ROLL OF HONOUR

ACCEDERE FONTES INTEGROS

MEMBERS OF THE LINNEAN SOCIETY OF NEW SOUTH WALES WHO SERVED IN THE GREAT WAR · 1914 – 1918 · A.D.

KILLED IN ACTION

D. B. FRY · H. STEPHENS

ACTIVE SERVICE

M. AUROUSSEAU, M.C. · C. BADHAM
E. I. BICKFORD · R. W. BRETNALL
PROF. R. BROOM · W. M. CARNE
PROF. T. W. E. DAVID, D.S.O. · M. HENRY
E. W. FERGUSON · G. M. GOLDFINCH
C. O. HAMBLIN · L. M. HARRISON
C. F. LASERON · W. R. B. OLIVER
F. H. KENNY · D. S. NORTH · E. S. STOKES

MUNITION WORK ETC.

E. GRIFFITHS · SIR. D. MAWSON · C. E. TILLEY

THE

PROCEEDINGS

OF THE

LINNEAN SOCIETY

OF

NEW SOUTH WALES

FOR THE YEAR

1920

Vol. XLV.

WITH THIRTY-TWO PLATES

And 138 Text-figures.

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1920-21.

CONTENTS OF PROCEEDINGS, 1920.

PART I. (No. 177).

(Issued 25th June, 1920.)

PART II. (No. 178).

(Issued 16th August, 1920).

PART III. (No. 179).

(Issued 8th November, 1920).

PART IV. (No. 180).

(*Issued 7th March, 1921.*)

LIST OF NEW TRIBAL AND GENERIC NAMES PROPOSED IN THIS VOLUME (1920).

CORRIGENDA.

Page 43, *for* line 48 (fourth from bottom) *read* whether if one pair of pinnae persists at a certain stage, that pair is always the

Page 190, line 16—
Page 198, explanation of text-fig. 12.— } for *margites*, read *margitis*.
Page 199, lines 11, 12, 19—

Page 198, line 24—(third from bottom) *for* little beyond discal cell, *read* little beyond the middle of the discal cell.

Page 199, line 10—*for* paratype, *read* allotype.

Page 265, line 32—(fifth from bottom) for *artica*, read *arctica*.

Page 267, line 27—*for* fig. 13, *read* fig. 6.

Page 290, line 27—for *Ptycomphalus*, read *Ptychomphalus*.
line 30—for *Phanerotrema australis*, read *Phanerotrema burindia*, the former name being preoccupied.
line 35—for *Hyolites*, read *Hyolithes*.

Page 291, line 26—*for* resting, *read* rest.

Page 309, line 41—*for* western, *read* eastern.

Page 356, lines 37, 38—for *Ptycomphalus*, read *Ptychomphalus*.

Page 359, lines 8, 28—for *Phanerotrema australis*, read *P. burindia*.

Page 363, line 1—for *Hyolites*, read *Hyolithes*.

Page 365, line 11—*for* Torryourn, *read* Torryburn.

Page 374, lines 26, 28, 31—for *Phanerotrema australis*, read *P. burindia*.
lines 30, 32—for *Ptycomphalus*, read *Ptychomphalus*.

Page 404, line 23—for *Canyza* read *Conyza*.

LIST OF PLATES.

PROCEEDINGS, 1920.

PROCEEDINGS

OF THE

LINNEAN SOCIETY

OF

NEW SOUTH WALES.

WEDNESDAY, MARCH 31st, 1920.

The Forty-fifth Annual General Meeting, together with the Ordinary Monthly Meeting was held in the Linnean Hall, Ithaca Road, Elizabeth Bay, on Wednesday evening, March 31st, 1920.

ANNUAL GENERAL MEETING.

Mr. J. J. Fletcher, M.A., B.Sc., President, in the Chair.

The Minutes of the preceding Annual General Meeting (March 26th, 1919) were read and confirmed.

PRESIDENTIAL ADDRESS.

(Plates i.-viii.)

Once again, after five years, we hold our Annual Meeting under the ægis of Peace. The interval since our last Annual gathering has been a very eventful period, a year crowded with stirring events. This has been due in part to the fact that so many of them have brought reminders of the "eternal verities" in their train. First of all, we have had the Proclamation, and then the Ratification of Peace, and the prospect of a League of Nations. But the War ended by armistice and not by surrender, and the Peace which followed was a peace by negotiation and not a peace after surrender; and so many nations had been drawn into the War, that the problems for consideration and settlement were so numerous and so difficult, that the preliminaries were protracted, and sometimes lacked unanimity. Now the war has ended, the return to a peace-footing has not come about quite so soon, or in quite the same way as perhaps was expected, so profoundly have world-affairs become involved, and been upset. For example, the belief that high prices for food and clothing would come down when the war-purchases ceased, has not been realised.

Not less eventful or moving to us has been our witness of the epilogue of the story, which began "Australia *will* be there"; then, in due time attained the clearer note, "Australia *was* there"; and then the epilogue "Australia *is* here again"—but not all, by about 60,000. This story has been a telling illustration of what the enemy quite failed to realise, namely, how great moral issues could stir and unite free democracies in a great crisis. The return of Anzacs and Diggers, as well as of those who whole-heartedly co-operated with them in all sorts of capacities, and of the men of the Australian Navy, has demonstrated to us the characteristic modesty of the modest man, who, thrice armed because the quarrel into which he was drawn was just, then did his bit, and played the game, but is loth to talk about his deeds. We are glad to know that the repatriation and demobilisation of the Australian troops has been almost completed; and that the problem of their return to civil life is receiving the attention and consideration which it deserves.

One of the most moving events of the year was the simple but very effective ceremony observed, by the wish of His Majesty, on the eleventh day of the eleventh month, at the eleventh hour, when, standing with uncovered heads, all business suspended and traffic stopped, our hearts took charge of us, and we paid our silent and sincere homage to the memory of the honoured and mighty Dead, who, though dead, yet speak to very many. I think we all hope that the observance of this simple and touching ceremony, "the King's Great Silence," as it has been aptly termed, so appealing in its directness and in its naturalness, will become an annual fixture; and that, in unison, we shall continue to hold these real and legitimate stop-work Meetings, not only "Lest we forget," but also to show that we have not forgotten.

Another stirring event in the early part of the year, not without its lessons, was a severe epidemic of influenza of a virulent type, which, as in other countries, not only upset, from top to bottom, the home-life, the educational life, the business-life, the industrial life, and every other grade of our community life, but brought bereavement to many households and aggregates. Nevertheless, the blackness of the calamitous cloud, which overshadowed us for so long, was not without some silver streaks of lining, in the shape of the unselfishness and self-sacrifice, heroic as often as circumstances required, on the part of doctors, nurses, and volunteers of both sexes, intent on doing their utmost, at all risks, for the relief of the prostrated and the helpless, and the succour and comfort of the bereaved.

Another great event was the memorable visit of the Triumphant Four, regardless of Father Neptune's approval, descending upon Australia like a "bolt from the blue." It was a great achievement, which justly evoked appreciative words and deeds. But have we, as a community, appreciated the real significance, and the inner meaning of this much-needed object lesson? Sir Ross Smith did not tell us how many strikes there were on the aerial voyage; or how the mechanics held a stop-work meeting aloft, and said—"Our mates produced this machine; therefore, we are entitled to all the products of this stunt. If you don't concede that, we will hitch the wagon to a star, and go on strike." Of course, we know why Sir Ross Smith did not mention the subject of strikes. So having shown very great enthusiasm and appreciation over a very successful enterprise, because the organisation, co-operation, co-ordination, concentration, single-mindedness, unity of purpose, were about as perfect, and as perfectly provided for as they could be, in a very limited space, under very strenuous and exacting conditions, waste of every kind, including energy potential and otherwise, eliminated, and friction reduced to a minimum what more did the sequel amount to than *revenons à nos moutons*, strikes, discord, ebullitions of accentuated, vituperative party-feeling on the eve of two elections, &c., &c. "Man is a scholar eager indeed to learn, but most forgetful having learned."

Other events that have come home to us by the experience of a shortage of bread, or a shortage of sugar, and the interruption of communications with the distant States or New Zealand, or in some other way, are the numerous Strikes which have interfered with what we are accustomed to call our normal, every-day social and business-life and activities. Fortunately the meeting of the Australasian Association for the Advancement of Science was due next year, and not this, or it must have lapsed.

We have also had the disturbing experiences of a Federal Election and a State Election, both carried out with a great deal of friction, and personal as well as party-bitterness and recrimination.

June 13th, ensuing, will be the centenary of the birth of the Society's benefactor, Sir William Macleay. The Council is arranging for a Special Meeting, to be held on June 14th, the actual day of the anniversary being Sunday this year. Further particulars will be furnished to Members in the Abstract of Proceedings after the Meeting to be held on 26th May.

Since the last Annual Meeting, more of our Soldier-Members, or Members who volunteered for war-work abroad, have returned to Australia; and we have had the pleasure of personally welcoming some of them at one or other of our Meetings. We are now able to compile a complete list of those who have served the Nation or the Commonwealth abroad, in some capacity or other as follows:—

ACTIVE SERVICE.

Aurousseau, M., M.C.	Ferguson, E. W.	Laseron, C. F.
Badham, C.	*Fry, D. B.	North, D. S.
Bickford, E. I.	Goldfinch, G. M.	Oliver, W. R. B.
Bretnall, R. W.	Hamblin, C. O.	*Stephens, H.
Broom, Prof. R.	Harrison, L. M.	Stokes, E. S.
Carne, W. M.	Henry, M.	
David, Prof. T. W. E., D.S.O.	Kenny, F. H.	

* Killed in action.

MUNITION WORK, ETC.

Griffiths, E.	Mawson, Sir D.	Tilley, C. E.

A special Honour Roll is in contemplation, of such a character that coloured copies of it can be prepared for insertion in the Parts of the Proceedings, so that every Member may have one, especially those Members who live at a distance. It is proposed that the original shall be displayed in a conspicuous place in the Hall; and that it shall be formally unveiled in a becoming manner, as part of the programme of the Special Meeting for the celebration of the William Macleay Centenary, on June 14th. It is to be a permanent, memorial record of the names of those Members of the Society, who represent, to the rest of us, the great aggregate of comrades who successfully strove to save the rest of the world from Might as against Right. The Council thinks that Members would like to have a direct, personal interest in this appropriate memorial; and it accordingly invites us to contribute, according to our means, a share of the cost of providing it, as a tribute to the great aggregate which our Soldier-Members represent, as well as to them collectively. I commend the proposal to your favourable consideration.

The concluding Part of Volume xliv., of the Society's Proceedings was issued on the 15th instant. The complete volume (912 and xxxii. pp., 47 Plates, and 212 Text-figures) contains thirty-four papers, ten of which were contributed by members of the Society's research staff. These cover a representative series of the subjects in which the Society is directly interested.

Our exchange-relations with Societies and Institutions outside the Commonwealth have begun to show gratifying signs of recovery. The Bureau of International Exchanges at Washington has been able to resume its despatches to this part of the world, after suspension brought about by war-conditions; and this means a great deal to the Society. Postal communications have improved somewhat, though still not altogether normal. Consequently, Scientific Societies in neutral and other countries are seeking to fulfil the obligations which were interfered with by abnormal conditions. But it affords me very special pleasure and satisfaction to be able to announce, that, after the turmoil of war, five out of the seven Belgian Scientific Societies with which we have exchanged publications for so many years, and from whom we were so abruptly cut off in 1914, have succeeded in getting into touch with us again. These are l'Academie Royale des Sciences des Lettres et des Beaux-Arts de Belgique, Societe Entomologique de Belgique, Societe Geologique de Belgique, Societe Royal de Botanique de Belgique, and Societe Royal Zoologique et Malacologique de Belgique. I gladly avail myself of this opportunity of offering to them the Society's cordial greetings on the resumption of their scientific activities, its sympathy with them in the anxieties and trials which they have endured, as well as any help that we can give, if it be necessary. The total number of exchanges received during the Session 1918-19 amounts to 799 additions to the library, received from 132 Societies, Institutions, &c., and ten private donors, as compared with 687, 846, 1243, 1028, and 1285 for the five preceding Sessions. Effort has been made, on the Society's part, to bring its despatches as far as possible up to date.

Six Ordinary Members were elected, five have resigned during the year; we have lost one of our older members by death; and, in addition, news came to us of the decease of one of our soldier-members some time ago.

HARRY STEPHENS, like Dene Fry, was a very promising young biologist, whose career ended prematurely amid the havoc of battle. After leaving school, he entered the Department of Agriculture as a cadet; later on he took the degree of B.Sc., in Agriculture; and was subsequently appointed to a Walter and Eliza Hall Agricultural Fellowship with the object of doing research-work upon Cereal Rusts. He had made some progress in this work, when war was declared, and he enlisted for active service in 1915. He left for the front, as Second Lieutenant, in February, 1916, and spent some time in Egypt. Thence he proceeded to Salisbury, where he was promoted to First Lieutenant; later, he accompanied his battalion to France, where, in May, 1917, he became Captain. On the night of 18th November, 1917, three weeks after his twenty-seventh birthday, he had just entered the trench to which he was allotted, when he was killed instantaneously by a bursting shell. Captain Stephens was elected a Member in 1915, but, in consequence of the pressure of his University and other work, we never had the pleasure of welcoming him to our Meetings. Professor Watt, with whom he had most to do at the University, as well as Mr. Maiden, speak of him in the highest terms as possessing in a marked degree the qualities which go to make a successful investigator, as well as a keen sense of honour and of duty. His University course was highly creditable, as he gained the Belmore Scholarship for Chemistry and Geology in his first year, and Mr. Maiden's prize for Agricultural Botany; and first class honours and a University medal at graduation. Biological research in Australia has suffered a great loss by the untimely deaths of the only two of our Soldier-Members who have not returned to us.

WILLIAM JOSEPH RAINBOW, elected a Member in 1893, migrated from England to New Zealand in 1873, and ten years later came to Sydney. While engaged in journalistic work, he became enthusiastically interested in natural history; and, in 1895, he was appointed entomologist to the Australian Museum, and continued to hold that position until his death on 21st November, 1919. He was especially interested in the *Araneidae;* and his numerous contributions to a knowledge of this and other groups, include seventeen papers in the Society's Proceedings for the years 1892-1902; and others in the Records of the Australian Museum, and in the "Australian Naturalist." He was also the author of two useful additions to our popular science manuals, namely "A Guide to the Study of Butterflies," and "Mosquitoes: their Habits and Distribution." Mr. Rainbow was personally known to many of us as a kindly, earnest, upright man, very keenly interested in his work, and very desirous of helping others to realise the attractiveness and the interest of the wonderful Australian fauna. One of his sons enlisted soon after the outbreak of war, and was killed at the Dardanelles on May 24th, 1915. This sorrowful event hastened the death of his wife soon afterwards. Another son also enlisted, and returned a few days after his father's decease.

Recent events have brought about some changes directly or indirectly affecting the scientific life of the community. Their decease has deprived it of two of our scientific veterans—Sir Thomas Anderson Stuart, Professor of Physiology in the University of Sydney; and Robert Etheridge, Junr., Director and Curator of the Australian Museum, both, at one time, Members of this Society, and the latter, for some years, a Member of Council.

Several of our Members have retired from active work after putting up long records of faithful and productive service.

PROFESSOR ANDERSON STUART, Dean of the Faculty of Medicine of the University of Sydney, and Chairman of Directors of the Royal Prince Alfred Hospital, has been a very prominent figure in the educational and public life of the State ever since his arrival in 1883. The development of the Medical School and its growing influence as a factor in medical education, afford abundant testimony to his organising capacity and his forceful character. His death, on February 29th, 1920, at the age of 64, closes an impressive chapter of personal history, as well as a very important stage in University history on the medical side.

ROBERT ETHERIDGE, JUNR., was, I think, the oldest scientific worker in harness in Australia. His first contribution to scientific knowledge, a geological quarter-sheet map of the Yan Yean district of Victoria (2 N.E.), embodying the results of his field-work during the preceding year, was published in 1869. His last, the second of two papers on the early history of the Australian Museum, was issued on 4th December, 1919, about a month before his decease; so that his published work covers a period of fully fifty years. He was the son of Robert Etheridge, Senr., to whom there is a very interesting reference in Geikie's "Life of Sir Roderick Murchison" (1875) (Vol. ii., p. 259) to this effect—"Early in July, 1856, Murchison betook himself into Gloucestershire to see some of his old Silurian haunts. Mr. Ramsay joined him, and some time was spent by them among the Silurian and Oolitic rocks of the Tortworth district, where they enjoyed the hospitality of Lord Ducie, who accompanied them in their excursions." . . . "Among the Cotteswold hills," Murchison records in his journal, "we made various excursions in the range of the Lower Oolites, and were accompanied by a very intelligent person who had been in business in Cheltenham, and had quitted it for the hammer. This was Robert Etheridge. Judging from his celerity, his quickness in finding shells and naming them, and in drawing sections, I said to Ramsay 'This is the man we must have to put our Jermyn Street Museum in order.'" Geikie adds, in a footnote,—"Mr. Etheridge, whose merits were already known to Lord Ducie, had been asked by his Lordship to meet the geologists at Tortworth. He was soon after appointed Assistant Naturalist to the Geological Survey; subsequently, on the resignation of Mr. Salter, he became Palæontologist, and since that time has gradually risen to hold a foremost place among the palæontologists of this country." Robert Etheridge, Junr., was a boy about nine years old at this time; and he seems to have inherited his father's interest in geology, and especially in palæontology; for, about 1868, as field-geologist, he joined the staff of the Geological Survey of Victoria, so ably organised in 1852 and conducted for seventeen years by Dr. Alfred Selwyn, with the co-operation of men like Richard Daintree, C. S. Wilkinson, C. D'Oyley H. Aplin, H. Y. L. Brown, and others, who not only left their mark on the records of Victorian geology, but subsequently occupied important official positions in Queensland, New South Wales, South Australia, or elsewhere in the Commonwealth, or in New Zealand. R. Etheridge, Junr., on severing his connection with the Geological Survey of Victoria, became palæontologist to the Geological Survey of Scotland, and afterwards senior assistant in the Geological Department of the British Museum. In 1887, he came back to Australia to fill the position of palæontologist to the Geological Survey of New South Wales and to the Australian Museum, of which, in 1895, he became Curator, and later on Director. The list of his contributions to scientific knowledge, and especially those relating to the palæontology and anthropology of Australia is very voluminous and valuable. Thirty-six of his papers, together with six joint papers, are to be found in the Society's Proceedings for the years 1888-1915, together with one in the Macleay Memorial Volume. One needs to be a palæontologist to appreciate the merits of his long-sustained work; but I think that it may be said of him, that he did very much for Australian palæontology, what his father did for British palæontology. But over and above this, in connection with the Australian Museum, he has left a good record as an able organiser and director. His labours ended on January 5th, 1920, in his seventy-third year, while he was away for a holiday at Mittagong. We may hope for a more extended biography written by one who was a colleague, and had a direct interest in his work.

