Tunnel Account of £140 6s. 11d. The sum of £100 has been paid off the account with the Government Printer for publishing the "Subantarctic Islands of New Zealand"; £58 19s. 7d. has been spent directly on the library; the cost of the jubilee celebration was £54 6s. 6d., which was more than met by donations from members.

Papers.—1. "Classification of Verse," by Johannes C. Andersen.

2. "New Zealand Bird-song," by Johannes C. Andersen.

3. "Notes on New Zealand Fishes: Pt. 3," by Edgar R. Waite.

4. "On Steiner's Envelope," by E. G. Hogg.

5. "New Species of Tertiary *Mollusca*," by Henry Suter.

6. "Action of Phosphorus on Copper Sulphate," by H. Rands; communicated by Dr. W. P. Evans.

7. "Chemistry of Flesh Foods: Pt. I," by A. M. Wright.

8. "New Plant-habitats (VIII)," by Dr. L. Cockayne.

9. "Redcliff Gully, Rakaia River," by R. Speight.

10. "On a Shingle-spit in Lake Coleridge," by R. Speight.

11. "Some Physiographical Features of the Lake Coleridge District," by R. Speight.

Election of Officers for 1913.—The following were elected officers: *President*—Dr. Charles Chilton; *Vice-Presidents*—Mr. S. Page, Mr. H. Suter; *Hon. Secretary*—Mr. A. M. Wright; *Hon. Treasurer*—Mr. R. Speight; *Hon. Librarian*—Mr. Edgar R. Waite; *Council*—Dr. C. Coleridge Farr, Dr. L. Cockayne, Mr. A. D. Dobson, Dr. F. W. Hilgendorf, Dr. W. P. Evans, Mr. R. M. Laing; *Hon. Auditor*—Mr. G. E. Way, F.I.A.N.Z.

OTAGO INSTITUTE.

FIRST MEETING: *14th May, 1912.*

The President, Dr. W. B. Benham, F.R.S., in the chair.

New Members.—Professor J. K. H. Inglis, M.A., D.Sc., and Messrs. G. H. Uttley, M.A., M.Sc., R. T. Stewart, and C. F. McDonald.

Papers.—1. "The Place-name Taitapu," by Mr. N. L. Buchanan.

A short paper protesting against the application of the name "Taitapu" to the inferior Takaka coalfield.

2. "How to combat the Grass-grub," by Mr. A. Bathgate.

The author advocated the introduction into New Zealand of the shrew and the toad, and the protection and further importation of the hedgehog.

3. "Volcanic Lavas of Otago North Head," by Dr. P. Marshall.

A summary of the results of the author's investigations into the chemical composition of the twenty-four distinct lava-flows found in the above locality.

SECOND MEETING: *4th June, 1912.*

The President, Dr. W. B. Benham, F.R.S., in the chair.

New Member.—Mr. E. P. W. Ford.

Address.—The President delivered his presidential address, entitled "Some London Museums."

The address was illustrated with a large number of lantern-slides, and dealt more particularly with the wonderfully complete historical and ethnographical collections of the Guildhall, and the Victoria and Albert Museum, and the Wallace Collection at Hertford House.

THIRD MEETING: *2nd July, 1912.*

The President, Dr. W. B. Benham, F.R.S., in the chair.

New Member.—Mr. P. J. Keligher.

Address.—"New Zealand Wild Flowers," by Mr. D. L. Poppelwell.

After some remarks on the magnitude and distribution of New Zealand flora, the lecturer proceeded to show a very large number of exceptionally fine slides illustrating the more beautiful and interesting native plants and flowers, and concluded with a strong appeal to the audience to use their influence for the preservation and protection of the native flora.

FOURTH MEETING: *6th August, 1912.*

The President, Dr. W. B. Benham, F.R.S., in the chair.

Exhibit.—Professor Park exhibited *Terebratula* fossils from near Akiteo, Hawke's Bay.

Papers.—1. "A New Species of *Macquartia*," by Mr. D. Miller.

2. "Pronunciation in Shakepeare's Time," by Mr. G. E. Thompson, M.A.

3. "Glacial Erosion in New Zealand," by Dr. P. Marshall.

A short *résumé* of observations made in the Hooker Valley and elsewhere.

FIFTH MEETING: *3rd September, 1912.*

The President, Dr. W. B. Benham, F.R.S., in the chair.

New Members.—Messrs. R. Richards and E. McEnnis.

Address.—"A Visit to Crete," by Dr. D. Colquhoun.

This address was given before a very large audience in Stuart Hall. In the first part of the lecture Dr. Colquhoun outlined the modern archaeological researches that have established the claim of Crete to be regarded as the cradle of modern European civilization and culture; the second portion consisted of comments on a large number of excellent slides showing the remains of ancient palaces and houses, pottery, frescoes, &c.

SIXTH MEETING: *1st October, 1912.*

The President, Dr. W. B. Benham, F.R.S., in the chair.

New Members.—Mr. James Black.

Exhibit.—Dr. Benham exhibited the skull of an extinct whale embedded in a block of sandstone from Milburn.

Papers.—1. "Some Contributions to South Island History (Maori)," by Mr. R. Buddle.

Containing much interesting information as to place-names in the southern parts of Otago and Southland. This paper will be published in the "Journal of the Polynesian Society."

2. "Simplified Spelling," by Miss Alice Woodhouse.

3. "Notes on the Larvae of Two New Zealand Moths," by Mr. G. W. Howes, F.E.S.

4. "New *Lepidoptera*," by Mr. G. W. Howes, F.E.S.

5. "Notes on the Entomology of Stewart Island," by Mr. G. W. Howes, F.E.S.

6. "*Rotifera* not previously recorded in New Zealand," by Mr. C. B. Morris, F.R.M.S.; communicated by Mr. Howes.

7. "Protective Colours and Devices of New Zealand *Diptera*," by Mr. D. Miller.

8. "Descriptions of New Species of *Lepidoptera*," by Mr. A. Philpott; communicated by Dr. Benham.