The untimely death of Dr. F. M. Gellatly, Director of the Commonwealth Institute of Science and Industry, at the early age of 46, is much to be deplored. He was appointed Chairman of Directors of the future permanent Institute, only so recently as June, 1918, with the object of organising the industrial scientific investigations of the Commonwealth. He possessed some special qualifications for the work to which he was appointed; but an attack of pneumonic influenza prematurely ended his promising career on 24th September, 1919, and deprived the Commonwealth of an able officer for whom it will be difficult to find a substitute with like qualifications.

Several of our Members, including Mr. J. E. Carne, Mr. T. Steel, Mr. C. T. Musson, Mr. A. G. Hamilton, and our Corresponding Member, Sir Baldwin Spencer, of Melbourne, have recently retired from active official work, but happily without losing their interest in scientific work generally. Mr. Carne's connection with the Department of Mines dates from 1879, and, on his retirement at the end of the year, he had been Government Geologist for about four years. His contributions to a knowledge of the geology of New South Wales are numerous and important; and all he knows is not yet on record. Mr. Steel has been associated for many years with an institution which provides one of our necessary food-stuffs, and, at the same time, is notable for its appreciation of the importance of the application of science to industry, and for its regard for the status and welfare of its scientific officers. Mr. Musson has been a member of the scientific staff of the Hawkesbury Agricultural College ever since its foundation in 1891. Mr. Hamilton has been connected with the Department of Education for many years, and latterly a member of the staff of the Teachers' Training College. Professor Baldwin Spencer, by his professorial work, his zoological and anthropological contributions, and the scientific records of his travels in Australian out-of-the-way places, has deservedly come to the front as one of Australia's representative men of science. Those of the younger generation who are coming on, nowadays more than ever, need the encouragement, the help, and a share of the fruit of the long experience of veterans such as these; and we may be sure that it will not be withheld when the opportunity offers. The Society is fortunate in having three of them still on the Council.

To Mr. E. C. Andrews, who has been appointed to succeed Mr. Carne, I would offer, on behalf of Members, our cordial congratulations, not only on his appointment to the important position of Government Geologist, but also on his having such worthy predecessors to follow, in carrying on the development of the geological knowledge of New South Wales.

To Dr. J. B. Cleland, who has recently been appointed to the newly established Chair of Pathology in the University of Adelaide, our congratulations are due. We regret that his removal to another State deprives us of an active Member, and also a Member of Council. But we know that his qualifications include much valuable experience, and that his appointment to Adelaide means an opportunity of undertaking effective work in a new field. We wish that he may be very successful.

To Dr. T. Storie Dixson, too, one of our senior Members, I would like to offer, on behalf of Members, our congratulations on the recent announcement in the newspapers, that His Gracious Majesty the King, as Patron, has conferred upon him the honour of Knight of Grace of the Order of St. John of Jerusalem in England, in recognition of his long and enthusiastic services in connection with the St. John Ambulance Brigade, of which he is Commissioner in New South Wales.

A change of printers became necessary during the year, and I am glad to say that our new printer is giving satisfaction. The cost of printing of every kind, however, has increased considerably. Taking advantage of the opportunity of making fresh arrangements, the Council has decided to enlarge the size of the Proceedings, from demy octavo to crown quarto, retaining the same size type, commencing with the volume for 1920. This will not only give more room for illustrations, but will simplify the work of supplying the reprints, which, by arrangement with the University, are furnished to Linnean Macleay Fellows, who carry out their research-work in the University laboratories, under the Regulations for Research Students. These, hitherto, have had to be specially printed.

The issue of the Monthly Abstracts, which was temporarily suspended, under war-conditions, after July, 1916, was resumed after the Meeting in October last, and will be generally appreciated, because it keeps distant Members and Societies in touch with what the Society is doing in the intervals between the issues of the successive Parts of the Proceedings. I would remind Members of the Council's injunction that the notices of exhibits at Meetings should be as brief as possible, and confined as far as possible to the scientific aspect of the specimens shown. Members are asked also not to exhibit too great a variety of different exhibits at the same Meeting, as this is likely to necessitate too complicated and too lengthy entries in indexing them.

Concomitantly with the growth of the Society's library, and of the natural accumulation of its reserve-stock of publications, we have, for some years past, felt a pressing need for more shelf-room, and more storage-room. During the recess, the Council has provided for some important structural alterations in the Society's Hall, to meet these and other requirements, together with the installation of the electric light, and for some necessary, new lavatory arrangements. These have been completed in a very satisfactory manner by the contractor, Mr. James Leckie, under the able superintendence of the architect, Mr. A. W. Warden, in time for the Annual Meeting.

The year's work of the Society's research-staff may be summarised thus. Dr. R. Greig Smith, Macleay Bacteriologist to the Society, contributed two papers on "The Germicidal Activity of the Eucalyptus Oils," which appeared in Parts i. and ii. of the Proceedings for 1919. He has also completed a paper "Ropiness in Wattle-bark Infusions," which will be communicated at this month's Meeting.

Dr. J. M. Petrie, Linnean Macleay Fellow of the Society in Biochemistry, has carried out an elaborate examination of the leaves, and also of the nuts, of *Macrozamia spiralis*, but, in both cases, the extracts failed to yield evidence of the presence of any poisonous substance, which was detrimental when fed to animals. A considerable amount of experimental work has been carried out with *Heterodendron oleaefolia*, in order to obtain the cyanogenetic glucoside which is contained in the leaves. The active principle can be concentrated into viscous syrup, but hitherto all attempts to induce it to yield a crystalline compound have failed. The results of these two investigations will be communicated to the Society, at an early date, in two papers, entitled, "The Chemistry of *Macrozamia*," and "The Stock-poison *Heterodendron*, including experiments on the Hydrocyanic acid Content." In addition to the foregoing, work is in progress on the Native Pomegranate (*Capparis Mitchelli*), which has proved to be another cyano-genetic plant, though not hitherto known to be, or even suspected of being poisonous. Also, a continuous series of quantitative experiments has been made, to determine the amounts of hydrocyanic acid evolved from *Zieria Smithii* under various conditions.

Dr. R. J. Tillyard, Linnean Macleay Fellow of the Society in Zoology, contributed seven papers during the year, all of which have been published. These include "On the Morphology and Systematic Position of the Family *Micropterygidae* (sens. lat.), Introduction and Part i.; "Mesozoic Insects of Queensland," Nos. 5, 6, and 7; "A Fossil Insect Wing belonging to the new Order Paramecoptera, ancestral to the Trichoptera and Lepidoptera, from the Upper Coal Measures of Newcastle, N.S.W."; "Studies in Australian Neuroptera," No. 8; and "The Panorpoid Complex. Part iii." Dr. Tillyard intends to continue working upon the life-histories of Australian Neuropteroid Insects, and to make an attempt to bring the systematic knowledge of certain groups up to date in order to facilitate his morphological work. In October, the Council granted him permission to visit New Zealand, in order to obtain important material for the further working-out of the phylogeny of the Panorpoid Orders, and especially the Family *Micropterygidae*, which has its headquarters there; and also to collect material in all Neuropteroid groups, in order to study it in conjunction with the closely allied Australian fauna. Good results were obtained, except in the Rotorua-Taupo district, where the rainbow-trout introduced into the lakes had exercised the first call on the insect-fauna in which he was mainly interested. But this visit to New Zealand opened the way for an offer of the position of Biologist at the Cawthron Institute, about to be established at Nelson, which Dr. Tillyard has decided to accept; and, after to-day, we part with our Senior Fellow next to Dr. Petrie. He has been a member of the Society's research-staff for five years; and his papers during that period have been a prominent feature in the Society's Proceedings. He has not only studied the Australian aspect of world-problems, but he has tried to open up world-problems from the Australian standpoint; which is my idea of what Australian workers, as far as possible and according to their opportunities and resources, should aim at doing. In losing Dr. Tillyard, what we regret is not so much that we are losing him as a Fellow of the Society, but that Australia is losing him; and that our hopes, that an opening for doing what he is about to undertake in New Zealand, would be available for him in Australia, have been without result. Consequently, it merely remains for me to voice, on behalf of the Council and of the Society, our appreciation of the importance of the work which he has been doing so enthusiastically for so long; of expressing our sincere regret at losing him, not only as a Fellow of the Society, but most of all as a scientific worker resident in Australia; and of wishing him every success in the new sphere of work which he is about to enter. At any rate, I think he will be ready to acknowledge that his official connection with the Society has been helpful to him as a research-worker; and that the fruits of his work are, in some measure, his tribute to the memory of the benevolent and far-seeing man who made the Society's Fellowships possible.

Dr. H. S. Halero Wardlaw, Linnean Macleay Fellow in Physiology, utilised the opportunity afforded by the outbreak of pneumonic influenza, in the early part of the year, of making an important investigation in connection therewith. Measurements of the oxygen-capacity and other properties of the blood of influenza-patients were made; and the results were embodied in a paper entitled "The Venous Oxygen-content and the Alkaline Reserve of the Blood in Pneumonic Influenza," which was published in Part iii. of the Proceedings for 1919. The work on the reciprocal dialysis of blood and milk has been continued. The effect on the total solid matter, ash, chlorine, phosphoric acid, and calcium has been examined. It has been found, contrary to expectation, that, when milk is dialysed against the blood of the same species, certain of the inorganic constituents of the milk pass into the blood in considerable quantity. The further surprising result, that the presence of the red corpuscles of the blood materially diminishes this effect has also been obtained. An interpretation of these phenomena has not yet been arrived at, and will need further consideration; as do also some other incompleted investigations. Dr. Wardlaw resigned his Fellowship in September, in order to take up a University appointment as Lecturer and Demonstrator in Physiology; and, in this capacity, he is taking part in the work of the Commission appointed to investigate the prevalence of disease among mine-workers at Broken Hill. While regretting the Society's loss of Dr. Wardlaw as a Linnean Macleay Fellow, I would offer to him, on behalf of the

Council and of Members, cordial congratulations on his appointment to the staff of the University, and of wishing him every success. His five papers contributed to the Society's Proceedings, as a Fellow for more than three years and a half, are important additions to the volumes, and bear testimony to his ability to do high-class research-work.

Miss V. Irwin Smith, Linnean Macleay Fellow of the Society in Zoology, has devoted her time to the study of Nematodes, and of the life-histories of the Brachycerous Diptera. Considerable progress has been made with both groups, in collecting material, in looking into the literature of the subject, and in the examination and drawing of specimens; and the results are already very promising.

Six applications for Linnean Macleay Fellowships, 1920-21, were received in response to the Council's invitation announced on October 29th, 1919; I have now the pleasure of making the first public announcement of the Council's re-appointment of Dr. J. M. Petrie and Miss V. Irwin Smith to Fellowships in Biochemistry and Zoology; and of the appointment of Miss M. I. Collins, B.Sc., to a Fellowship in Botany from 1st proximo; and, on behalf of the Society, as war-conditions have given place to something approaching a normal state of things, I have much pleasure in wishing them every success in carrying out their investigations. Dr. Tillyard was also re-appointed; but, as already mentioned, in consequence of his contemplated removal to New Zealand, he resigned his Fellowship as from 31st March, 1920.

Miss Collins has qualifications which justify our expectation of an enlargement of the Society's scope of work in a very desirable direction. She has an excellent University record, supplemented in an important way by some experience of research-work and of teaching. She won the Deas Thomson Scholarship and Professor David's Prize for Geology in 1914, and graduated in Science in 1915, with First Class Honours in Botany. Miss Collins was awarded a Science Research Scholarship in 1916 and the following year, up to the time of her appointment as Demonstrator in Botany in the University of Adelaide under Professor T. G. B. Osborn. For some time she has been actively interested in the effect of certain climatic factors—especially drought and excessive sunlight—upon the distribution and structure of Australian plants. This is a very characteristic, important, comprehensive, and promising Australian problem. Her paper "On the Leaf-anatomy of *Scaevola crassifolia*," with special reference to the "Epidermal Secretion," which was published in the Proceedings for 1918, was the starting-point. In several papers almost ready for publication, the condition of leaf-lacquering and the glandular structures responsible for the same, have been investigated in plants of other genera available, some of which were obtained from the Broken Hill district. Miss Collins will now have time to complete these, and still further to develop the subject in hand. Two branches of Science in which the Society is specially interested, and in which progress has lagged behind, are the morphology of Australian phanerogams, and Australian soil-bacteriology and the bionomics of soil-organisms, especially in the arid parts of Australia. Our old member, Mr. A. G. Hamilton, with only such laboratory-facilities as a private individual can extemporise, and in his wearied leisure, has, for years, manfully striven to accomplish some morphological and pollination-work; and, considering his drawbacks, his labours have not been in vain. The great hindrance to progress in this particular branch has been that, until 1913, there was no Botanical Department at the University, and no properly equipped botanical laboratory in this, the Mother-State of the Commonwealth. The Professor of Botany has been carrying out important investigations on Australian Cryptogams since its establishment. But Australian Phanerogams offer a no less attractive and important field for morphological research-work. We cannot but hail, with great satisfaction, the appointment of Miss Collins, because this is not only the first time that a Linnean Macleay Fellow in Botany has been appointed, but it is the first time that a botanical candidate has offered. Moreover, she is interested in Australian problems; and it is the investigation of characteristic Australian problems that is urgently needed, to the exclusion of purely academic biological problems which can be carried out anywhere else on the habitable globe; and which may be left to those who lack the opportunity or the resources for otherwise getting to work. Another source of satisfaction is that the systematists may now hope for some of that needful co-operation, without which they have had to work, as best they could, for so long.

Dr. A. B. Walkom, who succeeded me as Secretary, to-day completes his first year of service. As a Member of the Society since 1909, and as a Linnean Macleay Fellow in Geology, 1912-13, he began with some preliminary knowledge of the Society and its work, and was not a stranger to us. As Hon. Secretary of the Royal Society of Queensland for four years, and as President for one year before his removal to Sydney, he had the opportunity of gaining experience which has been very useful to him and to the Society. He was Lecturer in Geology in the University of Queensland for six years, and was selected by the Council out of thirteen candidates. As I have co-operated with him in preparing an up-to-date catalogue of the serial publications in the Society's library; and, in other ways, have been in close touch with him ever since his appointment, it affords me much pleasure to bear my testimony to his capacity for taking up and carrying out his duties, as well as to his zeal and efficiency.

The Council has also been able to provide for an assistant; and I have pleasure in saying that Miss Watson is very efficiently carrying out her duties.

One of the lessons which the War has forced upon the attention of the British, as well as other nations, is the importance of Science in the conduct of human affairs, and especially the need of a more satisfactory organisation of scientific effort. Scientific experts in Great Britain are expressing the views, not only from the purely British standpoint, but also from the British national or imperial standpoint. Through their representative, the Royal Society of London, they are asking the Dominions not only to co-operate with the mother-country to this end, and for this purpose; but also to join with the mother-country in an International co-operative effort with which it is associated, and for the establishment of which, some progress has already been made, as the result of two Inter-Allied Conferences on the future conduct of scientific work of an international character, held in Paris, November 26-29, 1918; and in July, 1919. Accordingly, early in the year, the Royal Society of New South Wales, as the senior Scientific Society of the Commonwealth, was asked by the Royal Society of London "to take the necessary steps to establish some organisation in Australia which could act as a National Research Council and nominate National Committees of such Associations as you may desire to join."

The Royal Society of New South Wales accordingly communicated with the Scientific Societies in the different States of the Commonwealth, asking them to appoint delegates; and when this had been carried out, it arranged for a Conference of the delegates to consider the proposal to form an Australian National Research Council. The Conference was held on 21st August, 1919, when certain Resolutions were unanimously passed. As it is desirable that publicity should be given to these before the next Meeting of the Australasian Association, in January, 1921, they are accordingly included herewith. I may say that, in the appointment of representatives, the effort was made to have all the States represented, as far as it was possible. To save space, only the representatives of the branches of Science in which the Society is directly interested are given.

1. That this meeting proceed to nominate a provisional Australian National Research Council.

2. That each important branch of science in Australia be represented on the Council.

3. That the branches of science to be represented include: Agriculture, Anthropology, Astronomy, Botany, Chemistry, Engineering, Geography, Geology, Mathematics, Meteorology, Pathology, Physics, Physiology, Veterinary Science, Zoology.

4. That there be two representatives of each of these sciences, on the National Council.

5. That the representatives of the provisional Australian National Research Council be:—

1. AGRICULTURE—
A. E. V. Richardson, M.A., B.Sc. (Victoria).
Professor R. D. Watt, M.A., B.Sc. (New South Wales).

2. ANTHROPOLOGY—
C. Hedley, F.L.S. (New South Wales).
Sir Baldwin Spencer, K.C.M.G., M.A., D.Sc., F.R.S. (Victoria).

4. BOTANY—
J. H. Maiden, I.S.O., F.R.S., F.L.S. (New South Wales).
Professor T. G. B. Osborn, M.Sc. (South Australia).

8. GEOLOGY—
Professor T. W. E. David, C.M.G., D.S.O., B.A., D.Sc., F.R.S. (New South Wales).
Professor E. W. Skeats, D.Sc., F.G.S. (Victoria).

13. PHYSIOLOGY—
Professor H. G. Chapman, M.D., B.S. (New South Wales).
Professor W. A. Osborne, D.Sc., M.B. (Victoria).

14. VETERINARY SCIENCE—
Professor J. D. Stewart, B.V.Sc., M.R.C.V.S. (New South Wales).
Prof. H. A. Woodruff, M.R.C.V.S., M.R.C.S., L.R.C.P. (Victoria).

15. ZOOLOGY—
Professor W. J. Dakin, D.Sc., F.Z.S., F.L.S. (Western Australia).
Professor W. A. Haswell, M.A., D.Sc., F.R.S. (New South Wales).

6. That Mr. R. H. Cambage, F.L.S. (New South Wales) be a member of the Australian National Research Council and also its Honorary Secretary.

7. That the provisional Council hold office until the new Council shall have been appointed at the next meeting of the Australasian Association for the Advancement of Science, in January, 1921.

8. That the election of the new Australian National Research Council be entrusted to the Council of the Australasian Association for the Advancement of Science at its meeting in January, 1921.

9. That at least ten of the retiring members of the Council shall not be eligible for re-election, but that this provision shall not operate at the election of the first Australian National Research Council in January, 1921.

10. That a provisional Executive Committee consisting of a Chairman, an Honorary Secretary, and three other members be appointed to act at once in all matters considered urgent, and that the members of such Executive Committee be:—Professor David (Chairman), Mr. R. H. Cambage (Hon. Secretary), Professor Chapman, Mr. J. H. Maiden, and Professor Pollock.

11. That it be recommended to this provisional Executive Committee that the Commonwealth Government be requested to make the financial provisions necessary for carrying on the work of the Australian National Research Council, and that for this purpose representations be made to the Prime Minister.

12. In the event of any of the members of the provisional Council or the Executive Committee, declining to accept office, that the Executive be empowered to fill the vacancies.

The International Research Council has already provided for the establishment of (1) An International Astronomical Union to promote and co-ordinate the study of Astronomy and Astrophysics; (2) An International Union of Geophysics, to promote the study of the various branches of the Physics of the Earth; and (3) An International Chemical Council, to promote international co-operation in chemistry. Steps will be taken to establish cognate Unions for other branches of Science. In the meantime, the Australian National Council has asked its representatives of Zoology to report on the desirability, or otherwise, of joining the International Union of Biological Science (when it shall have become established), more particularly as regards the section of Zoology; and they are inviting others to confer with them. The object aimed at in forming an International Union of Biological Science is "to encourage the study of Biology in its various branches, and more especially":—

(a) "To initiate and organise the conduct of researches which depend on co-operation between countries.

(b) "To provide for their scientific discussion and publication."

(c) "To encourage the establishment and improvement of Research Laboratories which are accessible to students of all nationalities."

(d) "To promote the organisation of International Congresses."

(e) "To facilitate the preparation and issue of bibliographical publications."

The sections proposed are—General Biology, Physiology, Zoology, Botany, Medical Sciences, Applied Biology.

Now, theoretically, what is proposed as above is admirable, and no one can gainsay the need for it, or at least for something of the sort, if the resources for carrying it out are forthcoming. But there is also another side to the question, which is not less important for us, and that is, the question of more, and better organisation of scientific effort from the purely Australian point of view. How are we to provide for this? At present men of Science in Australia are but a handful, occupied with official duties, centralised in the capital city of each of the States, at considerable distances apart, with few opportunities for personal intercourse. The only comprehensive, unifying organisation in the branches of Science in which this Society is directly interested, is the Australasian Association for the Advancement of Science. As a private individual, interested in Science, I venture to express the hope, that, after the next Meeting, to be held in Hobart in January, 1921, the Association will give up entirely the practice of reading papers in the different Sections, with a view to restricting its activities in the following manner—to providing opportunity, (1) for personal intercourse between the Members; (2) for Presidential Addresses as at present; (3) for discussing prearranged scientific problems of Sectional or general interest; (4) for discussing matters relating to the organisation of scientific effort in Australia; and for doing what it can to accomplish it. In other words, that it should leave to the Australian Scientific Societies the matter of reading and publishing scientific papers; and assume the functions of an Australasian Parliament of Science, in the interest of promoting co-operation, and a better organisation of scientific effort.

As an example of one of many Australian problems—a world-problem in process of being opened up from the Australian standpoint, under Australian conditions—which is being carried out in the right way, namely by organised team-work, and, not in Sydney, but at a remote country centre, where the problem takes its origin. I call your attention to a scientific investigation which is being carried out at Broken Hill, under the direction of one of our Members, Professor Chapman. A Technical Commission of Inquiry has been appointed recently, under the State Board of Trade, to investigate the prevalence of disease amongst mine-workers at Broken Hill. The investigations will occupy six months, and £15,000 has been allotted for the work. Professor Chapman, one of our Members, has been appointed Chairman of the Commission, and was asked by the Premier to associate with himself in the Commission such gentlemen as would be competent to take charge of different phases of the investigation. The Commission is making medical examinations of as many of the mine workers at Broken Hill as are available, with the object of ascertaining the degree of prevalence of miner's phthisis, lead-poisoning, and anchylostomiasis. It is hoped to study 4500 men who will form about 60 % of those employed along the lode. Two large X-ray machines have been installed and radiograms are made of each man's chest by Dr. W. A. Edwards. Six medical practitioners, working under the direction of Dr. S. A. Smith, are carrying out a thorough medical examination of each man. When needed special bacteriological and chemical and cytological tests are performed. Through the courtesy of the Commonwealth Government, the services of Dr W. A. Sawyer of the International Health Board have been made available to the Commission for the investigation of the occurrence of hookworm. As a result, a complete working-unit, comprising four microscopists and two assistants under the control of Dr. Rosenthal, has been transferred to Broken Hill from Queensland. The staff concerned in this medical investigation comprises seven medical practitioners, four microscopists, five assistants, and four statistical clerks, together with four members of the Commission. The Commission will endeavour to establish a relation between the sign and symptoms of disease noted in the mine worker, the appearance of the radiographic picture of the lungs and the pathological changes which can be observed in the lungs of dead miners. As the Commission has been asked to report on the conditions antecedent to the occurrence of ill-health among mine-workers, investigations are being made into the chemical and physical characters of the dust produced in the various operations of mining. Some analyses are being performed upon the ash of the lungs of mine-workers in the hope of adding to the store of our knowledge about the dust present in the lungs. Samples of the dust floating in the air of the mines are also being subjected to chemical and physical examination. This part of the work of the Commission has been under the control of Dr. H. S. H. Wardlaw, who is assisted by four chemists. We look forward, with great interest, to the results of this well-organised, well-equipped, co-ordinated effort, the most notable in these respects that we have yet had in New South Wales.

One of the events of the year has been the culmination of a disastrous drought; and though there has been relief in some districts, other localities are still much in need of rain. It has been a costly visitation to the State. The returns of the approximate number of live stock in New South Wales on 31st December, 1919, as compared with those of the corresponding period of 1918, show that there has been a decrease of 72,434 horses, partly due to very little breeding on account of low prices and small demand, and in part to the drought conditions experienced in many districts for the greater part of the year; of 399,378 cattle, attributable mainly to the effects of the drought, namely, to death from starvation, conditions not favourable to breeding, and the forwarding of cattle to market on account of the holdings not being able to carry large stock; and of 7,028,852 sheep, attributable almost wholly to the droughty conditions, which have been very severe on breeding-ewes, so that over the greater part of the State, the lambing was a failure.* In addition to the pecuniary loss represented by the depreciation of the State's flocks and herds by drought, it is necessary to take count of the fact that the Government is raising a loan of £1,000,000 by the issue of Treasury Bills bearing interest at the rate of 5½ per cent., with a currency of two years from March 1st, 1920, for the purpose of providing funds to finance advances to distressed farmers, and also to meet payments for seed-wheat purchased by the Government for issue to farmers, and for other purposes. The drought, therefore, has not only been another expensive intimation that Australia has still some lessons to learn about the solution of drought-problems; but that Australia has not learnt all there was to learn from previous similar experiences, particularly the drought which culminated in 1902, and was responsible, among other losses, for the reduction of the flocks of the State from forty-three to about twenty millions. "Prevention is better than cure," but as periodical droughts have a legitimate place in Nature's scheme of things in Australia, Man cannot, therefore, prevent their occurrence. But is it impossible to learn how to mitigate, if not to prevent, at any rate in some measure, the periodical levy on the wealth of the State by droughts? Why is it, for example, that it is left to droughts to cull the flocks and herds in the exacting way in which it is done by every serious drought? Answers to these, or other cognate questions are not hard to find. What Australia especially needs to learn is how to cope successfully with drought-problems; and to learn that, it is necessary to understand and take to heart, that droughts are teachers, and not a curse; since they are a legitimate factor in Nature's scheme of things in this quarter of the globe. Rabbits and Prickly Pear, &c., may be curses; but Nature is not responsible in any way for their foothold in Australia. A recent writer has diagnosed the state of Britain, before her eyes were opened by the War, in the following words†—"We have sloughed our besetting sins in many mental processes. Before the War, men of science were grossly academic and individual: often abstract to the point of perverted mysticism; and the line they took encouraged the men of commerce to the contempt of pure knowledge. Men of science, merchants, the banks, and the Government were all in watertight compartments, working apart, and more than

* For further details see the Sydney Morning Herald, February 26, 1920, p. 5 to which I am indebted for the particulars quoted.

†Thomas, W. B., "A Better England—Not a Worse," Nineteenth Century, No. 514, December, 1919, p. 1013.

this, contemning one another. The result was that, from the nation's point of view, the brains of the chemist were wasted, the activities of the merchants handicapped, the wealth of the banks locked up, and politicians a vain luxury. The British brain was working; but was a milch-cow for other astuter nations." What is here said or implied about the importance of the co-operation of men of science with commercial men and with Governments, and about the national lack of the appreciation and practice of it, before the War, is only too true. But the men of science are not, equally with others, to blame for it. For, from time to time, their representative spokesmen have pointed out what was needed, but their warnings and their recommendations have too often failed to arouse attention or elicit any response. Or if noticed, their views have been dubbed "counsels of perfection" or "arm-chair" advice, which the "practical" man can well afford to ridicule, or neglect altogether. Now, in the case of Australia, there is great need for a closer and more effective co-operation of Science with the primary producer, the man on the land. With the manufacturer also, but in this case, the need can be easily provided for, since all he has to do is to make the necessary provision for increasing his staff by the addition of such scientific experts, chemists or whatever they may be, as circumstances require. But the case of the primary producer is different, and it requires the most earnest consideration. It is necessary for him to learn and understand, what he is apt to overlook, or fail to realise the importance of—small blame to him, under the circumstances which have encouraged it—that there is a theoretical side to his practical activities, which needs to be taken into account; that in his case, as in others, the theoretical side and the practical side are complementary, since true theories are merely the generalisations upon which practice is to proceed. Now a lack of appreciation of this need of the recognition of the complementary relations of science and practice in relation to drought-problems is plainly in evidence in books and in newspaper records; and I shall refer to some of them presently. One imperative reason for taking account of them henceforth is, what is implied in the statement that "Australia's bid for greatness rests upon her agricultural possibilities";* and that considerable progress has been made in this direction since these words were recorded, with more to follow in the immediate future. The imperativeness of the reason referred to arises in this way. In the earliest days of settlement in the inland districts, the man on the land was a pastoralist solely. But now that he is devoting more and more attention to agriculture, it is necessary to remember that this means a steadily increasing removal of the natural covering of the soil—in the shape of forest, or scrub, or grasses, or whatever it may be—and that his operations necessitate, over a steadily increasing area, a profound disturbance of the soil-organisms and of their relations to the indigenous plants, which have come about as the result of Nature's long-standing arrangements. Now these are matters which cannot be treated with absolute indifference; for they mean much; and what they may do or mean, it is necessary to learn.

When Australia was colonised in 1788, the first settlers found everything very different from what they had been accustomed to. In due time, a spokesman took it upon himself to voice the strangeness of the land to which they had migrated. This was Mr. Barron Field, a Supreme Court Judge in Sydney from 1816-23. To him, the colonists were the antipodes of the old folks at home. Consequently Australia not only was, but ought to be, the Land of Upside Down. It was the great Freak-Land. The plants were freaks, the animals were freaks,

*Gullett, H. S., "Australia's Development: the Coming of the Farmer," Chambers' Journal, January, 1909.

the climate was freakish, the constellations were unfamiliar. He not only set about cataloguing the freaks—"But this is New Holland . . . where the swans are black and the eagles are white; where the kangaroo, an animal between the squirrel and the deer, has five claws on its fore-paws, and three talons on its hind-legs, like a bird, and yet hops on its tail; where the mole (Ornithorhynchus paradoxus) lays eggs, and has a duck's bill," &c., &c.* But he also proceeded to account for them on the supposition that other countries were created in the beginning, whereas the fifth Continent was an after-birth, not conceived in the beginning, but which emerged at the first sinning, and was, therefore, curst; and the freaks were the fruit of it.

At a later date (1884), another spokesman, Marcus Clark, expressed his views about Australia thus—"Europe is the home of knightly song, of bright deeds and clear morning thought. . . . In Australia alone is to be found the Grotesque, the Weird, the strange scribblings of Nature learning how to write. Some see no beauty in our trees without shade, our flowers without perfume, our birds who cannot fly, and our beasts who have not yet learned to walk on all fours."† These and similar effusions are not to be regarded simply as nonsense. On the contrary, they are most instructive and precious landmarks in the progress of a knowledge of Australia in Australia, in the days when Science was too undeveloped to offer the real interpretation. The spokesmen were educated men, but men of a too literary education, for whom science-teaching was not available in their youth; but what they said was untainted with the idea that gives birth to what is apt to be regarded as the only thing worth while, "That's the way to make money."

In Barron Field's time, even scientific men thought that species were created as such. If the animals and plants of Australia were freaks, then that was what they were intended to be. Marcus Clark might have read Darwin's "Origin of Species," but, if so, it failed to impress him. But to-day, scientific men can explain the supposed freakishness. Some of it was due to the fact that Australia was a sort of "Noah's Ark" for "living fossils"; some of it had no particular significance, but much of it was the outward and visible sign of successful adaptation to periodically arid conditions, whereby the supposed freaks were enabled to survive droughts, and to live in harmony with a variable and, at times, exacting environment. *Mutatis mutandis*, just what the man who goes on the land needs to know.

At a still later period, only sixteen years ago, another spokesman, another kind of spokesman, expressed his views about life on the land in Australia. These deserve caustic criticism, not merely because what the writer has to say is nonsense, but because it is pernicious nonsense. I refer to a leading article, entitled "Australian Pessimism," in the Evening News for April 4th, 1903. After remarking upon the absence of poems of a fresh, joyous nature written by an Australian; of successful attempts to write on the two topics which engross writers of most other nations—viz., love and home-life, the writer proceeds to say—"The secret is to be found in the conditions of existence here: life in the Australian bush is one long weary gamble with malignant fate; no man feels sure of his return for his labour and money; that incomprehensible deity known as 'luck' rules everything. The greatest care may be wasted, the greatest precau-

*Geographical Memoirs of New South Wales. Edited by Barron Field (1825), pp. 461, 494.

† Preface to "Poems of the late Adam Lindsay Gordon" (1884).

tions come to naught against the breath of drought or the ravage of the bush-fire. Life becomes a long watching, with as much cynicism and fortitude as the watcher can avail himself of, the turning of the great wheel of fortune, which deals out failure to one man, and success to another, quite irrespective of their merits. Under these circumstances, it is no wonder that a tone of cynical levity towards life is the dominant note of Australian literature. 'Home' is just a place where one makes money or loses it, as the case may be," and so on. Now the most appropriate label for this diatribe is just—"The Squeaker has squoken." Australia surely offers no *locus standi* to such an undesirable alien as fatalism. But fatalism harnessed to ignorance is a hopeless combination, which deserves no quarter from Science. Is there one returned soldier who would deliberately say, of the recent terrible war, that the incomprehensible deity known as "luck" ruled everything in connection with it, the only drawback being that the huge armies of the two sets of opponents had to engage in a death-struggle, in order to find out which side the incomprehensible deity favoured, and intended to win? No wonder that Australia has never been in a position to export a single bale of wool or of sheepskins, a single hide, or a frozen carcase! No wonder, also, that Australian bush-children have never learned to sing "Home, Sweet Home; there is no place like Home"! And how delightful, by comparison, it must be for a man on the land to live in a country where the thermometer is often down to zero or lower, for weeks or longer at a stretch, and the culled stock need to be housed and fed for about five months, more or less, out of the twelve!