Seventh Meeting: *14th November, 1912.*

The President, Dr. W. B. Benham, F.R.S., in the chair.

New Members.—Rev. A. M. Dalrymple, M.A., Miss G. F. Gibson, M.A., and Mr. Robert McLintock.

Address.—"The Natural History of Otago Harbour," by Mr. G. M. Thomson, F.L.S., M.P.

The address described in some detail the characteristics and life-habits of most of the better known fishes and *Crustacea* met with in the harbour or just outside the Heads.

Eighth Meeting: *3rd December, 1912.*

Mr. A. Bathgate, Vice-President, in the chair.

New Member.—Mr. W. J. Whyte.

Papers.—1. "New Species of New Zealand *Diptera*," by Mr. D. Miller.

2. "Notes on a Botanical Excursion to the Northern Portion of the Eyre Mountains," by Mr. D. L. Poppelwell.

3. "Notes on the Botany of the Ruggedy Mountains, Stewart Island," by Mr. D. L. Poppelwell.

4. "Some Localities for Tertiary Fossils near Oamaru," by Dr. P. Marshall.

The annual report and the balance-sheet for 1912 were read and adopted.

Abstract.

The Council has co-operated with the Wellington Philosophical Society in urging the Government to acquire the small area of Native land around the Ketetahi Hot Springs, and so include the springs in the surrounding Tongariro National Park, and also to enlarge the boundaries of the park in the manner recommended in the report drawn up some time ago by Dr. Cockayne and Mr. Phillips Turner.

Meetings.—Eight meetings of the Institute have been held during the session, at which there have been read or received fifteen papers embodying the results of original work. These may be classified as follows: Entomology and natural history, 9; geology, 3; botany, 2; New Zealand history, 1.

The following addresses were delivered: "Some London Museums" (presidential address), by Dr. W. B. Benham, F.R.S.: "New Zealand Wild Flowers," by Mr. D. L. Poppelwell; "Pronunciation in Shakespeare's Time," by Mr. G. E. Thompson, M.A.; "A Visit to Crete," by Dr. D. Colquhoun; "The Natural History of Otago Harbour," by Mr. G. M. Thomson, M.P.; "How to combat the Grass-grub," by Mr. A. Bathgate; "Simplified Spelling," by Miss Alice Woodhouse.

Technological Branch.—The Technological Branch has well maintained the excellent standard it set for itself in the first year of its existence. At the seven ordinary meetings attendances averaged thirty-nine.

The following papers were read during the session: "Factors in the Selling-price of Electricity," Mr. E. E. Stark; "X-rays and Radium," Dr. P. D. Cameron; "Dunedin-Mosgiel Duplication-works," Mr. W. R. Davidson; "The Problem of Interference in Wireless Telegraphy," Mr. E. E. Stark; "Reasons in Architecture," Mr. B. B. Hooper; "A Steam Turbine," Mr. J. Lythgoe; "Flight and Gravitation," Mr. F. W. Payne; "Steam-engines, Ancient and Modern," Mr. R. McLintock; "Reinforced Concrete," Mr. C. Fleming McDonald.

In addition, many members took advantage of a Saturday afternoon excursion to inspect the engineering operations at the Chain Hill Tunnel works.

Astronomical Branch.—The annual meeting of this branch was held on the 16th May, when the following office-bearers were elected: *Chairman*—Mr. R. Gilkison; *Secretary*—Mr. A. Megget; *Committee*—Revs. P. W. Fairclough and D. Dutton, Dr. P. D. Cameron, Professor J. Park, and Messrs. W. S. Wilson, J. W. Milnes, and F. W. Payne.

The branch has pushed on with the erection of a telescope-house on Tanna Hill, the Otago University having kindly granted the site. Solid cement foundations were put in, and a revolving house has been erected on the same. The Beverley telescope (3 in. refractor) and the Skey (9 in.) reflecting-telescope are now erected there. Steps are being taken to procure and erect an astronomical clock and transit instrument. The opening address after the completion of the telescope-house was delivered at the University by the Rev. T. Roseby, LL.D., F.R.A.S.

Membership.—During the year fifteen new members have been elected, whilst sixteen members have resigned or have been struck off, and one member (Mr. W. J. Scoullar) has been removed by death. The membership roll now stands at 254.

Library.—Thanks are due to Mr. Skinner for rearranging the books during last summer, and for making a card catalogue of the contents of the library. The number of volumes has been largely increased by purchase, in addition to the usual periodicals to which the Institute subscribes.

The Institute has also received one book by presentation (Mr Jeffery)—viz., Hansen and Sorensen's "Arachnida Opiliones," a technical work. There are several technical works on *Diptera* on order. The Government has presented the usual reports of the various Departments. A large number of periodicals and other works were bound during the summer.

Balance-sheet.—The balance-sheet, presented by the Treasurer (Mr. W. Fels), showed a credit of £56 17s. 4d. The receipts totalled £760, including subscriptions amounting to £243, deposits at call amounting to £440.

Election of Officers for 1913.—*President*—Professor J. Malcolm, M.D.; *Vice-Presidents*—Professor W. B. Benham, D.Sc., F.R.S., and Mr. F. W. Payne; *Council*—Professors P. Marshall, D.Sc., F.G.S., and James Park, F.G.S., Dr. R. V. Fulton, Messrs. H. Brasch, R. Gilkison, G. E. Thompson, M.A., and G. M. Thomson, M.P.; *Hon. Secretary*—Mr. E. J. Parr, M.A., B.Sc.; *Hon. Treasurer*—Mr. R. N. Vanes, A.R.I.B.A.

TECHNOLOGICAL BRANCH.

First Meeting: *21st May, 1912.*

Mr. F. W. Payne, Vice-Chairman, in the chair.

Address.—"Factors in the Selling-price of Electricity," by Mr. E. E. Stark.

The lecture dealt with the subject of selling-prices for a municipal enterprise.

Second Meeting: *18th June, 1912.*

Mr. E. E. Stark, Chairman, in the chair.

Address.—"X-rays and Radium," by Dr. P. D. Cameron.

Third Meeting: *16th July, 1912.*

Mr. E. E. Stark in the chair.

Address.—"The Dunedin–Mosgiel Duplication-works," by Mr. W. R. Davidson, A.M.Inst.C.E.

Attention was paid more particularly to the technical aspect of the undertaking. The lecture was well illustrated by slides.

Fourth Meeting: *20th August, 1912.*

Mr. E. E. Stark in the chair.

Paper.—"The Problem of Interference in Wireless Telegraphy," by Mr. E. E. Stark.

Fifth Meeting: *17th September, 1912.*

Mr. E. E. Stark in the chair.

Papers.—1. "Reasons in Architecture," by Mr. B. B. Hooper, A.R.I.B.A.

2. "The Steam Turbine," by Mr. Joseph Lythgoe.

3. "Flight and Gravitation," by Mr. F. W. Payne.

Sixth Meeting: *15th October, 1912.*

Mr. E. E. Stark in the chair.

Address.—"The History of the Steam-engine," by Mr. R. McLintock.

Seventh Meeting: *19th November, 1912*

Mr. E. E. Stark in the chair.

Paper.—"Reinforced Concrete," by Mr. C. Fleming McDonald.

An interesting paper, giving the history of concrete and of reinforced concrete as building-materials, and going very fully into the wonderful qualities and possibilities of the latter variety. At the close of the lecture a large number of views were exhibited showing in an admirable manner the adaptability of ferro-concrete to various forms of construction, and its stability and endurance in the case of fire and earthquake.

ASTRONOMICAL BRANCH.

First Meeting: *29th October, 1912.*

Mr. R. Gilkison in the chair.

Address.—"Astronomy: its Utility, Achievements, and Problems," by Rev. T. Roseby, LL.D., F.R.A.S.

HAWKE'S BAY PHILOSOPHICAL INSTITUTE.

FIRST MEETING: *31st May, 1912.*

Present: Dr. Moore, President, in the chair, and thirty-eight others.

Presidential Address.—"The Problem of Shakespeare."

New Members.—William Oates, J.P., E. J. Humphreys, Harry Bull, P. Loftus Poole, D. Whyte, and C. D. Kennedy.

SECOND MEETING: *5th July, 1912.*

Present: Mr. J. Wilson Craig, in the chair, and twenty-seven others.

New Member.—E. G. Matthews, Gisborne.

Papers.—1. "The *Mollusca* of Taupo and its Environment," by H. Hill, jun.

2. "Taupo Trout," by the Rev. T. Fletcher.

A sub-committee was set up to consider the trout-smoking industry.

3. "The Distribution of the Moa along the East Coast: an Outline," by H. Hill, B.A., F.G.S.

THIRD MEETING: *29th July, 1912.*

Present: Mr. J. Wilson Craig, in the chair, and a number of others.

Report of Taupo Trout Sub-committee.—Mr. Patterson reported his representations to the Government, and the reply.

Papers.—1. "Soil-temperatures in Napier South," by E. G. Loten.

2. "Characteristics of Fungi," by E. G. Loten.

Moa Find.—Mr. Hill reported that a moa-bone had been found in a Napier limestone-quarry.

FOURTH MEETING: *28th August, 1912.*

Present: Dr. T. C. Moore, President, in the chair, and forty-nine others.

Paper.—"Old Hawke's Bay," by W. Dinwiddie.

Illustrated by lantern-slides.

Fifth Meeting: *28th September, 1912.*

Present: Mr. W. Kerr, M.A., Vice-President, in the chair, and a number of others.

Microscope-slides. — The evening was spent in viewing microscope-slides of many different objects.

Sixth Meeting: *28th October, 1912.*

Lapsed for want of a quorum.

Seventh Meeting: *29th November, 1912.*

Present: Mr. H. Hill, B.A., F.G.S., in the chair, and fifty-one others.

Papers.—1. "Liquid Air: its Preparation and Commercial Applications," by J. H. Edmundson.

Illustrated by experiments with liquid air.

2. "The Maori Dog and the Shepherd's Cur," by Taylor White.

New Members.—C. E. Armstrong, G. M. Piper, — Henderson, J.P.

Annual Meeting: *13th December, 1912.*

Present: Mr. W. Kerr, Vice-President, in the chair, and a number of others.

Annual Report.—The annual report was adopted.

Abstract.

Six general meetings and eight Council meetings were held during the year, the attendance ranging from fifty downwards.

Ten new members were elected; the membership now stands at eighty-two.

Twenty-three additions were made to the library.

The balance-sheet shows a credit balance of £27 18s. 6d.

Election of Officers.—*President*—W. Kerr, M.A.; *Vice-President*—W. Dinwiddie; *Hon. Secretary*—J. Niven, M.A., M.Sc.; *Hon. Treasurer*—J. Wilson Craig; *Council*—G. Clark, T. C. Moore, M.D., W. Fossey, T. Hyde, G. K. Sinclair, and H. Hill, B.A., F.G.S.; *Hon. Auditor*—J. S. Large; *Hon. Lanternist*—E. G. Loten.

MANAWATU PHILOSOPHICAL SOCIETY.

First Meeting: *15th February, 1912.*

Mr. R. Gardner, President, in the chair.

Notes.—Mr. R. McNab gave some very interesting notes on two recent discoveries in the South Island.

Lecture.—Mr. H. H. Wilson, of Singapore, gave a short lecture on submarine telegraphy, describing in some detail the laying of a cable, the different types of cable employed, and the different systems of working.

The lecture was illustrated by samples of cable belonging to the Museum and by specimens supplied by Mr. Watson, showing the alphabet used and the effect produced by earth-currents.

Second Meeting: *21st March, 1912.*

Mr. R. Gardner, President, in the chair.

Lecture.—Mr. J. T. Ward, of Wanganui, gave a lecture on "The Worlds of Space as seen by the Astronomical Telescope."

Third Meeting: *17th April, 1912.*

Mr. R. Gardner, President, in the chair.