Another writer, in reference to the 1902 drought, speaks of it as—"the struggle of man against a relentless, cruel environment: the sweeping away by overwhelming odds of fortunes, won by years of toil; of the barren mockery of 'what has been,' of disaster, desolation and ruin; of men stripped and wounded fighting to the end with enduring pluck."* Why not emigrate to Siberia, Russia, or Canada, which are not troubled with droughts, but merely have hard winters?

"Old Saltbush" (Walter Smith) in his poem entitled "Drought: written in 1877, when the Drought was at its worst,"† furnishes another example. This is really, though it is not what it was intended to be, the story of a squatter who, after a run of good seasons, thought he would take a sporting chance for just one year more, at any rate; or perhaps he tossed-up over it. But the drought came when he was not expecting it, and caught him wholly unprepared, with a full complement of stock and sheep. It will be noticed that the starving animals are not spoken of as crawling around the empty siloes, or the dried-up dams, or about the artesian bore, which is on strike, but only along the banks of the empty "great stream-beds," where the "rotting carcasses" are. The following is portion of what the poet has to say about it:—

In the great stream-beds, muddy holes
  Where once was water deep,
Are filled with rotting carcasses
  Of cattle and of sheep;
Along the banks in ghastly groups
  (Full half their number gone)
The starving stock all feebly crawl,
  Poor wrecks of skin and bone.

. . . . .

Oh! Demon Drought! that sweeps away
  The hard-earned wealth of years, etc.

* Sydney Morning Herald, November 17th, 1908, in "On the Land" column.

† Australian Ballads and other Poems, selected and edited by D. Sladen, p. 261.

Still another quotation, this time a character-sketch from an article entitled "The Man Out Back," published in the Sydney Daily Telegraph of December 29th, 1906. "Times have changed, and a certain type of the old Australian pioneer has well-nigh gone. He was one who did things in a large way, and usually made his fortune. He was an interesting character, and his methods, if primitive, were effective. Rough in speech, plain of dress, fond of hard work, with long hours and simple food, he was yet genial in company. In business, he was usually hard and stern, and he was especially noted for his shrewd dealings in money-matters. He lived to make money, and any hindrance that stood in his way was brushed aside by his strong personality. 'A pound saved is as good as two pounds made,' one that I knew used to say. He succeeded, and accumulated money, and, what is more to the point, stuck fast to it. 'You'll have to leave your wealth behind you, and whoever gets it will probably spend it recklessly,' I said to him once, with a frankness that did not displease him. 'Well,' he answered with a hard laugh, 'if those who come after me get half as much pleasure in spending it as I have had in making the money, I'll be perfectly satisfied.' When he took up 250,000 acres in the back country, he was content with a poor dwelling-place. A shelter from the rain was almost the main consideration. He did not believe in making improvements. 'Eat out the country, and then move elsewhere, was his motto. 'If they want you to make improvements, throw up the country,' he said. In time of drought his sheep were dying for want of water and feed. 'Let them die; it doesn't pay me to feed them. I can buy plenty more when the rain comes. That's the way to make money.' "

What is amiss with the sentiments expressed in the extracts quoted? They are wrong in at least two respects. Firstly, they are views of Man's relation to Nature based upon self-interest, that is upon his money-making instinct—the idea that it may be cheaper and less trouble to take chances, even if it results in drought culling the flocks and herds, than it is to learn how to prevent it; and that "That's the way to make money." And, secondly, they take no account whatever of the complemental, scientific side of what droughts are, of what they mean, and of the part they play in the economy of Nature, and of Man's concern with them from this point of view.

Man needs rest after strenuous work, whether physical or mental; and the physiologist can give a scientific explanation of the need of it, and of the result of it.

The land also periodically needs a rest or sweetening, and the biologist can give a scientific explanation of the need of it, as well as of the result of it. It is a matter of experience, that the year after a drought breaks up, is a bumper year for crops and herbage.

Nature has adopted two ways of resting and sweetening the land, and, at the same time, of generally clearing up and putting things in order, getting rid of weaklings and undesirables, and putting species, that have got out of bounds, back into their proper places. These are, (1) annually recurring, hard winters, as in the extra-tropical countries of the Northern Hemisphere, the hardness varying with the latitude. This may be distinguished as the winter-sleep or resting of the land. And (2) periodical droughts in the subtropical countries of the Southern Hemisphere, like Australia, Subtropical South America, and South Africa, which have mild winters, not severe enough to give the land a thorough rest or sweetening. The arrears accumulate until, sooner or later, the drought comes, puts things straight again, strikes a balance, and makes way for a new start, the onset of the bumper year. This may be distinguished as the drought-sleep or resting or sweetening of the land. The difference between Nature's two methods of doing the same kind of thing depends on geographical position, and on cosmical conditions of high and low pressure areas, sun-spots perhaps, and so on; and, of these, the meteorologist and the astronomer can give a scientific account.

Therefore, to rail at droughts, to call them a curse, to speak of them as responsible for a relentless, cruel environment for the man who goes on the land in Australia, or as a Demon who robs the squatter of his hard-earned wealth, some of it earned simply by allowing Nature to convert grass, her own grass, into wool and mutton, is to be as ignorantly foolish as to say, night, the need of sleep and recreation, the Sabbath-day's rest, and holidays are curses, unfriendly Demons, because they nightly, weekly, or periodically interrupt his money-making activities. And it might be supplemented by lamenting that Man is such an imperfect creature, because a perfect man should have an iron constitution, which would enable him to dispense with sleep and rest, so that he might uninterruptedly be making money, twenty-four hours per diem, seven days per week, three hundred and sixty-five days per annum, year in and year out. That would be the way to make money!

The man on the land in the Northern Hemisphere, after generations of experience, has learned his lesson, and is able to live in harmony with his environment. The severity of the annually recurring winters compels him to house and feed his stock; therefore, he must grow enough fodder to provide for them, and he must cull his flocks and herds, so that the demand for fodder shall not exceed the supply. What helps him to learn his lesson is, that the recurrence of winter-conditions, on the whole, is so regular, that he can arrange his programme of work by the almanac; and, not less, that he certainly knows that he will be ruined, if he does not come up to the mark. So, knowing exactly what he has to do, and how to do it, and what will happen if he fails to do it, he makes good; and abstains from talking nonsense and heresy about his relentless, cruel environment, even when the thermometer goes below zero; or about winter being a curse. In a word, he becomes a philosopher, in the primary sense of the word; and the idea of a long, weary gamble with malignant frost and ice finds no place in his mind.

The man on the land in Australia, Subtropical South America, and South Africa, has to carry out his work on a different basis, inasmuch as he has to learn how to adapt himself to Nature's arrangements for giving the land its needed rest and sweetening, not by a regularly, annually recurring winter-sleep, but by a periodical but not regularly recurring drought-sleep. Nature, in Australia, has provided a genial climate, with splendid natural pasture-grasses and fodder-plants; with no hard, annually recurring winter, requiring the man on the land to house his stock, and grow crops to feed them under those circumstances, as well as to cull out all but what he can feed; and, in many cases, with procurable water, though it may not always be visible on the surface. Nevertheless, he has not yet learned to live in harmony with his environment, so successfully as his representative in the Northern Hemisphere, because, though he knows from experience or from historical records, that droughts are certainly to be looked for from time to time, he cannot tell from the almanac exactly when to expect them. This recurrence of droughts at uncertain intervals, which he cannot calculate,—and Science cannot definitely help him in that respect at present—is a disturbing factor, which periodically makes his environment erratic, and puts him out of harmony with it. This uncertainty introduces the temptation to take chances, which may be disastrous, and underlies the idea of the "Gamble out West."

What Australia needs to learn, by the guidance and co-operation of Science —and there is no better way of doing it—is, how to insure against damage by droughts. That is:—(1) How to prevent the production of "necessitous farmers," requiring State aid, to the amount of about £1,000,000, in order to rehabilitate themselves after a visitation of drought. The State Treasurer reports that, already, £600,000 has been disbursed for this purpose. Do hard winters in the Northern Hemisphere ever or often produce "necessitous farmers" requiring to be relieved by the State, to such an amount?

(2) How to prevent droughts from culling the herds and flocks, on the customary colossal scale; and from obliterating the promise of harvests.

This can be expressed in another way—How can the man on the land in Australia, with the aid of Science, learn to solve the following questions?

1. In attempting to insure against, or to cope with droughts, is he attempting to accomplish the impossible; or is he only in some districts, or in some cases, trying to accomplish the impossible?

2. Or is he attempting to accomplish the possible (a) in the right way; or (b) with good intentions, but with insufficient knowledge or equipment, or with inadequate resources?

From time to time, especially on festive occasions, important personages indulge in forecasting the future population of Australia as 100 millions, or even 200 millions, and in descanting upon the necessity of filling up the empty spaces of the continent, but, in the reports of their speeches in the newspapers, as far as I have seen, without insisting on the very necessary stipulation—if and when Australia learns, or is going to learn, or has learned, how to cope with drought problems. The strength of a chain is the strength of the weakest link. The population that Australia can support, is the population that she can safely carry when droughts come. The State is recovering in part from a very severe experience of drought. Great activity is being displayed in all the States in the way of facilitating the settlement of returned soldiers, and immigrants on the land. This Meeting seems to me to be an opportune occasion for asking what, I think, is a proper and a pertinent question, because drought problems are primarily scientific problems, and, therefore, the guidance and co-operation of Science is needed for their solution. The question, I would ask, is the twofold, neglected question—How is it, seeing that drought-problems are so very important, that we have no Handbook, or Manual, or *Vade mecum* of Australian Drought-Problems; and if not, why not; and how soon may we look forward to having one? We have manuals of the flora, of the fauna, of the birds, of the fishes, of the fungi, of the fodder-plants and grasses, of the minerals and fossils, and so on; and we know them to be of fundamental importance, and to be most helpful and suggestive, in the investigation of problems to which they relate. In anticipation of the visit of Members of the British Association for the Advancement of Science in 1914, an admirable series of Handbooks, one for each of the older States, and one for the Commonwealth as a whole, was published. These served not only for the enlightenment of the visitors, but are standard works of reference to-day. What I have in view is something different from these, and something which is not intended in any way to clash with, or supersede the publications of the State Department of Agriculture, for example, some of which contain articles bearing upon some aspect or other of drought-problems. It is not to be a book to teach the man on the land how to grow crops, or how to raise stock, primarily, or how to accumulate shekels, or anything of that sort. It is to be a book solely for the purpose of setting forth the complemental, theoretical side of the practical activities of the man on the land, especially in relation to drought-problems, with the object of enabling him to understand what it is he needs to learn in order to make the most of his resources in providing against disaster; that is how to live and keep in harmony with his somewhat erratic environment; and to understand that drought is not a curse, and that he is not called on to fight droughts, but to fight his ignorance about how to cope with them, which ought to be, sooner or later, enlightenable, provided that Science is afforded an opportunity of helping him.

Apart from the fact that no such book, as I have proposed, is available at present, the need of such a book is not that nothing at all is known about drought-problems, but that so much of what is known is to be found in back numbers of newspapers or in scientific journals, where it is not accessible to those who want it, and could make use of it; and that these contributions to knowledge deal only with particular aspects or cases, and not comprehensively with the subject in its entirety. What is wanted, as I think, is a selfcontained Handbook of the complementary, theoretical side of drought-problems. I give a sketch of the ground that, in my opinion, might be covered by it, just as something for consideration and discussion:—

SYNOPSIS.

Nature and Man, Nature's Insurgent Son—Disturbance of Nature's Balance by Settlement, and what that involves; the reckless or careless introduction of undesirable Aliens, like Rabbits, Prickly Pear, &c.; and the reason why they flourish in their new environment—Droughts: their History and Periodicity in Australia—Droughts in South Africa, and Subtropical South America—Their Cause and Meaning in the Economy of Nature: Nature's two ways of resting or sweetening the land, and, at the same time, of clearing up, putting things in order, and striking a balance, by (1) severe cold, or (2) more or less intense aridity—The year after a drought, the bumper year for crops and herbage, and the scientific explanation of the resting and sweetening of the land—The Lessons to be learned from the high level and low-level Flood-plains of the Hawkesbury River Valley, as in evidence at Richmond; and from the desiccated Lake Eyre Basin of Central Australia, called by Gregory "The Dead Heart of Australia"—The Adaptations of the indigenous Plants and Animals to arid conditions, and the lessons to be learned from them—The Man on the Land in the Northern Hemisphere, with an annually recurring hard winter, in harmony with his environment—The Man on the Land in the Southern Hemisphere, with mild winters but periodical droughts, whose periodicity cannot at present be calculated, not yet wholly in harmony with his environment—The need to conserve the fertility of the Soil, and the indigenous grasses and fodder-plants—Disturbance of the Soil-organisms, and of their long-standing association with the indigenous Plants, especially the Acacias and Eucalypts; the Bionomics of Soil-organisms in the arid portions of the Continent; and the risks from strong, dry, Westerly Winds, in the absence of a covering of Snow, when the natural covering of the ground has been removed—Lessons from Droughts; and the Application of the Lessons—Bibliography, as a guide to more detailed consideration of special subjects—Index, &c.

Happily there have been and are men on the land in Australia, who have learned that droughts are not a curse, though rabbits and prickly pear may be;

that the land needs a periodical rest or sweetening; that it is the dry climate and the high-class nutritive native grasses and herbage, which are largely responsible for the excellence of Australian wools; that if every season were a good one, the stock and sheep would suffer severely from parasites, and from diseases; and, best of all, men who do not believe that Nature's great scheme of things, which, by slow degrees, has evolved from the womb of Time, has arrived at its present advanced state of development, for the sole and only purpose of gratifying the money-making instincts of the Get-rich-quick Dollarton Shekelfords, just as and how they would like to be able to order it. Records of the actual experience of intelligent and enlightened men of this kind, are among the things wanted; and some of it is already on record in the files of old newspapers. They are men who can appreciate the words of Mr. Roosevelt, when President of the United States, in his opening Address to the American Forest Congress, held at Washington, January, 1905—"All of you know that there is opportunity in any new country for the development of the type of temporary inhabitant whose idea is to skin the country and go somewhere else. . . . That man is a curse and not a blessing to the country. The prop of the country must be the business man who intends so to run his business that it will be profitable to his children after him. . . . I ask, with all the intensity I am capable of, that the men of the West will remember the sharp distinction I have just drawn between the man who skins the land, and the man who develops the country."

The book should not be a one-man book, but a team-work book, supervised by a capable editor. It should be simply but scientifically written by specialists in the different branches, after the manner of the Handbooks prepared, at different times, for the Meetings of the Australasian and of the British Associations for the Advancement of Scienece. But, for the chapters to which they relate, and especially those on the lessons of droughts and their application, from the practical man's side, the files of the newspapers, at least as far back as the drought which began in 1888, should be systematically looked up. Some of the articles therein are excellent, for they are often the records of actual experience and first-hand knowledge; and, as such, they are of historical interest. The cream of all these should be skimmed, supplemented as may be required, and put into the Handbook; and, if desirable, referred to in the Bibliography. Papers in scientific journals should be utilised in a similar manner.

But the publication of a Handbook, in the way of propaganda, is not enough. The annual output of books is so enormous, that any particular book is apt to be put on the shelf, and perhaps forgotten. Therefore some propagandists are needed. A good way of providing for these, I think, would be the endowment of a course of three annual lectures. One lecturer always to be a scientific man; another always to be a man on the land; and the third always to be a business man capable of dealing with the statistical and financial aspects of drought-problems. The lecturers to be appointed annually, a year in advance, so that they may have time for the preparation of their lectures. The lecturers to be allowed to choose the subjects of their lectures, provided—and this is to be a *sine qua non*—that the aim and object thereof is to elaborate, to expound, to make clear, and, if possible or necessary, to amplify the Handbook. The lectures sometimes to be delivered in Sydney when the primary producers come to hold their annual Congresses; and, sometimes in one or other of the centrally situated and accessible country towns, as may be decided. In this way, attention would periodically be focussed on the Handbook, and on the subject with which it has to do. Discussion thereon would be promoted. If taken up and entered into enthusiastically, the subject of drought-problems should become a live subject, as it ought to be, and as it needs to be; and then we may expect to make some progress.

Next only to the need of righteousness, and of the maintenance of the integrity and welfare of the Empire, the question of how to cope successfully with droughts in Australia, stands second to none in its importance. For Australia's bid for greatness rests upon this, inasmuch as her agriculture and other possibilities can only be imperfectly realised without it.

On the correct Interpretation of the so-called Phyllodes of the Australian Phyllodineous Acacias.

(Plates i.-viii.)

The Australian flora furnishes numerous examples of plant-structures, which, as one usually sees them, are difficult to understand, partly because they represent secondary developments which have been superimposed on the primary, natural order of things; and partly because one commonly meets with complicated adult structures, of which the early stages are not always readily obtainable. The so-called phyllodes of Australian Acacias are one of the most common and familiar examples of these plant-puzzles. These have been regarded as the "classical" examples of phyllodes, because there are so many species of phyllodineous Acacias, and they are so widely distributed. Nevertheless, strictly speaking, they are not "phyllodes" within the meaning of the recognised definition of these leaf-substitutes. For example, in the Glossary of Terms prefixed to the first volume of the Flora Australiensis (p. xxxix.) will be found the definition—"Phyllodium = a flat petiole with no blade." Asa Gray defines a phyllodium as "a petiole usurping the form and function of a leaf-blade." In both cases, these definitions are intended to apply to the flattened leaf-substitutes of the Australian phyllodineous Acacias.* Bentham says of Division i., *Phyllodineae*—"Leaves all (except on young seedlings and occasionally one or two on young branches) reduced to *phyllodia*, that is to the petiole either terete or angular or more or less vertically dilated so as to assume the appearance of a rigid simple leaf, with an upper and a lower edge or margin, and two lateral similar surfaces, and either sessile or contracted at the base into a short petiole, the upper edge often bearing 1, 2, or rarely 3 or more shield-shaped or tubercular or depressed glands." (Fl. Austr., ii., p. 319.)