Paper.—"The Changes which have taken place in the more Recent Geological Periods in New Zealand, especially in the North Island," by M. A. Eliot.

The author pointed out the evidences of these changes still to be seen in the physical configuration of the country and in the unusually wide range of its flora.

The Secretary announced that the Council had decided, for the benefit of country visitors, to open the Museum on Thursdays as well as on Wednesdays and Saturdays.

The Secretary also reported that since the last meeting Mr. T. W. Kirk, F.L.S., had paid a special visit to Palmerston to set up his own most valuable private collection of native and imported grasses and weeds, which he had generously lent to the Council, in the hope, as he had said, that the Council might be able gradually to develop the Museum, so that it might become of educational value to the whole Dominion in every department of agriculture.

Numerous recent additions to the Museum were displayed on the table.

FOURTH MEETING: *16th May, 1912.*

The President, Mr. R. Gardner, in the chair.

Paper.—A paper by Messrs. Park and Black, the Curator of the public reserves, was read, describing a visit paid in March to Ruapehu and the Tongariro National Park, and quoting from Dr. Cockayne's report particulars of the local fauna and flora.

Specimens of the latter were exhibited, collected and mounted by Mr. Roe, a member of the party, and the paper was illustrated by about thirty-five lantern-slides.

In the course of the paper reference was made to the utterly inadequate accommodation provided for tourists, and a suggestion was made that the Society should make application to the Government for the immediate enlargement of the accommodation.

FIFTH MEETING: *25th July, 1912.*

The President, Mr. R. Gardner, in the chair.

Exhibits.—The admirable collection of New Zealand and Australian wools recently presented to the Museum by Messrs. Mellsop, Eliott, and Co., and prepared by their London agents, Messrs. Gilbert Anderson and Co., was on view, as well as the collection of local ferns which had gained the prize offered by the Council at the recent winter show.

Papers.—1. "Notes on a Moth-eating Spider," by W. W. Smith, F.E.S.

2. "Notes on the Wool Exhibit," by M. A. Eliott.

3. "Description of the Collection of Ferns," by A. G. Roe, the collector.

ANNUAL MEETING: *27th November, 1912.*

The President, Mr. R. Gardner, in the chair, and about fifteen members were present.

Paper.—The President read a paper giving a summary of the chief events in the world during the past year, with brief comments thereon.

Election of Officers for 1913.—*President*—Mr. R. McNab, M.A., LL.B., F.R.G.S.; *Vice-Presidents*—Messrs. R. Gardner and F. Foote, B.Sc.; *Officer in Charge of the Observatory*—Captain Hewitt, R.N.; *Secretary and Treasurer*—Mr. K. Wilson, M.A.; *Council*—Messrs. E. J. Armstrong, C.E., J. L. Barnicoat, G. de S. Baylis, W. E. Bendall, M. A. Eliott, and W. Park; *Auditor*—Mr. J. Mitchell.

Resolution.—The following resolution was carried: "That the Council of the Society represent to the Minister of Lands the pressing need of improved accommodation for tourists at Ruapehu, and that the Borough Council and the Council of the Chamber of Commerce be invited to join in the representation."

WANGANUI PHILOSOPHICAL SOCIETY.

The Society was founded at a meeting held on Thursday, the 24th August, 1911, in the Museum Hall, Wanganui. Addresses were delivered by Dr. Hatherly, who presided; Mr. A. Hamilton, Dominion Museum, Wellington; Rev. J. L. Dove, M.A.; Mr. Louis Cohen, LL.B.; Mr. C. E. Mackay, Mayor of Wanganui; and others. Sixty-four of those who attended the meeting indicated their intention to become members or associates of the newly formed Society.

The Society was incorporated with the New Zealand Institute on the 2nd December, 1911.

Officers. — *President* — Dr. Hatherly, M.R.C.S.; *Vice-Presidents* — Rev. J. Ll. Dove, M.A., Mr. J. T. Ward; *Council*—Messrs. T. Allison, G. D. Braik, M.A., Louis Cohen, M.A., T. W. Downes, H. W. Hesse, B.A., B.Sc., F.L.S., R. Murdoch, H. B. Watson, M.A., James Watt, LL.B.; *Hon. Treasurer*—Mr. F. P. Talboys; *Hon. Secretary*—Mr. J. P. Williamson.

First Meeting: *26th September, 1911.*

Dr. H. R. Hatherly, President, in the chair.

Lecture.—"The Original Discovery of New Zealand in the Ninth–Tenth Century," by Mr. S. Percy Smith, F.R.G.S.

Second Meeting: *2nd October, 1911.*

Dr. H. R. Hatherly, President, in the chair.

Rules.—Rules and by-laws for the Society were adopted.

Third Meeting: *16th October, 1911.*

Mr. J. T. Ward, Vice-President, in the chair.

Papers on "The Character of Macbeth" were contributed by Mr. G. D. Braik, M.A., Mr. J. H. Keesing, and Dr. Hatherly; and a paper on "Prehistoric Man: Recent European Discoveries," by Mr. H. W. Hesse, B.A., B.Sc.

Mr. H. B. Watson exhibited some specimens of Japanese ceramic art; Mr. S. G. Harper, old books, newspapers, and illuminated manuscripts; and Mr. H. W. Hesse, native fibres from Fiji.

Fourth Meeting : *13th November, 1911.*

Dr. H. R. Hatherly, President, in the chair.

Lecture.—"The Worlds of Space as revealed by the Astronomical Telescope," by Mr. J. T. Ward, Honorary Director, Wanganui Observatory.

The lecture was illustrated by numerous lantern-slides.

Fifth Meeting : *20th November, 1911.*

Rev. J. L. Dove, Vice-President, in the Chair.

Lecture.—"University Reform," by T. H. Laby, B.A., Professor of Physics, Victoria College.

Sixth Meeting : *11th December, 1911.*

Dr. H. R. Hatherly, President, in the chair.

Lecture.—"Some Aspects of Music," by Mr. F. Leslie Peck, Wanganui Collegiate School.