But the so-called phyllodes of the Australian phyllodineous Acacias are not simply flattened petioles which have lost their blades. The current statements about them, such as those quoted above, are imperfect generalisations based upon inadequate material. On the contrary, they are the flattened, primary leaf-axes or common petioles of bipinnate leaves which have lost their pinnae; and it is the former which have usurped the form and function of the latter; and not flattened petioles which have usurped the form and function of leaf-blades. The so-called phyllodes of Australian Acacias may be long, or short, or very short. If long, they are the flattened primary axes, or common petioles, of potentially long bipinnate leaves, with numerous pairs of pinnae. If short, or very short, they are the flattened primary axes, or common petioles, of potentially

*Gray's Botanical Text-book (1887), pp. 110, 426.

short, bipinnate leaves, with several, or only one pair of pinnæ, whose pinnæ have vanished. Therefore, as the so-called phyllodes of the Australian phyllodineous Acacias are not exactly comparable with the phyllodes of other plants, and are not phyllodes within the meaning of the current definitions thereof, they should be distinguished from ordinary phyllodes, and also have a distinctive name. As they are neither cladodes nor phylloclades, within the meaning of the current definitions of these structures, I propose to call them Euphyllodia or euphyllodes, in the sense that they are something more than is implied in the accepted definition of phyllodes; and, therefore, something more than simply flattened petioles; inasmuch as they really are, as I shall show, in what follows, vertically flattened, primary leaf-axes or common petioles, whose pinnæ have been suppressed, which have usurped the form and function of leaves. Instead of Phyllodineæ and phyllodineous Acacias, I propose to use the terms Euphyllodineæ and euphyllodineous Acacias, in order to be consistent.

Several more detailed interpretations of the phyllodes, so-called, of Australian Acacias are on record. One was offered by Morren, in 1852.* Unfortunately, no copy of this paper is available in Sydney, and I do not know on what kind of evidence he based his views. But two authors, Maxwell Masters and Baron von Mueller, have given the substance of Morren's hypothesis. Masters says§—"When the blade of the leaf is suppressed it often happens that the stalk of the leaf is flattened, as it were, by compensation, and the petiole has then much the appearance of a flat ribbon (phyllode). This happens constantly in certain species of *Acacia*, *Oxalis*, &c., and has been attributed, but doubtless erroneously, to the fusion of the leaflets in an early state of development and in the position of rest."

Baron von Mueller seems to have accepted Morren's hypothesis, but without mentioning the author of it. In his "Introduction to Botanic Teachings" (p. 25, 1877), he says of the Australian Acacias—"This enormous number of congeneric plants [about 300 species] can conveniently be separated into two main groups, according to the structure of their leaves, whether consisting of a simple blade, or whether formed by distinct leaflets. The first of this primary division is called that of the Phyllodineæ, from a Greek word implying leaf-like form, because the supposed simple leaves are in reality formed by the confluence of leaflets, stalklets and stalks into one leaf-like mass, or according to the more generally adopted but less accurate views simply dilated leaf-stalks (phyllodia); this metamorphosis is most readily demonstrated and proved by observing the apparently simple-leaved Acacias in early growth, when the first leaves developed by the young seedling will be found to be compound, consisting of leaflets arranged in two rows, thus forming pinnæ, several again of these pinnæ forming the *bipinnate leaf*, the axes along which the leaflets are placed being also arranged in a pinnate manner. What in the phyllodineous division of the genus Acacia is noticed only on the leaves of the young plant, becomes normal throughout for the second group, that of the Bipinnatæ."

A second interpretation is current in Textbooks of Botany. This is not less unsatisfactory than the Baron's. It is frequently presented as a brief, definite, and apparently authoritative statement—an axiom or a postulate, as it were, which the student is to accept in faith. For example, Bentham, in his generic description of *Acacia*, says—"Leaves twice pinnate or reduced to a simple

*C. Morren, Bull. Acad. Belg., 1852, t.xix., p.444.

§Masters, Vegetable Teratology, p.329, 1869.

phyllodium or dilated petiole" (Fl. Aust., ii., p. 301). Kerner says* —"It has already been mentioned on p. 335 [quoted later on for another reason] that a like modification of function occurs in many Australian Acacias, the foliage-leaves of which are devoid of green blades whilst the leaf stalks are developed as green, flattened, outspread organs, the so-called phyllodes." These, and similar statements are based on no more logical argument than this—The phyllodineous Acacias have phyllodes; phyllodes are flattened petioles, &c.; therefore the phyllodes of Acacias are flattened petioles, which have lost their blades. The fallacy of the argument lies in the fact, that the so-called phyllodineous Acacias have not phyllodes in the accepted meaning of the term.

Sometimes however, authors venture to give an explanation. But the explanations known to me are not less fallacious than the definitions of the phyllodes, so-called, of Australian Acacias. For example, Lubbock, in his "Flowers, Fruits, and Leaves" (p. 120, fig. 75; 1886) gives an explanation, together with an illustration of a seedling the first ever published, as far as I know. He says "The typical leaves of Acacias are pinnate with a number of leaflets. On the other hand, many of the Australian Acacias have leaves (or, to speak more correctly, phyllodes) more or less elongated or willow-like. But if we raise them from seed we find, for instance, in *Acacia salicina*, so called from its resemblance to a Willow, that the first leaves are pinnate (Fig. 75), and differ in nothing from those characteristic of the genus. In the later ones, however, the leaflets are reduced in number, and the leafstalk is slightly compressed laterally. The fifth or sixth leaf, perhaps, will have the leaflets reduced to a single pair, and the leaf-stalk still more flattened, while when the plant is a little older, nothing remains except the flattened petiole." Now the passage quoted is very remarkable, but hardly more so than others of similar import to be found in other books. Such statements are imperfect generalisations based upon inadequate material. Though put forward in good faith, they are nevertheless pitfalls and stumbling-blocks, both for teachers and students. The first statement that "the typical leaves of Acacias are pinnate" is faulty. There are no Acacias with pinnate leaves. On the contrary, the typical Acacias have twice pinnate or bipinnate leaves. Next, "But if we raise them from seed we find, for instance, in *Acacia salicina* . . . that the first leaves are pinnate (Fig. 75), and differ in nothing from those characteristic of the genus." The seedling shown in Fig. 75 has no pinnate leaf or leaves. The first is a bipinnate leaf with one pair of pinnæ, the second is also a bipinnate leaf with one pair of pinnæ, and with an indication of the so-called phyllode on the upper side; the third is also bipinnate with one pair of pinnæ, and indications of the so-called phyllode on both upper and lower sides; while the fourth and fifth are complete phyllodes, so-called.

Lubbock's description and figure of a seedling of *A. salicina* are the only ones of this species yet published. But if the seedling figured was not an anomalous one, it was an incomplete specimen; and Lubbock did not notice that the first leaf, which should have been a simply pinnate leaf, or perhaps a pair of opposite simply pinnate leaves, was missing. But what one particularly wants to know, is, why Lubbock calls the structure, to which the single pair of pinnæ of his bipinnate leaves is attached, the "leaf-stalk," which is firstly slightly compressed laterally, and then finally become the flattened petiole or phyllode? In other words, on what grounds is it taken for granted that the pinnæ of the

*Natural History of Plants, English Translation, Vol. i., p.637.

bipinnate leaves of Acacia-seedlings with only a single pair of them, which appear successively after the first simply pinnate leaf, or in some cases after an opposite pair of them, represent a pair of pinnæ at the node immediately above the leaf-stalk or petiole? I have not yet met with any description of Acacia seedlings or Acacias in which this question is answered, or even considered, except by Preston, referred to later on. As a matter of fact, the pair of pinnæ of bipinnate leaves, with only one pair, such as successively make their appearance after the first simply pinnate leaf, or a pair of them, represents the apical pair; and what is below them is the entire primary leaf-axis or common petiole, and not simply the ordinary petiole. That is to say, the succession of the pairs of pinnæ in the development of a bipinnate leaf with several pairs of pinnæ, of an Australian Acacia, is basipetal; and not basifugal, as tacitly assumed, and taken for granted.

It is interesting to note, therefore, how two eminent biologists, like von Mueller and Lubbock, independently came to the conclusion that, not merely the same sort of evidence, but the selfsame evidence—the evidence afforded by the "first leaves" of phyllodineous Acacia-seedlings—demonstrated and proved two divergent, and irreconcilable hypotheses: the metamorphosis of bipinnate leaves into phyllodes by the confluence of leaflets, stalklets and stalks in the one case; and by the flattening of the petioles and the disappearance of the blades, in the other. What is wrong with these two discordant conclusions is not that one is correct, and the other incorrect; but that neither of them is wholly correct, and that both are partially incorrect. Mueller's hypothesis is incorrect in so far as the leaflets and stalklets, that is the pinnæ, are concerned; for these abort entirely, and take no part whatever in the formation of the so-called phyllodes. The evidence on that point is clear and conclusive; and one is at a loss to understand how Morren and he were led to think that the leaflets and stalklets concresced with the stalks or axes. But the stalks, that is the primary axes, or common petioles of the actual or potential bipinnate leaves, the ordinary petioles together with the rhachises, do flatten to form the so-called phyllodes, and are the only components thereof; and, to that extent, his hypothesis is correct. But supposing that there is a confluence of leaflets, stalklets and stalks, why was Mueller content to call such structures phyllodes, when, by the current definition, phyllodes are flattened petioles, which have lost their blades—neither more nor less?

On the other hand, Lubbock's hypothesis is incorrect in supposing that, in the formation of Acacia phyllodes, so called, "nothing remains except the flattened petiole"; whereas, in truth, everything remains except the pinnæ. But it is correct in so far as the pinnæ are concerned, for these vanish entirely.

While lack of adequate material, and of personal knowledge of the plants as they grow under natural conditions, are the ultimate reasons for the long-standing, incorrect, current ideas about the phyllodes, so-called, of Australian Acacias, there are three main proximate reasons:—

(1) The ambiguous, because too general, statements about the "first leaves" of the seedlings of the Australian phyllodineous Acacias; and the neglect to determine the mode of the succession of the pairs of pinnæ in the development of the bipinnate leaves.

(2) Either the non-recognition of the presence of the "*seta terminalis*" of Bentham, or "the recurved point," or the "excurrent point" of the common petiole or of its distal component, the rhachis; or, if noticed and mentioned, the disre-

gard of its meaning and significance, when discussing the nature and interpretation of Acacia-phyllodes, so-called.

And (3) The omission to take into account the simple but very significant fact, that the petioles, or apparent petioles of all the known Australian bipinnate Acacias, of which twenty-two species are described by Bentham in the Flora Australiensis, are short or even very short, relatively to the length of the entire, primary leaf-axes, or common petioles; whereas some Acacia-phyllodes, so-called, are not only much longer than the petioles of any existing bipinnate Australian Acacia, being as long as 12 to 20 inches in some species; but are even longer than the common petioles of the longest leaves of any known, bipinnate, Australian Acacia.

I propose, therefore, to consider these three questions seriatim, and in some detail, because it is time the real nature of the so-called phyllodes of Australian Acacias was recognised and taken into account. The current belief about them is a barren conception, which has obstructed the progress of knowledge, and leads one into the wilderness. If the so-called phyllodes of Australian Acacias are simply flattened petioles which have lost their blades, there is nothing more to be said about them that is of any importance. But when one knows what they really are, it is a simple matter to reconstruct the euphyllodineous Acacias, and, then having done this, to find corresponding analogues among the existing, bipinnate species. And not only so, but when one knows where, when, and how to look for reversion-foliage and reversion-shoots of the right sort, one can find Nature actually reconstructing them, as I shall presently show. Having arrived at this stage, the study of the euphyllodineous Acacias takes on an entirely new, and extremely interesting and promising aspect.

The "First Leaves" of the Seedlings of Australian Acacias.

From the extracts given above, it is evident that, by the expression the "first leaves" of Acacia-seedlings, Mueller and Lubbock mean—and the same remark will apply to other authors who express themselves similarly—the earliest leaves which successively develop on young seedlings; and that neither of them takes account of the simply pinnate leaf, or sometimes a pair of opposite, simply pinnate leaves, which is, or which are, actually the first to appear.

The foliage of the young seedlings of the Bipinnatæ is similar to that of other plants with bipinnate foliage, in that the earliest leaves to make their appearance are of a simpler type than those which follow them in later stages of the development of the complete bipinnate leaf. The march of progress, as is usual, is from simple to complex.

The very first leaf is an abruptly pinnate leaf, with several pairs of leaflets, or there may be an opposite pair of them. The second is an abruptly bipinnate leaf with one pair of pinnæ and more or less numerous pairs of leaflets. Now this leaf, and others like it, which follow, represents and corresponds to a leaf like the first, in which the apical pair of leaflets has been replaced by an apical pair of pinnæ; while the lower pair, or pairs, of leaflets, counting from above, have been suppressed. That this is the correct view to take is shown by the presence of the *seta terminalis*, or terminal seta, in which the primary leaf-axis terminates in both cases. This is the remnant of a terminal leaflet in the first, abruptly pinnate leaf; and the remnant of a terminal pinna in the abruptly bipinnate second leaf, and in others like it, as will be discussed more in detail later on.

In seedlings of *A. discolor*, one of the very common bipinnate Acacias of the Sydney district, for example, the first leaf is abruptly pinnate with about six pairs of leaflets; the second, third, and fourth may be bipinnate with seven pairs of leaflets on the second and third, and twelve pairs on the fourth. The fifth, sixth, and seventh may be bipinnate, with two pairs of pinnæ: these correspond to a leaf like the first, in which the apical pair of leaflets, and the pair next below, have been replaced by pairs of pinnæ. The eighth leaf may have three pairs of pinnæ; this corresponds to a leaf like the first, in which the apical pair of leaflets, and two pairs next below, have been replaced by pinnæ. After the eighth the number of pinnæ may increase by one pair more or less consecutively in succeeding leaves, until something approaching the maximum is attained. In one seedling however, and the only one seen, the third leaf had two pairs of pinnæ. In seedlings of other species, the number of pairs of pinnæ increases sometimes a little sooner, sometimes a little later, much in the same manner as described above in *A. discolor*. The terminal seta, unless accidentally missing, terminates the common petiole of every leaf, at every stage of growth. Therefore, the mode of succession of the pairs of pinnæ in the gradual development of the bipinnate leaf is basipetal, and not basifugal, as has hitherto been tacitly assumed and taken for granted in every case that has come under my notice.

The primary leaf-axis of the first, abruptly pinnate leaf may be slightly longer than that of the second bipinnate leaf with one pair of pinnæ, but the latter have more than twice as many leaflets. As the number of pinnæ increases, the axis lengthens proportionally, until it reaches its final dimensions. When the maximum number of pairs have been developed it will be noticed that the petiole is relatively short.

Young seedlings of the Euphyllodineæ, old enough to show the transition from bipinnate leaves to euphyllodes, are very interesting and instructive. They are the embodiment, and, at the same time, the visible presentment or picture of an intense struggle between two antagonistic tendencies or forces. On the one hand, the hereditary tendency to produce the ancestral type of foliage makes a start in the normal way. The first leaf is an abruptly pinnate leaf, or, in some species, there may be an opposite pair of them. The second leaf is an abruptly bipinnate leaf with one pair of pinnæ, just as in the seedlings of the Bipinnatæ. Very soon, somewhat sooner in some species than in others, the antagonistic tendency, the euphyllode-producing tendency, nowadays also an inherited tendency, manifests itself, and, after a few preliminary stages, the usurper succeeds in swamping the natural tendency to continue the production of bipinnate foliage. This commonly, but not always, happens before the seedlings are strong enough to enable the bipinnate leaves to develop a second pair of pinnæ; and, in such species, the second, third, fourth, fifth leaf or some later one may be the earliest complete euphyllode.

The object of the struggle is to get rid of the pinnæ, whose leaflets are the transpiring and assimilating organs proper, and to substitute for them the vertical, flattened, leaf-like leaf-axes or common petioles, or euphyllodes, capable of taking over and carrying out the functions of the leaflets on a more economical basis for regulating the water-supply and expenditure. It is important to realise this; and that the contest is not between flattening, ordinary petioles, and leaf-blades, which are to vanish. Now a substitutional structure, and a structure for which a substitute is being provided, cannot completely coexist and function in all respects simultaneously. In the case of the substitution of euphyllodes or flattened leaf-axes for pairs of pinnæ, from the nature of the case, the substitution or replacement cannot take place instantaneously in a flash, but only by gradual, intermediate stages. It necessarily follows, therefore, that some indication of both can and may be present at the same time, but in an inversely proportional ratio. If the pinnæ are strongly in evidence, after the struggle begins, the euphyllode will be only slightly indicated; whereas if the euphyllode is strongly in the ascendant, but not yet complete, the pinnæ will show signs of some kind or other that they are on the wane. The swamping, euphyllode-producing tendency usually acts too promptly in young seedlings to show the inversely proportional relations between the two contestants very satisfactorily. But good examples of reversion-foliage, and the leaves of reversion-shoots show them most beautifully and convincingly.

Sir John Lubbock, afterwards Lord Avebury, in his great book "On Seedlings" (1892), mentions or describes, or describes and figures seedlings of seven species of Acacia. But his material was very limited, and sometimes restricted to a single seedling. It is remarkable that the species, whose seeds he was able to get, are all out-of-the-way or inland species, and do not include a single example of our common and familiar species. Lubbock was interested in them as seedlings merely; and it was not his object to discuss the nature of the euphyllodes of those that were euphyllodineous species. Having complete seedlings at his disposal, he was able to recognise, this time, that the first of six of them was an abruptly pinnate leaf. But of two species, not figured, *A. Oswaldi* and *A. acanthocarpa* he says—"Leaves compound and abruptly pinnate or reduced to phyllodes," and "First leaves compound, abruptly pinnate"; but as he makes no mention of the presence of bipinnate leaves in either case, one does not know how to take these statements, since his descriptions of the seedlings of these two species are all that are available at present. On the other hand, he describes the first six leaves of a seedling of *A. Burkitti* as bipinnate. This is the only Acacia-seedling, without an abruptly pinnate first leaf, or a pair of them, yet recorded. Lubbock also recognises the presence of Bentham's terminal seta in the seedlings of two species, but unfortunately he locates it on the petioles. Thus, of the first six leaves of *A. Burkitti*, all bipinnate with one pair of pinnæ, he says "petiole excurrent between the pinnæ, with a subulate slender point." Also of *A. verticillata* he says—"Leaves at first pinnate then bipinnate, then reduced to phyllodes . . . petioles laterally compressed . . . and projecting beyond the pinnæ with a subulate acute aristate point." The petiole of a compound leaf is the portion of the common petiole, or primary leaf-axis, below the lowest pair of pinnæ; therefore, all the pinnæ are attached to the rhachis; consequently it is the common petiole, or its distal component, the rhachis, which terminates in an excurrent point or terminal seta. If the petiole terminates in an "excurrent point," then, since the latter is above the pair of pinnæ, these must be attached to the petiole—which is absurd. He correctly adds, however—"rhachis of pinnæ excurrent in the form of a small subulate point." And he should have said common petiole, or the rhachis which is its distal component, with an excurrent point. But, accepting the current idea, that the phyllodes of Acacias are simply flattened petioles, he tacitly assumed and took for granted, as he did in the earlier passage quoted above, that the single pair of pinnae of his bipinnate leaves was the lowest or basal pair, whereas it is the apical or uppermost pair which appears first; and that the stalk to which the pinnæ were attached was the petiole, whereas it was the common petiole or primary leaf-axis, as is proved by its terminating in an excurrent point or terminal seta.

Mr. R. H. Cambage has recently taken up the study of Acacia-seedlings where Lubbock left off; and, from his extensive knowledge of the Australian flora, and of Acacias growing under natural conditions, he is eminently qualified to undertake it. Since 1915, he has published five instalments of a monograph on "Acacia-Seedlings," which include descriptions and excellent photographs of the seeds, pods, and young seedlings of fifty-five species. This is an excellent beginning of a very important contribution to knowledge, which can only be done properly as he is doing it, with personal knowledge of the plants under natural conditions, and with adequate material. As it is necessarily a leisure-time study, he deserves, in an especial manner, all the encouragement and help that we can give him. If he will take into consideration the evidence I am now bringing forward, and will modify his terminology accordingly, I venture to predict that his work will become more inspiring and interesting even than it has been.

Cambage's papers and illustrations show admirably, how promptly the swamping effect of the usurping, euphyllode-producing tendency takes place in all the euphyllodineous species he has described, with the exception of *A. melanoxylon*. This is one of a small group of exceptional species, which includes *A. rubida*, and apparently also the non-Australian species, *A. heterophylla*, that is in need of special and detailed study of good series of gradational stages.

The transition from an abruptly pinnate leaf, or more usually from a bipinnate leaf with one pair of pinnæ, or sometimes two pairs, to the first complete euphyllode, of seedlings of the euphyllodineous Australian Acacias, may take place on any leaf, from the second to the ninth, or even later, according to the species, and according to circumstances. The difference in seedlings of the same species is mainly due to the absence or the presence of lingering stages of the dwindling pinnæ. It is usually, but not invariably, complete before the seedlings are able to develop leaves with two pairs of pinnæ. Cambage has found it to be the second leaf in *A. alata* (not counting the members of the opposite first pair of simply pinnate leaves separately), in about a dozen specimens, so that no bipinnate leaves with one pair of pinnæ had a chance to develop. He has also found it to be the third leaf sometimes in *A. excelsa*. In the seedling figured by me (Pl. ii., fig. 2) it is the fourth leaf. This is the seedling of the species (probably *A. implexa*, as Mr. Cambage has been good enough to advise me) which has furnished me with my best and most instructive reversion-shoots and suckers, because the euphyllodes are so long, up to about 9 inches. I was not interested in the plants before they were scorched, and the portions of the plants above ground killed, but without damage to the root-system, by a bush-fire, or in some cases injured in other ways; and there has not been time yet for the new shoots to flower; and I have been unable to find adult, uninjured plants in a condition suitable for exact identification of the species. In the seedling shown, the first abruptly pinnate leaf had three pairs of leaflets, but the apical pair, and one of the next pair below, were missing, when I got the specimen. The second, third, and fourth are bipinnate, with only one pair of pinnæ in all of them. One pinna of the second is damaged, and is represented by one leaflet and a portion of its fellow. Above what remains of the damaged pinna in the position shown, the terminal seta at the apex may be seen in the photograph of the common petiole, projecting to the left. The fifth is a short, relatively broad, complete euphyllode, $2\frac{3}{4}$ inches long; the sixth is longer but narrower; the seventh is still longer; the eighth (bent in the photo) is $7\frac{5}{16}$ inches long. An average sample of a complete euphyllode from a reversion-shoot, $8\frac{3}{4}$ inches long, is shown beside the seedling on the left. My reversion-shoots show fifteen later stages that are skipped in this seedling, to be referred to later on.

Of sixteen bush-seedlings of *A. falcata*, the first complete euphyllode was the fifth leaf in nine, the sixth in six, and the seventh of one; the leaf immediately preceding the first complete euphyllode in each of two seedlings had two pairs of pinnæ. Of sixteen bush-seedlings of *A. myrtifolia*, the first complete euphyllode was the fifth of two, the sixth of seven, the seventh of six, and the eighth of one; seedlings of this species also sometimes have one, and occasionally two leaves with two pairs of pinnæ. Seedlings of *A. linifolia*, of which the first complete euphyllode may be the sixth-ninth, may also have one leaf, or two leaves, or, as in one of my specimens, three leaves, with two pairs of pinnæ. The leaves of seedlings of *A. suaveolens* often show most interesting lingering stages of dwindling pairs of pinnæ, the last of which may be represented by only a single pair of leaflets, with the terminal seta at the apex of the rhachis; and this is quite as conspicuous at the apices of the succeeding euphyllodes. Further details will be found in Cambage's papers.*

The Terminal Seta or Recurved Point of the Bipinnate Leaves and Euphyllodes of Australian Acacias.

No. 3 of the definitions given in Bentham's paper on the Mimoseæ, referred to later on, is very important, namely—"A small point terminates the petioles whether common or partial, in all or nearly all *Mimoseae*. It is usually setiform, though sometimes short and thick, and occasionally almost foliaceous, sometimes apparently continuous with the petioles [*i.e.*, the common or partial petioles as defined on p 324; but not petioles in the sense in which some later authors use the term, following Kunth], at other times falling readily off. This point has by some been termed a gland; but, it would appear, erroneously. It may possibly be the rudiment of a terminal pinna or leaflet; but as there is no evidence beyond its position [*i.e.*, terminating the common or partial petioles] to shew that it is so, I have been unwilling to give it any other name than *seta terminalis*."

Now this was written some seventeen years before the publication of Darwin's "Origin of Species." Chapter xiii., of the "Origin" deals, in part, with the subject of Rudimentary Organs. Darwin's treatment of the subject gave an altogether new view of the importance and significance of rudimentary organs and vestigial structures. To-day, remnants and vestigial structures mean very much more to the morphologist than they did seventy-eight years ago. Then, Bentham knew of "no evidence, beyond its position," to say more than that the *seta terminalis* was possibly "the rudiment of a terminal pinna or leaflet." To-day, I imagine, no one qualified to speak, will take exception to the statement that it really is, what Bentham, seventy-eight years ago, said it possibly might be. The *seta terminalis* of the pari-pinnate leaf of *Cassia Candolleana*, for example, a common garden plant, or of the pari-pinnate first leaf of Acacia-seedlings, undoubtedly represents the remnant of an aborted terminal leaflet, corresponding to the terminal leaflet present in *Robinia pseudacacia*, for example; just as, in the bipinnate foliage of seedlings or of the adult plants of the Bipinnatae, or in the bipinnate foliage of seedlings, on the young euphyllodes, and frequently on the adult euphyllodes of the Euphyllodineæ, unless accidently missing, it repre-

* Cambage, "Acacia Seedlings." Parts i.-v. Journ. Proc. R. Soc. N.S.Wales, Vols. xlix-liii., 1915-19.

sents the remnant of a vanished terminal pinna corresponding to the terminal pinna of the impari-bipinnate leaves of *Caesalpinia Gilliesii*. (Pl. ii., fig. 1).

Moreover the *setae terminales* of the reversion-foliage of *A. suaveolens* are sometimes green and foliaceous, like incomplete leaflets or a pair of leaflets (Pl. i., figs. 4. 8, 9, 10); and the leaves of reversion-shoots of *A. implexa* (?) and *A. podalyriaefolia* sometimes have thread-like rudiments of the axes of the terminal pinna present, without leaflets, but with a terminal seta at the apex (Pl. viii. 5, 6).

Admittedly, the *seta terminalis* is of no practical importance to the describer of species. Nevertheless, in his paper on the *Mimoseae*, almost all the species of which have bipinnate leaves, Bentham took the trouble to discuss what he conceived to be its meaning and significance. It was unfortunate, therefore, that, when he came to deal with the Australian Acacias in the second volume of the Flora Australiensis, especially as the euphyllodineous species far outnumber the bipinnate species, he took no account of the *seta terminalis*, as defined in the paper on Mimoseæ, or of its significance, except that he merely mentions its occurrence, under another name, the "recurved point," in two only of the twenty-two species of Bipinnatæ which he describes, as if these were the only two species in which it was to be found. Thus of *A. polybotrya* he says—"the rhachis terminating in a recurved deciduous point" (p. 414); and of *A. leptoclada*—"Pinnæ 3-5 pairs, 3-4 lines long, on a common petiole of ¼ to ½ in., ending in a recurved point" (p. 416).

But the recurved point, or *seta terminalis*, unless it is accidentally missing, is usually equally constant and significant, not only in other bipinnate Acacias in which no mention is made of its presence; but also on the leaves of seedlings of the *Euphyllodineae*, and at the apices of euphyllodes, especially in the young stages. Bentham furnished descriptions of 271 species of euphyllodineous Acacias. It is remarkable, therefore, that the *setae terminales* of some of them did not attract his notice, or arouse his suspicion that the so-called phyllodes of Acacias were something more than merely flattened petioles.

Kerner is the only author known to me† who rightly recognises that there is a vestigial structure at the apex of the so-called phyllodes of Acacias, which, in reality, is Bentham's *seta terminalis*, in which the common petiole, or the rhachis, its distal component, terminates; but not the petiole, as Lubbock expressed it.—Thus he says—"In many of the vetches of the Southern European flora (*Lathyrus*, *Nissolia*, *Ochrus*) but especially in a large number of Australian shrubs and trees, principally acacias (*Acacia longifolia*, *falcata*, *myrtifolia*, *armata*, *cultrata*, *Melanoxylon*, *decipiens*, etc.) it is the leaf-stalks which are extended like leaves placed vertically, and then the development of the leaf-lamina is either entirely arrested, or has the appearance of an appendage at the apex of the flat, green leaf-stalk or "phyllode" as it is called."* As far as the Acacias are concerned, the appendage at the apex of the "phyllodes," here referred to, is simply Bentham's *seta terminalis*, or recurved point, the rudiment of an arrested terminal pinna, in which the common petiole, or its distal component, the rhachis, terminates. It is not, as Kerner supposes, under the influence of the current dogma, that Acacia phyllodes, so-called, are simply flattened leaf-stalks or petioles, the remnant of an arrested leaf-lamina. The pinnæ only have been arrested, and not the rhachis as well. Consequently, the terminal seta retains its normal position at the apex of the rhachis, that is, the apex of the common petiole, or the primary axis of

* Natural History of Plants, English Edition, Vol. i., p. 335.

† But see the reference to Goebel's views *postea*, p.44.

the leaf. But that Kerner should be the only author, so far as I can learn, to have recognised the occurrence of an apical, vestigial structure on the so-called phyllodes of the Australian Acacias, is both surprising and interesting. His mistake, like the mistakes of others, was attributable to a lack of adequate material for study. Nevertheless, his observation is notable.

The meaning and significance, and in some cases the occurrence, of the terminal seta or recurved or excurrent point, or rudiment of the terminal pinna, of the leaves of the Australian Acacias, whether in the seedling-stage or otherwise, have received such scant consideration from authors, that a comparison of the leaves of Acacias with those of other genera with remarkable bipinnate leaves is not only very instructive, but what can be learned in this way needs to be emphasised and allowed for.

For comparative purposes, the most satisfactory material is afforded by the leaves of three plants belonging to exotic genera, more or less common in gardens in Sydney. I am unable to find anything about them in any books available to me, from the particular standpoint in which I am interested in them. These are *Caesalpinia Gilliesii* Wall., native of La Plata States, which is of interest because the leaves have a terminal pinna, but the pinnæ lack a terminal leaflet; *Jacaranda ovalifolia* R.Br., native of Brazil, which is remarkable because the leaves have a fugacious terminal pinna which is wanting in the mature leaves, the pinnæ have a terminal leaflet, and the mode of succession of both the pinnæ and the leaflets in the development of the bipinnate leaf is basifugal; and the West Indian *Calliandra portoricensis*, whose leaves, like those of the bipinnate Acacias, have neither a terminal pinna, nor have the pinnæ a terminal leaflet; but, in both cases, especially in the young leaves, unless it is accidentally missing, the terminal setæ are conspicuous.

C. Gilliesii has leaves up to nearly 7 inches long, to the base of the terminal pinna; with twelve or thirteen pairs of short pinnæ, with about eight to ten pairs of leaflets. As in the Acacias, the leaves present anomalies. Some of the pinnæ are alternate instead of opposite; one of a pair is sometimes missing; the terminal pinna is occasionally missing; the number of pairs of leaflets of the pinnæ is variable. The leaves show:—(1) that the internodes are about as long as the spread of an expanded pair of leaflets, measured from tip to tip across the partial rhachis; (2) that the pinnæ of the lower pairs are fairly at right angles to the axis, but that the apical pair and several pairs next below do usually move inwards slightly, so that there may be some slight overlapping of the lower leaflets of the apical pair and the terminal pair, even though the latter has a longer petiole than the others; (3) and that the petiole may be no longer than the lowest internode, or half as long again; but however much it may be, it is but a small fraction of the length of the entire axis or common petiole. Fig. 1 of Pl. iii., represents the upper portion of a leaf, in which the pinnæ of the apical pair are at right angles to the axis; and this was chosen for illustration because the terminal pinna was fully displayed. Lubbock figures a very young seedling of this species, with only the first leaf, which is abruptly pinnate, but no further particulars are given.

The longest Jacaranda leaf that I have, without portion of the tip, which is missing, is 21½ inches long, petiole 2¾, with 32 pairs of pinnæ, some of which are alternate. Longer leaves may be seen on some trees. Mature leaves rarely show anything at the apex, but the basal scar of something which is missing. I figure a small leaf from a young plant 8½ inches long, which should have eighteen pairs of pinnæ and a terminal pinna; but the terminal pinna, and four pairs of pinnæ are represented by large leaflets, some of them with serrated edges. I have also other leaves showing more advanced, but still, incomplete transformations. On the other hand, one can get examples in which the terminal pinna is present, but the leaflets are not expanded. In this condition, it is apt to be fugacious; and one often finds only a withered or broken remnant of it. The basifugal succession of both the pinnæ and the leaflets in the development of the bipinnate leaves is very interesting. The pinnæ in the basal region are usually short; in the middle region they are very long, with numerous pairs of pinnæ, and a terminal leaflet. The internodes may be as long as, or shorter than the spread of an opposite pair of expanded leaflets. The petiole is relatively very short, as long as about two or three, or more, internodes, if some of the possible lowest pinnæ do not develop. The variable length of mature leaves on the same plant, that is the variable number of the pairs of pinnæ present, is, I think, attributable to accidents, at different stages of growth, to the apical portion of the leaves before the basifugal development of the full number of pinnæ is complete.

The leaves of *Calliandra* have up to six or seven pairs of pinnæ. As in the bipinnate Acacias, the terminal pinna, as well as the terminal leaflet of the pinnæ, has been arrested; but, in both cases, their remnants, the terminal setæ, are present, unless accidentally missing, and are especially noticeable in young leaves. Of a leaf with six pairs of pinnæ, the length of the common petiole was $3\frac{1}{8}$ inches; the spread of a pair of opposite expanded leaflets $\frac{11}{16}$, or about the length of two internodes; and the length of the petiole $2\frac{1}{16}$. The petioles of these leaves, proportionately to the length of the common petioles, are the longest I have met with; and the length of the internodes is less than the spread of an opposite pair of leaflets; but this causes no overlapping as the apical pair of pinnæ, and one or two pairs below them move upwards and inwards, and the basal pair move downwards and inwards.

The youngest leaves of *A. discolor* that one can get, show excellently the terminal setæ both of the common petiole and of the pinnæ (Pl. viii., fig. 2). Also that there is no addition of pinnæ at the apex of the leaf, after the lowest pinnæ are developed, as in *Jacaranda*. All the pinnæ that are to be present in the mature leaf, are represented in the primordium of the leaf; and when the pinnæ of the young leaves move into place, and the leaflets expand, the pinnæ are all equally developed. Similar statements are applicable to the very young leaves of *A. decurrens*.