Mr. Peck classified his remarks under the headings, "Melody," "Rhythm," and "Education in Music." The lecturer traced the origin and evolution of melody from the earliest times to the present day, and showed by examples the affinity between melody and rhythm.

Exhibit.—Mr. H. S. G. Harper exhibited his fine numismatical collection.

Seventh Meeting : *15th December, 1911.*

Dr. H. R. Hatherly, President, in the chair.

Lecture.—Sir Robert Stout, K.C.M.G., Chief Justice, lectured on "What is Culture, and how may we best obtain it?"

The large attendance included, by invitation, a number of the general public.

Eighth Meeting : *15th April, 1912.*

Mr. J. T. Ward, Vice-President, in the chair.

Lecture.—"Some Aspects of Insanity," by Dr. Hatherly.

Ninth Meeting : *13th May, 1912.*

Dr. H. R. Hatherly, President, in the chair.

Lecture.—"Life of the Ngati Kahu-ngunu Chief Nuku Pewapewa," by Mr. T. W. Downes.

Exhibit.—Members were invited to inspect some Indian curios deposited by Mr. McLachlan, the most interesting of which was a metal panel from the original Juggernaut car.

The origin and history of the car were explained by Mr. Hesse, Curator of the Museum.

TENTH MEETING: *30th May, 1912.*

Dr. H. R. Hatherly, President, in the chair.

Lecture.—"Old-time Memories of Cook Strait," by Hon. Robert McNab.

ELEVENTH MEETING: *10th June, 1912.*

Rev. J. L. Dove, M.A., Vice-President, in the chair.

Lecture.—"Industrial Conditions and Social Progress," by H. E. Sturge, M.A.

TWELFTH MEETING: *8th July, 1912.*

Rev. J. L. Dove, M.A., Vice-President, in the chair.

Lectures.—1. "Education in Japan," by Mr. H. B. Watson, M.A.

In his paper the lecturer embodied his observations during a three months' stay, when the authorities gave him every opportunity of investigating all classes of schools and educational institutions.

2. Lecture, illustrated with lantern-slides, "Ruapehu," by Mr. Thomas Allison.

The lecturer recounted the Maori legend of the first ascent of Ruapehu by Nga-toro-ai-rangi, an ancestor of the Maoris at Poutou. He climbed the mountain, but suffered anguish from the cold, and his cries for help were heard by his sisters at their home on an island in Poverty Bay. They set off with torches of sacred fire to his assistance, and the falling sparks started numerous volcanoes and *puias* on their route. The historicity of this ascent is vouched by the fact that their footprints where they crossed the Poutou River were pointed out by an old Native to Mr. Batley about 1882!

In November, 1877, the lecturer, with his brother, Mr. John Allison, climbed the northern peak of Ruapehu. On this trip they found an English artist named Connolly stranded at Tokaanu. His Maori guides, explaining that the mountain was *tapu*, robbed him of his horses, sketches, and camera. In December, 1877, the lecturer and his brother, Mr. John Allison, ascended Ruapehu *via* the north-eastern spur. The ascent of Messrs. Beetham and Maxwell next year was rendered interesting by their discovery of the crater-lake.

The lecturer described the valley of Stony Creek, or perhaps Waihi-anoa, on the eastern side of Ruapehu, which is probably the finest valley or gorge in the North Island. It runs back three or four miles into the heart of the mountain. Half-way up the valley is very narrow, with a torrent flowing between cliffs about 900 ft. high of black shattered rock. Farther up the valley is a small hill of columnar basaltic or andesite rock. Near the source of the torrent the rocks are very fantastically shaped. The cliffs are at least 2,000 ft. high, while the southern peak, the finest peak of the mountain, rises to a height of between 4,000 ft. and 5,000 ft. above the floor of the valley. This splendid valley is easily accessible from Waiouru, and a tourist route to it, which would also give access to the Wangaehu Gorge, could easily be made.

Officers for 1912–13.—*President*—Dr. Hatherly, M.R.C.S.; *Vice-Presidents*—Rev. J. Ll. Dove, M.A., Mr. J. T. Ward; *Council*—Messrs. T. Allison, W. A. Armour, M.A., M.Sc., C. P. Brown, M.A., LL.B., T. W. Downes, R. Murdoch, H. E. Sturge, M.A., H. B. Watson, M.A., and H. W. Hesse, B.A., B.Sc., F.L.S.; *Hon. Treasurer*—Mr. F. P. Talboys; *Hon. Secretary*—Mr. J. P. Williamson.

APPENDIX.

NEW ZEALAND INSTITUTE ACTS.

NEW ZEALAND INSTITUTE ACT, 1903.

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 his 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.

NEW ZEALAND INSTITUTE ACT, 1908.

1908, No. 130.

An Act to consolidate certain Enactments of the General Assembly relating to the New Zealand Institute.

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

1. (1.) The Short Title of this Act is the New Zealand Institute Act, 1908.

(2.) This Act is a consolidation of the enactments mentioned in the Schedule hereto, and with respect to those enactments the following provisions shall apply:—

(*a.*) The Institute and Board respectively constituted under those enactments, and subsisting on the coming into operation of this Act, shall be deemed to be the same Institute and Board respectively constituted under this Act without any change of constitution or corporate entity or otherwise; and the members thereof in office on the coming into operation of this Act shall continue in office until their successors under this Act come into office.

(*b.*) All Orders in Council, regulations, appointments, societies incorporated with the Institute, and generally all acts of authority which originated under the said enactments or any enactment thereby repealed, and are subsisting or in force on the coming into operation of this Act, shall enure for the purposes of this Act as fully and effectually as if they had originated under the corresponding provisions of this Act, and accordingly shall, where necessary, be deemed to have so originated.

(*c.*) All property vested in the Board constituted as aforesaid shall be deemed to be vested in the Board established and recognized by this Act.

(*d.*) All matters and proceedings commenced under the said enactments, and pending or in progress on the coming into operation of this Act, may be continued, completed, and enforced under this Act.