Fig. 2 of Pl. iii., shows the leaf of a seedling of this species, with three pairs of pinnae, the middle pair of which illustrate the incomplete basipetal development of the leaflets.

Due recognition of the meaning and significance of the terminal setæ of the leaves of the bipinnate Acacias, and especially of the leaves of seedlings with only one pair of pinnæ, is the key to the understanding of euphyllodes. Whatever else may be wanting, the apical pair of pinnæ is always present, unless accidentally missing, except in decadent stages such as are shown in Plate vii.

The Petioles of the Leaves of Bipinnate Australian Acacias

The euphyllodes of some Australian Acacias are very long, from 12-20 inches. In considering the nature of such remarkable developments as these, it is necessary to consider some of the characters of the leaves of the bipinnate Acacias, and especially of their petioles.

Seventy-eight years ago, Mr. Bentham monographed the species of *Mimosa.* He began his paper by formulating some definitions.* Thus he said—"Before entering into descriptive details, some preliminary explanations may be necessary relating to some of the terms used in characterising *Mimoseae,* and applied by different writers in different senses. . . . I have uniformly adopted the phraseology usually followed by De Candolle, giving the name of *pinnae* to the primary divisions, and of *foliola* to the ultimate divisions [of the bipinnate leaf]. . . . I have also designated by *petiolus communis,* the *whole* of the stalk to which the pinnae are affixed, not (as is done by Kunth), that part only which is below the lowest pair of pinnæ, and by *petiolus partialis* I have meant the whole of the stalk to which the foliola are attached." Accordingly, in this paper, Bentham refrains altogether from using the terms petiole and rhachis.

The adoption of the term common petiole, in the sense defined, has the advantage of avoiding a possible difficulty—namely, if the portion of the common petiole of a bipinnate leaf below the lowest pair of pinnae, the petiole in the Kunthian sense, is longer than the internode immediately above, how is one to be quite sure that at least one pair of pinnæ, below the lowest pair present, has not been suppressed; and that, consequently, the supposed petiole is only apparently, and not really, the actual petiole?

When Bentham came to deal with the Acacias in the second volume of the Flora Australiensis (1864), he adopted a somewhat different and mixed terminology, partly as defined above for the *Mimoseae* proper, and partly in accordance with the definitions given in the Introduction and Glossary prefixed to the descriptive matter in the first volume. While still using the term common petiole for the whole of the stalk to which the pinnæ are affixed, he also uses the term petiole, in the Kunthian sense, for that part which is below the lowest pair of pinnæ; and he also uses the term rhachis. But I do not understand Bentham to use the term common petiole as synonymous with the term rhachis, as defined in the Introduction—"39. The common stalk [of a compound leaf] upon which the leaflets are inserted is called the *common petiole* or the *rhachis.*"

If one examines the impari-pinnate leaves of *Tecoma capensis* (4 pairs), *T. radicans* (4-5 pairs), *Robinia pseudacacia* (8 pairs), *Ailanthus glandulosa* (up to 14 or more pairs)—all common garden-plants, with leaves of the same type, varying considerably in length according to the number of the pairs of leaflets, with fairly large leaflets, much about the same breadth—it may be noticed: (1) that the length of the internodes corresponds to, or is a little longer than the greatest breadth of the leaflets, so that these may be fully exposed to the light without any overlapping; (2) that the leaflets are fairly at right angles to the axis to which they are attached; (3) that by the lengthening of the petiole of the terminal leaflet, this also is fairly displayed without overlapping the leaflets of the pair next below; and (4), that the petioles—the portions of the common petioles below the lowest pair of pinnæ—are relatively short or very short, no longer sometimes than the lowest internode, or half as long again, or a little longer.

If, next, one examines the pari-pinnate leaves of *Cassia Candolleana,* also common in gardens, with four pairs of leaflets, it may be noticed:—(1) that the internodes are about as long as, or a little longer than, the greatest width of the leaflets; (2) that, in the absence of the terminal leaflet, the leaflets of the first pair, or of the first and second pairs next below, usually move slightly inwards,

* Bentham, "Notes on *Mimoseae*, with a short Synopsis of Species." Hooker's Journal of Botany, Vol. iv., p. 342, 1842.

while the two still lower pairs are more or less at right angles to the axis; (3) that there is a terminal seta representing a remnant of the missing terminal leaflet, unless it is accidentally wanting, as it often is in the full-grown leaves, which is green and very conspicuous in quite young fresh leaves; and (4) that the petiole, real or apparent, is somewhat variable in length in different leaves, and may be about half as long again as the lowest internode, or even a little more.

In the pari-bipinnate leaves of the Australian Acacias, it will be noticed—(1) that, in the absence of the terminal pinna, represented by the terminal seta, the pinnæ of the apical pair invariably, as far as I have seen, move inwards so as almost or actually to touch or even slightly overlap; that those of a few pairs below, if the pairs are numerous, may also move inwards, but that some of the lowest pairs may be more or less at right angles;—(2) that the internodes are about as long as the spread of an opposite pair of expanded leaflets measured from tip to tip, but may be slightly longer; the internodes of the same leaf may also vary slightly in length—and (3) that the petioles, apparent or real, are short if the leaflets are short, excessively short sometimes as in *A. Baileyana*, and *A. Jonesii*, but much longer, though still relatively short, if the leaflets are long as in *A. pruinosa*, or very long indeed, as in *A. elata*. Following are the measurements of the leaves of the five species available:—

A. Baileyana—4 pairs of pinnæ; common petiole, $1\frac{1}{4}$; lowest internode, $\frac{1}{4}$; petiole, $\frac{1}{8}$ inch. (Pl. iv., fig. 1). The largest number of pinnæ noticed is five pairs. The leaflets of this species are not sensitive.

A. discolor—9 pairs of pinnæ; common petiole, $4\frac{1}{2}$; lowest internode, $\frac{5}{16}$; petiole, 1 inch. In another leaf on the same branch, the petiole was no longer than the internode above.

A. decurrens—17 pairs of pinnæ; common petiole, $5\frac{1}{4}$; lowest internode, $\frac{1}{4}$; petiole, $\frac{7}{8}$ inch.

A. pruinosa—6 pairs of pinnæ; common petiole, $6\frac{5}{8}$; leaflets up to $\frac{3}{4}$; lowest internode, $\frac{7}{8}$; petiole, $1\frac{5}{8}$ inch.

A. elata—5 pairs of pinnæ; common petiole, $9\frac{3}{4}$; leaflets up to $1\frac{5}{8}$ (Bentham gives up to 2 inches); lowest internode, $1\frac{3}{4}$; petiole, $2\frac{3}{4}$ inches. Three other leaves have the petioles somewhat shorter. This species has very long pinnæ, up to more than 8 inches.

Bipinnate leaves may be short, or long, or of intermediate length, according to the number of pairs of pinnæ present; that is, according to the number and length of the internodes, and the length of the apparent petiole. The number of pairs of pinnæ present in a given length depends on the length of the leaflets, and this is a very variable quantity.

The bipinnate leaves of *A. elata* and *A. pruinosa*, of all the twenty-two species described in the Flora Australiensis, and as described therein, have the longest leaflets. Therefore, they may be expected to have, as they actually have, the longest internodes, and the longest petioles, real or apparent. No seedlings of euphyllodineous Acacias have as yet, been described by Cambage, with leaflets promising to be anything like as long as those of *A. elata*.

Allowing about 3 inches as the maximum length of the petioles of the Australian bipinnate Acacia with, by far, the longest leaflets known, what valid ground is there for supposing, if the so-called phyllodes are simply flattened petioles which have dropped their blades, that they can attain lengths of "from 6 in. to 1 ft." (*A. macradenia*), "above a foot long, the upper ones $\frac{1}{2}$ ft." (*A.

cyanophylla), "lower phyllodia 6 to 10 in. long" (*A. Lindleyi*), "3-10 in. long or even more" (*A. pachycarpa*), and others, as described by Bentham? I have euphyllodes of *A. longifolia* up to 13½ inches long, and 1½ broad; and Maiden has recorded a variety of this species with phyllodes, so-called, up to 20 inches long. Allowing one-third of the total length for that of the petioles, euphyllodes 12-20 inches long—if they are simply flattened petioles which have lost their blades—should belong to potential bipinnate leaves 3 to 5 feet long!

The euphyllodes of Australian Acacias may be short or they may be long. If very short, they are the flattened axes of species, which, if they had not become euphyllodineous, would have only a few (1, 2, or 3) pairs of pinnæ. If long, under similar circumstances, they should have numerous pairs of pinnæ, as shown in my photographs (Pls. v.-vii.) of leaves of reversion-shoots of a species with long euphyllodes, up to 8¾ (Pl. ii., fig. 1) inches long, or even longer. But flattened petioles of leaves of Australian Acacias, which have lost their blades, as long as 12-20 inches, are mythical structures; and the idea that there are, or may be such is nothing less than fantastic!

The current idea that the euphyllodes of Australian Acacias are simply flattened petioles which have lost their blades, is a barren conception which has retarded the progress of knowledge. If that is all they are, one is precluded from discussing the question of what sort of bipinnate Acacias the euphyllodineous Acacias would or might be if they did not develop euphyllodes.

But when it is realised that the euphyllodes are the flattened, primary leaf-axes or common petioles of bipinnate leaves which have lost their pinnæ, it becomes possible to reconstruct them theoretically in a very simple way, and then to find analogues of them among the existing Bipinnatæ, since these include Acacias of which the adult leaves have—one pair of pinnæ only, "on a common petiole of about ¼ inch long," as Bentham records of *A. Gilberti*, or "1 or 2 pairs, the common petiole about ¼ inch" (*A. suberosa*), or any number of pairs up to "usually 10 to 20 pairs" (*A. dealbata*, length of common petiole not stated), or "15 to 20 pairs, the common petiole 2 to 3 inches" (*A. Bidwilli*), or possibly even more, if one were to search carefully over abundance of material.

The simple method of reconstructing them is, to measure with a pair of compasses the length, from tip to tip across the partial rhachis, of a good pair of opposite, expanded leaflets on the bipinnate leaves of a seedling. This will give approximately the length of an internode. Then measure off the internodes on a euphyllode, beginning at the apex, and what is over, regard as the petiole. This will enable one to calculate approximately the possible number of pairs of pinnæ that could be present. If one can get a seedling with a leaf with two pairs of pinnæ, one can compare the length of the internode with the length of an opposite pair of leaflets. Having done this, then look for the bipinnate analogue among the bipinnate species described by Bentham, or others, and figured in Mueller's "Iconography of the Acacias," or elsewhere. But, of course, reversion-foliage, and especially reversion-shoots, if one can get good specimens, will show Nature's method of actually doing it.

Reversion-Foliage, Reversion-Shoots, and Suckers.

Textbooks sometimes mention, in an indefinite way, the occurrence of reversion-foliage on euphyllodineous Acacias which have been pruned or otherwise injured. Lubbock and Thomé's figure sprays of *A. melanoxylon*, with both euphyllodes and bipinnate leaves; and other authors mention similar peculiarities. This species is an exceptional one, in need of special investigation. It is a species which I have not had the opportunity of examining. *A. longifolia* is much infested by borers, and one can find plants which have been broken by people in getting the flowers, but I have never met with reversion-foliage. Seedlings of *A. falcata* are often so badly attacked by insect gall-makers, that the growing point may be killed, but I have not found that it induces the production of reversion-foliage. Plants of *A. myrtifolia* often show a disorganised production of crowded euphyllodes, apparently due to fungoid attacks, but I have failed to find reversion-foliage.

Quite the most satisfactory species for foliage of this kind is *A. suaveolens*, because one can get it in abundance. Advanced seedlings up to 5 feet high, seem to be particularly liable to fungoid attacks, which sometimes seriously interfere with, or even kill the growing-point, often resulting in large excrescences of abnormal growth on the summit. If this happens, not too close to the ground, it frequently results in an outburst of reversion-foliage along a portion of the stem, or on the proximal portions of any branches that may be present. This will often supply most instructive stages in the transition from bipinnate leaves to euphyllodes, which are not shown in normal seedlings.

Eleven examples of remarkable leaves (nat. size) are shown in Plate i. These are of interest because, in addition to the ordinary apical pair of pinnæ, or this and the second pair next below it, some of them show pairs of reduced pinnæ, or single reduced pinnæ, pairs of leaflets or single leaflets, at different levels, on the margin of the developing euphyllode or half-euphyllode, instead of on the midrib; others show foliaceous terminal setæ; and two have three leaves at a node. Figs. 1, 3, and 11 have no or but slight development of the lower side of the euphyllodes. All three have an odd pinna below the first pair of pinnæ, or just below the second pair (the leaflets missing in Fig. 3); and, at a lower level, a pair of pinnæ with a reduced number of leaflets, on the margin of the euphyllode. *A. suaveolens* is remarkable in this respect, namely, for the transference of the leaf-buds to the margin of the euphyllode, instead of their remaining on the midrib.

Figs. 2 and 6 show two pairs of pinnæ (one pinna missing in Fig. 6) and a single, small pinna, with but few leaflets, on the edge of the euphyllode. They are figured especially to show, what I have seen only in the reversion-foliage of this species, in which it is common—the occurrence of three leaves at some of the nodes, of which the middle one is always the most developed. In the examples given, the two lateral leaves of the trio are simply pinnate. But, sometimes, one or both may be bipinnate; or the middle one may be a complete large euphyllode, while one, at least, of the lateral ones may be a smaller euphyllode. The two lateral leaves probably develop from reserve-buds. Lubbock describes and figures a seedling of *A. verticillata*, of which the sixth leaf was represented by a single euphyllode, but some of the succeeding ones by broken or complete whorls of euphyllodes. Other species may also have whorled or verticillate or grouped euphyllodes; but, as far as I know, nothing analogous to it is known in bipinnate Acacias. Fig. 2 shows the terminal seta; and the retarding effect of the presence of the second pair of pinnæ on the flattening of the internode, and for some distance below.

Figs. 4, 5, and 7 show a pair of leaflets, or two odd leaflets, on the margins of the euphyllode at different levels. Sometimes a pinna, or a leaflet or leaflets, may be quite close to the base, indicating that the petiolar portion of the euphyllode is relatively very short. I have two examples of nearly complete euphyllodes, one of which has an apical pair of pinnæ, and a large leaflet with an opposite pair of small ones, on the margin $\frac{3}{8}$ inch from the base; while the other has an apical pinna with two pairs of leaflets, and a marginal pinna with two pairs of leaflets, $\frac{3}{8}$ inch from the base. Another specimen has one pair of pinnæ, of which one has a terminal leaflet. I have one leaf with three complete pairs of pinnæ.

Figs. 4, 8, 9, 10 show foliaceous terminal setæ. Two of them have marginal leaflets, and in one case, a pinna which shrivelled in drying.

I am indebted to Mr. C. T. Musson for some very interesting reversion-shoots from a shrub of *A. podalyriaefolia*, which had been cut back. These are particularly interesting, because this species has short euphyllodes, which are nearly as broad as they are long, up to $1\frac{1}{2} \times 1\frac{3}{16}$ inches. Seventeen leaves show no flattening on the lower side, and fifteen of these have two pairs of pinnæ. Three of these are figured. (Plate vii., figs. 1-3.) They all show much flattening of the upper side of the leaf-axis up to the level of the lower pair of pinnæ, and some flattening of the internode. But the lower, broad, flattened portion has a loose end. The presence of the lower pair of pinnæ, by retarding the flattening of the internodal contribution to the complete euphyllode and blocking the way, left the portion below the lower pair of pinnæ in the lurch, in all three cases; and I have others more or less like them. Two examples, with one pair of pinnæ (Pl. vii., figs. 4-5) show very well the rudiment of the terminal pinna, without leaflets, with the terminal seta, which, in this species, unless accidentally missing, is usually conspicuous on the early euphyllodes, and particularly on the young ones. It is so long sometimes that, when dry, it twists. It is obvious that, in this case, the euphyllode comprises two, or at the most, three, internodes, and the petiole. If it were not euphyllodineous, this species would be a bipinnate Acacia with three pairs of pinnæ, occasionally, perhaps, four at the most. Cambage has recently described and figured the seedling of this species [Part v. of his papers].

The finest examples of reversion-shoots and suckers, I have yet seen, are two lots of *A. implexa* (?), which I quite casually met with in March, 1919: One lot comprises specimens from two plants, 8-10 feet high, growing close together, that had been badly scorched by a bush-fire, which killed the parts above ground, but without injury to the root-system. Reversion-shoots from the base of the stems, and suckers from some of the roots came up freely. I fortunately found them in the early stages; and specimens were taken, from time to time, over a period of six months, until what were left had only euphyllodes, or a few bipinnate leaves of no importance. The second lot was procured from some half dozen plants at the side of a country-road, which had been mischievously broken or cut off a little above the ground.

From the complete collection, I have been able to select a sequence of leaves, which include— (1) simply pinnate leaves, present on two suckers, but, if developed, missing on the reversion-shoots; (2) bipinnate leaves with from one to eleven actual or potential pairs of pinnæ, some of the lowest pairs being represented by leaflets; and (3) the five late stages of the waning pinnæ, and the waxing flattening of the long common petioles or primary leaf-axes, shown in Plate vii. The entire sequence is not shown, my main object being to show as many as possible of the best examples illustrating the inversely proportional ratio in which the two antagonists are represented at various stages. The substitution of flattening axes for pinnæ is not a case of "walk in, walk out." It is an intense struggle between them. The potentially heavyweight euphyllodes knock-out the bantam pinnæ very promptly in weak seedlings. But, in reversion-shoots, with a well-established root-system to back them up, they put up a much better fight, and are able to prolong the strugglel, hopeless though it is.