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* See *New Zealand Gazette*, 1st September, 1904.

2. (1.) The body now 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 heretofore have been or may hereafter be incorporated therewith in accordance with regulations heretofore made or hereafter to be made by the Board of Governors.

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

3. The control and management of the Institute shall be vested in a Board of Governors (hereinafter referred to as "the Board"), constituted as follows:—

The Governor:

The Minister of Internal Affairs:

Four members to be appointed by the Governor in Council, of whom two shall be appointed during the month of December in every 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; and the next year in which such an appointment shall be made is the year one thousand nine hundred and nine:

One member to be appointed by each of the other incorporated societies during the month of December in each alternate year; and the next year in which such an appointment shall be made is the year one thousand nine hundred and nine.

4. (1.) Of the members appointed by the Governor in Council, the two members longest in office without reappointment shall retire annually on the appointment of their successors.

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

5. The Board shall be a body corporate by the name of the "New Zealand Institute," and by that name 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.

6. (1.) The Board 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.) The Board 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.) The Board shall have power from time to time to make regulations under which societies may become incorporated with 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 from time to time vested in it or acquired by it; and shall make regulations for the management of the same, and 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.

7. (1.) Any casual vacancy in the Board, 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.

(2.) Any person appointed to fill a casual vacancy shall only hold office for such period as his predecessor would have held office under this Act.

8. (1.) Annual meetings of the Board shall be held in 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 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.

9. The Board 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 New Zealand by any means that may appear desirable.

10. The Minister of Finance shall from time to time, without further appropriation than this Act, pay to the Board the sum of five hundred pounds in each financial year, to be applied in or towards payment of the general current expenses of the Institute.

11. Forthwith upon the making of any regulations or the publication of any Transactions, the Board shall transmit a copy thereof to the Minister of Internal Affairs, who shall lay the same before Parliament if sitting, or if not, then within twenty days after the commencement of the next ensuing session thereof.

Schedule.

Enactments consolidated.

1903, No. 48.—The New Zealand Institute Act, 1903.

REGULATIONS.

The following are the 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

* *New Zealand Gazette*, 14th July, 1904.

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.

Publications.

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 :—

(*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, type-written, 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.

Management of the Property of the Institute.

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. 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.

8. 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.

9. 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.

10. 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.

General Regulations.

11. Subject to the New Zealand Institute Act, 1908, 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.

12. 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.

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

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.

THE HUTTON MEMORIAL MEDAL AND RESEARCH FUND.

Resolved by the Board of Governors of the New Zealand Institute that—

1. The funds placed in the hands of the Board by the committee of subscribers to the Hutton Memorial Fund be called "The Hutton Memorial Research Fund," in memory of the late Captain Frederick Wollaston Hutton, F.R.S. Such fund shall consist of the moneys subscribed and granted for the purpose of the Hutton Memorial, and all other funds which may be given or granted for the same purpose.

2. The funds shall be vested in the Institute. The Board of Governors of the Institute shall have the control of the said moneys, and may invest the same upon any securities proper for trust-moneys.

3. A sum not exceeding £100 shall be expended in procuring a bronze medal to be known as "The Hutton Memorial Medal."

4. The fund, or such part thereof as shall not be used as aforesaid, shall be invested in such securities as aforesaid as may be approved of by the Board of Governors, and the interest arising from such investment shall be used for the furtherance of the objects of the fund.

5. The Hutton Memorial Medal shall be awarded from time to time by the Board of Governors, in accordance with these regulations, to persons who have made some noticeable contribution in connection with the zoology, botany, or geology of New Zealand.

6. The Board shall make regulations setting out the manner in which the funds shall be administered. Such regulations shall conform to the terms of the trust.

7. The Board of Governors may, in the manner prescribed in the regulations, make grants from time to time from the accrued interest to persons or committees who require assistance in prosecuting researches in the zoology, botany, or geology of New Zealand.

8. There shall be published annually in the "Transactions of the New Zealand Institute" the regulations adopted by the Board as aforesaid, a list of the recipients of the Hutton Memorial Medal, a list of the persons to whom grants have been made during the previous year, and also, where possible, an abstract of researches made by them.

Regulations under which the Hutton Memorial Medal shall be awarded and the Research Fund administered.

1. Unless in exceptional circumstances, the Hutton Memorial Medal shall be awarded not oftener than once in every three years; and in no case shall any medal be awarded unless, in the opinion of the Board, some contribution really deserving of the honour has been made.

2. The medal shall not be awarded for any research published previous to the 31st December, 1906.

3. The research for which the medal is awarded must have a distinct bearing on New Zealand zoology, botany, or geology.

4. The medal shall be awarded only to those who have received the greater part of their education in New Zealand or who have resided in New Zealand for not less than ten years.

5. Whenever possible, the medal shall be presented in some public manner.

6. The Board of Governors may, at an annual meeting, make grants from the accrued interest of the fund to any person, society, or committee for the encouragement of research in New Zealand zoology, botany, or geology.

7. Applications for such grants shall be made to the Board before the 30th September.

8. In making such grants the Board of Governors shall give preference to such persons as are defined in regulation 4.

9. The recipients of such grants shall report to the Board before the 31st December in the year following, showing in a general way how the grant has been expended and what progress has been made with the research.

10. The results of researches aided by grants from the fund shall, where possible, be published in New Zealand.

11. The Board of Governors may from time to time amend or alter the regulations, such amendments or alterations being in all cases in conformity with resolutions 1 to 4.

Award of the Hutton Memorial Medal.

1911. Professor W. B. Benham, D.Sc., F.R.S., University of Otago—For researches in New Zealand zoology.

Grant from the Hutton Memorial Research Fund.

1911. To Professor C. Chilton, Canterbury College — £10 for the preparation of illustrations for a revision of the *Crustacea* of New Zealand.

HECTOR MEMORIAL RESEARCH FUND.

Declaration of Trust.

This deed, made the twenty-seventh day of January, one thousand nine hundred and twelve, between the New Zealand Institute, a body corporate duly incorporated by the New Zealand Institute Act, 1908, of the one part, and the Public Trustee, of the other part: Whereas the New Zealand Institute is possessed of a fund consisting now of the sum of one thousand and forty-five pounds ten shillings and twopence (£1,045 10s. 2d.), held for the purpose of the Hector Memorial Research Fund on the terms of the rules and regulations made by the Governors of the said Institute hereinafter set forth: And whereas the said money has been transferred to the Public Trustee for the purposes of investment, and the Public Trustee now holds the same for such purposes, and it is expedient to declare the trusts upon which the same is held by the Public Trustee:

Now this deed witnesseth that the Public Trustee shall hold the said moneys, and all other moneys which shall be handed to him by the said Governors, for the same purposes upon trust from time to time, to invest the same in the common fund of the Public Trust Office, and to hold the principal and income thereof for the purposes set out in the said rules hereinafter set forth.

And it is hereby declared that it shall be lawful for the Public Trustee to pay, and he shall pay, all or any of the said moneys, both principal and interest, to the Treasurer of the said New Zealand Institute upon being directed so to do by a resolution of the Governors of the said Institute, and a letter signed by the Secretary of the said Institute, enclosing a copy of such resolution, certified by him and by the President as correct, shall be sufficient evidence to the Public Trustee of the due passing of such resolution: And upon receipt of such letter and copy, the receipt of the Treasurer for the time being of the said Institute shall be a sufficient discharge to the Public Trustee: And in no case shall the Public Trustee be concerned to inquire into the administration of the said moneys by the Governors of the said Institute.

As witness the seals of the said parties hereto, the day and year first hereinbefore written.

Rules and Regulations made by the Governors of the New Zealand Institute in relation to the Hector Memorial Research Fund.

1. The funds placed in the hands of the Board by the Wellington Hector Memorial Committee be called "The Hector Memorial Research Fund," in memory of the late Sir James Hector, K.C.M.G., F.R.S. Such fund shall consist of the moneys subscribed and granted for the purpose of the memorial, and all other funds which may be given or granted for the same purpose.

2. The funds shall be vested in the Institute. The Board of Governors of the Institute shall have the control of the said moneys, and may invest the same upon any securities proper for trust-moneys.

3. A sum not exceeding one hundred pounds (£100) shall be expended in procuring a bronze medal, to be known as the Hector Memorial Medal.

4. The fund, or such part thereof as shall not be used as aforesaid, shall be invested in such securities as may be approved by the Board of Governors, and the interest arising from such investment shall be used for the furtherance of the objects of the fund.

5. The Hector Memorial Medal and Prize shall be awarded annually by the Board of Governors.

6. The research for which the medal and prize are awarded must have a distinct bearing on New Zealand—(1) Botany, (2) chemistry, (3) ethnology, (4) geology, (5) physics (including mathematics and astronomy), (6) zoology (including animal physiology).

7. Whenever possible the medal shall be presented in some public manner.

Award of the Hector Memorial Research Fund.

1912. L. Cockayne, Ph.D.—For researches in New Zealand botany.
1913. T. H. Easterfield, Ph.D.—For researches in chemistry.

NEW ZEALAND INSTITUTE.

ESTABLISHED UNDER AN ACT OF THE GENERAL ASSEMBLY OF NEW ZEALAND INTITULED THE NEW ZEALAND INSTITUTE ACT, 1867; RECONSTITUTED BY AN ACT OF THE GENERAL ASSEMBLY OF NEW ZEALAND UNDER THE NEW ZEALAND INSTITUTE ACT, 1903, AND CONTINUED BY THE NEW ZEALAND INSTITUTE ACT, 1908.

Board of Governors.

EX OFFICIO.

His Excellency the Governor.
The Hon. the Minister of Internal Affairs.

NOMINATED BY THE GOVERNMENT.

A. Hamilton (December, 1911); A. H. Turnbull (December, 1912); John Young (December, 1911); Charles A. Ewen (December, 1912).

ELECTED BY AFFILIATED SOCIETIES (DECEMBER, 1911).

Wellington Philosophical Society ...	Martin Chapman, K.C. Professor H. B. Kirk, M.A.
Auckland Institute	D. Petrie, M.A., Ph.D. J. Stewart, C.E.
Philosophical Institute of Canterbury ...	C. Coleridge Farr, D.Sc. R. Speight, M.A., M.Sc., F.G.S.
Otago Institute	Professor Marshall, D.Sc., F.G.S. G. M. Thomson, M.P., F.C.S.
Hawke's Bay Philosophical Institute ...	H. Hill, B.A., F.G.S.
Nelson Institute	L. Cockayne, Ph.D., F.L.S., F.R.S.
Manawatu Philosophical Society ...	K. Wilson, M.A.
Wanganui Philosophical Society ..	W. Hesse, B.A.

OFFICERS FOR THE YEAR 1913.

President: C. Chilton, D.Sc., M.A., M.B., LL.D., F.L.S.

Hon. Treasurer: C. A. Ewen.

Hon. Editors: R. Speight, M.A., M.Sc., F.G.S.
C. Chilton, D.Sc., M.A., M.B., LL.D., F.L.S.

Secretary: B. C. Aston, F.I.C., F.C.S.
(Box 40. Post-office, Wellington.)

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	6th January, 1905.
Wanganui Philosophical Society	2nd December, 1911.

FORMER HONORARY MEMBERS.

1870.

Agassiz, Professor Louis.
Drury, Captain Byron, R.N.
Flower, Professor W. H., F.R.S.
Hochstetter, Dr. Ferdinand von.
Hooker, Sir J. D., G.C.S.I., C.B., M.D., F.R.S., O.M.
Mueller, Ferdinand von, M.D., F.R.S., C.M.G.
Owen, Professor Richard, F.R.S.
Richards, Rear-Admiral G. H.

1871.

Darwin, Charles, M.A., F.R.S.
Gray, J. E., Ph.D., F.R.S.
Lindsay, W. Lauder, M.D., F.R.S.E.

1872.

Grey, Sir George, K.C.B.
Huxley, Thomas H., LL.D., F.R.S.
Stokes, Vice-Admiral J. L.

1873.

Bowen, Sir George Ferguson, G.C.M.G.
Lyell, Sir Charles, Bart., D.C.L., F.R.S.

1874.

McLachlan, Robert, F.L.S.
Newton, Alfred, F.R.S.
Thomson, Professor Wyville, F.R.S.

1875.

Filhol, Dr. H.
Rolleston, Professor G., M.D., F.R.S.

1876.

Clarke, Rev. W. B., M.A., F.R.S.
Etheridge, Professor R., F.R.S.

1877.

Baird, Professor Spencer F.
Weld, Frederick A., C.M.G.

1878.

Garrod, Professor A. H., F.R.S.
Müller, Professor Max, F.R.S.
Tenison-Woods, Rev. J. E., F.L.S.

1880.

The Most Noble the Marquis of Normanby, G.C.M.G.

1883.

Carpenter, Dr. W. B., C.B., F.R.S.
Ellery, Robert L. J., F.R.S.
Thomson, Sir William F.R.S.

1885.

Gray, Professor Asa.
Sharp, Richard Bowdler, M.A., F.R.S.

1888.

Beneden, Professor J. P. van.
Ettingshausen, Baron von.
McCoy, Professor F., D.Sc., C.M.G. F.R.S.

1890.

Riley, Professor C. V.

1891.

Davis, J. W., F.G.S., F.L.S.

1895.

Mitten, William, F.R.S.

1896.

Langley, S. P.

1900.

Agardh, Dr. J. G.

1901.

Eve, H. W., M.A.
Howes, G. B., LL.D., F.R.S.

FORMER MANAGER AND EDITOR.

[Under the New Zealand Institute Act, 1867.]

1867–1903.

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

PAST PRESIDENTS.

1903–4.

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

1905–6.

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

1907–8.

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

1909–10.

A. Hamilton.

1911–12.

T. F. Cheeseman, F.L.S.

HONORARY MEMBERS.

1870.

Finsch, Professor Otto, Ph.D., Braunschweig, Germany.

1873.

Günther, A., M.D., M.A., Ph.D., F.R.S., Litchfield Road, Kew Gardens, Surrey.
Cambridge, The Rev. O. Pickard, M.A., C.M.Z.S.

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.

Wallace, A. R., F.R.S., O.M., Broadstone, Wimborne, England.

1890.

Nordstedt, Professor Otto, Ph.D., University of Lund, Sweden.

Liversidge, Professor A., M.A., F.R.S., London.

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.

Goebel, Professor Dr. Carl von, 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., D.Sc., F.R.S., University of Manchester.

David, Professor T. Edgeworth, F.R.S., C.M.G., 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., King's College, University of London, England.

Diels, Professor L., Ph.D., University of Marburg.

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.

1910.

Bruce, Dr. W. S., Edinburgh.

1913.

Davis, Professor W. Morris, Harvard University.

Hemsley, W. Botting, England.

ORDINARY MEMBERS.

WELLINGTON PHILOSOPHICAL SOCIETY.

[* Life members. † Honorary members.]

Adams, C. E., M.Sc., F.R.A.S.
Adams, C. W., Bellevue Road, Lower Hutt
Adamson, Professor J., Victoria College
Adkin, G. L., Queen Street, Levin
Anderson, W. J., M.A., LL.D., Education Department
Aston, B. C., F.C.S., F.I.C., Devon Street, Wellington
Atkinson, E. H., care of Tudor Atkinson, Wellington
Bakewell, F. H., M.A., Education Board
Baldwin, E. S., 215 Lambton Quay
Bartrum, J. A., M.Sc., Geological Survey
Beere, W. O., 155 Featherston Street, Wellington
Beetham, W. H., Masterton
Begg, Dr. C. M., 164 Willis Street, Wellington
Bell, E. D., care of Bell, Gully, Bell, and Myers, Wellington
Bell, Hon. H. D., K.C., care of Bell, Gully, Bell, and Myers, Wellington
Berry, C. G. G., 35 Bolton Street
Birks, L., B.Sc., A.M.Inst.C.E., M.I.E.E., Public Works Department, Wellington
Blair, J. R., 214 The Terrace
Blake, Val., Survey Office, Wellington
Brandon, A. de B., B.A., care of Brandon, Hislop, and Brandon
Bridges, G. G., 2 Wesley Road
Browne, M. H., Education Department
Burnett, J., M.Inst.C.E., Railway Department
Campbell, J., Public Works Department, Wellington
Campbell, O. N., Rangitaiki Drainage-works, Matata
Carter, F. J., M.A., Diocesan Office, Wellington
Carter, W. H., jun., 10 Mowbray Street, Wellington
Chapman, Martin, K.C., Brandon Street
Christie, Mrs. H. M., 182 Moxham Avenue, Kilbirnie
Chudleigh, E. R., Orongomairoa, Waihou
Climie, J. D., Lower Hutt
Cotton, C. A., M.Sc., Victoria College
Crawford, A. D., P.O. Box 126, Wellington
Crewes, Rev. J., 90 Owen Street, Wellington
Dymock, E. R., Woodward Street, Wellington
Easterfield, Professor T. H., M.A., Ph.D., Victoria College
Ewen, C. A., 126 The Terrace
Ferguson, William, M.A., M.Inst. C.E., 131 Coromandel Street, Wellington
Field, W. H., 160 Featherston Street, Wellington
FitzGerald, Gerald, A.M.Inst.C.E., Brandon Street, Wellington
Fleming, T. R., M.A., LL.B., Education Board, Wellington
Fletcher, Rev. H. J., The Manse, Taupo
Freeman, H. J., Manners Street, Wellington
Freyberg, C., Tourist Department
Fulton, J., 14 North Terrace, Kelburne
Furkert, F. W., Public Works Department, Wellington
Garrow, Professor J. M. E., B.A., LL.B., Victoria College
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