These specimens are most interesting because the euphyllodes are so long, up to about 9 inches, and yet not too narrow. This means that, if they were not euphyllodes, they would be bipinnate leaves with numerous pairs of pinnæ, up to 15-20. Therefore, they contrast admirably with, and supplement the two cases, one with very short and the other with euphyllodes of medium length, already considered. Nevertheless, they show only another phase of the same kind of thing. The three are not special cases, but only those of which I have been able to get adequate material.

The illustrations (Plates ii.-vii.) need little explanation, if it is kept in mind:—

(1) That the succession of the pinnæ in the development of the compound, bipinnate leaves of the Australian Acacias is basipetal, not basifugal, as in the leaves of Jacaranda. In seedlings, the first leaf, or a pair of them, is simply pinnate, a simpler type of those which come after it. Then follows an abruptly bipinnate leaf with one pair of pinnæ, representing the replacement of the apical pair of leaflets of the first pinnate leaf, without any representatives of the other pairs of leaflets. That it is the apical pair, is shown by the presence of the terminal seta at the apex of the common petiole of every leaf, from start to finish, unless it is accidentally missing. Then, in due course, in the seedlings of the Bipinnatae, of some of the Euphyllodineæ, and in reversion-foliage and reversion-shoots of any of them, follow leaves with two, three, or more up to the complete number, or approximating thereto. These represent always the apical pair and one, two, three, or more pairs, as the case may be, up to the full number, of successive pairs of pinnæ, in order next below the apical pair. The apical pair is always present in every leaf, however many pairs of pinnæ may be present, except in the decadent stages of the outgoing pinnæ, as illustrated in Plate vii.

(2) Therefore, if the full possible number is not present, the shortage is in the lower portion of the series. Also, the good, well-developed pinnæ, if all of them are not equally well-developed, when a number of pairs are present, are those attached to the upper part of the common petiole; and the poor specimens, sometimes only represented by leaflets, are attached to the lower part of the leaf-axis, as is shown in figs. 1-4 of Pl. vi., and figs. 4 and 6 of Pl. vii.

(3) This provides an opening for the flattening of the axis to make a start on the proximal portion of the leaf-axis, where pinnæ are absent or poorly developed. If only one pair of pinnæ is present at the apex, the surviving apical pair, as shown by the presence of the terminal seta, the entire leaf-axis may flatten from top to bottom (Pl. iii., fig. 5; Pl. vii., fig. 4). Illustrations of flattening axes with an apical pair of pinnæ, more or less resembling my examples, are commonly shown in textbooks, as confirmation of the statement, that the so-called phyllodes of Acacias are flattened petioles which have lost their blades!

The figures of Plates iv.-v., and fig. 5 of Pl. vi., show a few pairs (2-5) of strong pinnæ attached to the upper part of the leaf-axis; well-marked flattening of the axis in the lower part; but retarded flattening where the pinnæ are situated, though there may be unmistakable indications of it. Fig. 3 of Pl. iv., and fig. 5 of Pl. vi., show the damping effect of the presence of good pinnæ excellently.

Figs. 1-4 of Pl. vi., show the retarding influence of the presence of pinnæ on the flattening, in the leaves with the maximum number of pairs of pinnæ, that I have succeeded in finding. These are very instructive. Leaves with 7-9 pairs are not shown, only for want of space, and because they do not show anything more than these do.

Plate vii. shows the last stages of the decadent pinnæ, correlated with a maximum of flattening of the leaf-axis. Figs. 1, 2, 4 and 6, representing the pinnæ on their last legs, are the only ones of the entire series which lack the apical pair of pinnæ. Figs. 4 and 5 are particularly instructive, because they show a minimum amount of flattening in the proximal part of the leaf-axis, where the forlorn surviving pinnæ or leaflets are stranded; and then, distad of them, the flattening soon increases. Fig. 4 has but two single pinnæ with a reduced number of leaflets; unfortunately the upper portion of the euphyllode was missing when I got it. Fig. 6 shows the lowest pair, and the one next above, represented by leaflets; and then, above these, a pair of reduced pinnæ, and a distal better pair. The portion of the axis below the lowest leaflet, the real or apparent petiole, is longer than the internode above it—even allowing that it may be the real petiole—but it is relatively very short. In the face of such evidence as this, can anyone still believe that the so-called phyllodes of the Australian Acacias are merely flattened leafstalks or petioles which have lost their blades?

An interesting paper by Dr. C. E. Preston, on "Peculiar Stages of Foliage in the Genus Acacia," is contained in the American Naturalist, Vol. xxxvi., p. 727, September, 1902. This is worth attention, because what is so often tacitly assumed and taken for granted, is discussed in this paper; namely, to which pair of leaflets of the first simply pinnate leaf of a seedling does the single pair of pinnæ of the next bipinnate leaf correspond? Preston says: "A peculiar transition-stage between the singly pinnate and the bipinnate is sometimes found in seedlings of *A. leprosa* Sieber, when growing under cultivation. The shadow-prints (Figs. 1 and 2) annexed show the nature of this peculiarity. The lower pair of leaflets only is replaced by a pair of strongly developed pinnæ, while the rest of the axis runs on singly pinnate and rather weak in structure. As a rule, no such continuation of the main axis is to be found." Shadow-prints of two young seedlings are given, showing an "abnormal third leaf" in each case; the first being simply pinnate, the second bipinnate, and the third apparently tripinnate. With all due deference to the author, and simply on the basis of *magna est veritas et prevaleat*, I venture to express the opinion that, having inadequate material, he completely missed the significance of his abnormal leaves, and misinterpreted them.

From my standpoint, they are one of two things (1) either examples of tripinnate leaves, an apical pair together with a terminal pinna (the middle one); or, what is more probable, a complete, apical pair (the middle one, and one of the lateral ones), and an incomplete pair next below (the other lateral one, its fellow, missing), the internode which should have separated the pairs (complete or incomplete) not having lengthened. One cannot decide which view is correct, because the terminal seta is not mentioned; and it is not recognisable in the small shadow-prints. In both cases, the stalk below the three pinnæ is the common petiole or primary leaf-axis, and not the petiole only, as the author supposes; as is suggested by the length of it.

Cambage has examined seedlings of more species than any other writer; descriptions and illustrations of fifty-five have already been published. He has not so far found a leaf of a seedling with the terminal pinna present, but he has met with one instance of it in the leaf of a sucker. I have had the opportunity of looking over several thousand wild seedlings, representing about twelve species, in the hope of finding anomalies, but with little success. I have not yet seen a leaf of any Acacia, seedling or adult, which had a complete terminal pinna; but a leafless thread-like representative of its axis, with a terminal seta, is sometimes to be found in the leaves of reversion-shoots (Pl. iii., figs 5, 6; Pl. viii., figs. 5-6). I have also one bipinnate leaf of a seedling, of which one pinna has a terminal leaflet. *A. leprosa* is an Australian species, but no other descriptions of seedlings have been published. If the leaves of Preston's two seedlings really represent tripinnate leaves (that is the apical pair, together with a terminal pinna), they are, as yet, the first to be recorded.

What I believe to be the correct explanation of them is, that they are merely examples like the three shown in my Pl. iii., fig. 3; and Pl. viii., figs. 9-10. The first of these is the leaf of a reversion-shoot. I have others like it; and others with the two pairs complete, but separated by a very short internode. The second is a leaf of a seedling of *A. myrtifolia*, and the only specimen I have. But Cambage has figured similar leaves of *A. buxifolia* and *A. pycnantha* [Acacia Seedlings, Part iii., p. 393]. When the terminal seta is taken account of, there is no difficulty in interpreting them. The third is a leaf of *A. decurrens*, which is comparable with the others.

I have failed to find any evidence whatever that the lowest or proximal pair of leaflets of the first simply pinnate leaf is ever replaced by a pair of strongly developed pinnæ, while the rest of the axis runs on simply pinnate, and rather weak in structure. On the contrary, the apical pair of leaflets is replaced by an apical pair of pinnæ; and there is no replacement at all of the lower leaflets of the first pinnate leaf before the transition of complete euphyllodes in seedlings of many species, though there is in others, as in the Bipinnatæ. Therefore, in every leaf, at every stage of development, whatever else may be present or absent, the apical pair is normally present, and, in the very early stages, it is the only pair. The succession of the pinnæ in the development of the bipinnate leaf is basipetal.

The leaf of *A. decurrens* figured by Preston as "showing a tendency towards a triple pinnation," that is, "showing clearly the third degree on some of the basal leaflets of the pinnæ," is a remarkable but rare aberration. This species is a very common one in the Sydney district, and I have examined many leaves; but I have not succeeded in finding specimens of this or any other Acacia which show it. But I have collected three leaves of Jacaranda, which have a few of the basal leaflets of the lowest pinnæ exemplifying a tendency toward a triple pinnation.

But what Preston has to say about the leaves of *A. heterophylla*, of which he gives illustrations, is very important. This is a species indigenous to the Island of Bourbon and Mauritius, or both of them, I believe; and I cannot hear that it is cultivated in Sydney gardens. It is sometimes mentioned in textbooks, and it appears to be a remarkable species, like *A. melanoxylon*, *A. rubida*, and perhaps some others, all of which are worthy of a detailed study of gradational series of plants of various ages. Preston says—"There was also found a fairly large number of stages [of *A. heterophylla*] which lead one to doubt greatly whether in all cases it is the petiole only which is transformed to the phyllode, and pinnæ. They illustrate very well the inversely proportional ratio in which the proximal one. The prints which follow may, to be sure, represent mere anomalies, but from their number, at least, they cannot but raise in one's mind a certain hesitation to consider the existence of a law as to method in any way established.

Here the flattening appears in some cases entirely on the distal portions without affecting the petiole, in others both petiole and rhachis are involved to varied extents. How these are to be interpreted under one general law seems incomprehensible."

Preston does not say whether the seven leaves figured are such as are to be found on ordinary plants, whose growth has not been interfered with by pruning or otherwise. In the absence of descriptions of the plants or of seedlings, and of personal knowledge of the species, or of any other like it, I cannot settle the point. But they are certainly comparable with some of the leaves of reversion-shoots, as shown in my Plates, especially Pl. iii.-vi. They are pictures of the contest between the flattening common petioles, or leaf-axes, and the pairs of pinnæ. They illustrate very well the inversely proportional ratio in which the two antagonists are present in any particular leaf; and how, if pinnæ are present, no matter where they may be located, the flattening of the leaf-axis is retarded where they are situated; and how, if they are absent on some part of the axis, no matter where, the flattening of the axis is correspondingly favoured in that particular region. The localised damping or retarding effect of the presence of the pinnæ on the flattening of the leaf-axis is very well shown in some of his figures.

But the idea that the so-called phyllodes of some Acacias are flattened petioles which have lost their blades, and of others, that they are flattened axes which have lost their pinnæ, is erroneous. There are not two kinds of phyllodes, so-called, of Acacias. The two hypotheses, that there are, cannot be harmonised. Therefore, I am prepared to go further than Preston, and say that the attempt to interpret them under one definite law not only seems, but is, incomprehensible, inasmuch as it is not possible. The so-called phyllodes of Australian Acacias are not flattened petioles which have lost their blades, as both seedlings, when they are correctly interpreted, and reversion-foliage and reversion-shoots demonstrate. Therefore, they have been improperly called phyllodes; and consequently any attempt to interpret them in terms of something which they are not, cannot but be futile. But when it is realised that the euphyllodes of all the Acacias of which we have sufficient knowledge, are flattened leaf-axes or common petioles, which have lost their pinnæ, then it becomes possible to say, that there is but one definite law which applies to all that are known, and that it is a readily comprehensible law.

I regret that I am unable to consult Reinke's paper,* referred to by Preston. It is not available in Sydney. The abstract of it in the Journal of the Royal Microscopical Society (1897, p. 549) does not include Reinke's views about phyllodes. Under the circumstances, Preston supplies what one chiefly wants to know, namely—"*A. rubida* A. Cunn. and *A. heterophylla* Willd., have already been described by Reinke, and in his article one stage in the transition as it occurs in *A. heterophylla* is figured. According to that author, the change is merely a gradual flattening of the petiole, accompanied by the reduction of parts more distal." It is not surprising that Preston was unable to reconcile the views here stated, with the characteristics of the leaves which he figures.

Goebel, in his "Organography of Plants" (Vol. i., p. 166, fig. 102) remarks—"The best known and most frequently quoted are the species of Acacia which produce phyllodes. The phyllodes arise by the broadening in a vertical direction of the leaf-stalk, sometimes also of the leaf-midrib, whilst the lamina aborts. Seedling plants (Fig. 102), however, have, without exception, so far as they have been examined, leaves which are like those of the species—possessing a bipinnate

* Reinke, J., "Untersuchungen über die Assimilationsorgane der Leguminosen." Pringsheim's Jahrb. f. wiss. Bot. Bd. xxx., 1896.

lamina and a normal leaf-stalk. As successive leaves are formed, the leaf-stalk gradually broadens, whilst the lamina is reduced until the form of the phyllode is attained. In some species foliage-leaves may again appear after the phyllodes, for instance in *A. heterophylla*."

Also, in Vol. ii., p. 355 he adds—"The best examples of the formation of phyllodes are to be found in a number of Australian species of Acacia." It is usually said that in the phyllode of Acacia the lamina is entirely wanting. This is incorrect, for the lamina can always be seen upon the primordium. . . . In some species, for example *A. floribunda*, *A. melanoxylon*, and *A. uncinata*, there are transition-forms which show that the rhachis may have a share in the formation of the phyllode."

Inadequate material, and the disregard of the presence, the meaning, and the significance of the terminal seta, as in so many other cases, are herein responsible for the misinterpretation of seedlings. What Goebel calls the primordium of the lamina, which is always present upon the phyllode, I should term the terminal seta merely, or sometimes, in the young or early euphyllodes (but not in late ones), juvenile stages of a pair of pinnæ, always the apical pair, together with the terminal seta, at the apex of the flattened common petiole. His suspicion that, in some species, the so-called phyllodes are something more than flattened leaf-stalks, is interesting. I regret that I have not been able to make more use of Goebel's important treatise. I have been unable to purchase or borrow it; and there are so few copies in Sydney, that one can consult them only under time-consuming conditions.

EXPLANATION OF PLATES i.-viii.

REFERENCE LETTERS.

a. t. p., leafless, thread-like axis of the terminal pinna—*f. t. s.*, foliaceous terminal seta *t. p.*, terminal pinna—*t. s.*, terminal seta

Plate i.—*A. suaveolens* (reversion-foliage).

Figs. 1-7 and 11 show leaves with two pairs or one pair of good pinnæ on the upper part of the common petiole or primary leaf-axis; and poorer pinnæ with a reduced number of leaflets, or a pair of leaflets or odd leaflets *on the margin* of the lower part of the flattening leaf-axis below the second good pair (when there are two pairs), that is, on the developing half-euphyllode (the flattening on the upper side of the axis only), or euphyllode. Note the inversely proportional ratio in which the two antagonists are present.

Figs. 2 and 6 show also three leaves at a node, the two lateral ones simply pinnate.

Figs. 4, 7, 9, 10 show green, foliaceous, terminal setæ.

Plate ii.—*A. implexa* (?).

Fig. 1—An average complete euphyllode.

Fig. 2.—A seedling showing the transition from a bipinnate leaf with one pair of pinnæ (the apical pair) to a complete euphyllode on the fifth leaf. The fourth leaf is a portrait of the two juvenile antagonists—a pair of pinnæ (bantam), and the leaf-axis or common petiole to which they are attached (the potential heavy-weight, which, after the tussle is all over, attains the dimensions of the example shown in Fig. 1).

Plate iii.

Fif. 1.—Upper portion of a leaf of *Caesalpinia Gilliesii* to show the terminal pinna present in this species. This, in the Acacias, aborts, and is represented by a remnant, the terminal seta.

Fig. 2.—Leaf of a seedling of *A. discolor*, showing the basipetal, incomplete developments of the leaflets of the middle pair.

Figs 3-6.—Leaves of Reversion-shoots of *A. implexa* (?).

Fig. 3.—Back view of a leaf with what appears to be a terminal pinna The middle one and the one on the right constitute the apical pair, as indicated by the presence of the terminal seta (discernible with a lens in the photo). The one on the left, whose fellow did not develop, represents an incomplete second pair next below, very close to the apical pair because the internode did not lengthen.

Fig. 4.—Leaf with one pinna of the second pair missing. Two alternate, or perhaps odd pinnæ below, represented by large leaflets.

Fig. 5.—Leaf with the apical pair of pinnæ only, and a terminal pinna represented by a leafless thread-like axis, and a terminal seta. The whole of the axis is more or less flattened.

Fig. 6.—Another leaf with three pairs of good pinnæ, and a rudimentary, leafless, terminal pinna, and a terminal seta. Some flattening of the axis throughout, but retarded where the pinnæ are.

Plate iv.

Fig. 1.—Complete leaf (back view) of *A. Baileyana*, with four pairs of pinnæ, and a terminal seta, visible with a lens. Note the excessively short petiole.

Figs. 2.—Leaves of reversion-shoots of *A. implexa*, including two complete euphyllodes. The branchlet shows the order of the succession. Note the inversely proportional ratio in which the two antagonists are present—good pinnæ on the upper part of the axis; much flattening on the lower part, extending upwards, but retarded where the pinna are (especially in Fig. 3). Also the terminal seta at the tip of the larger phyllode; rudimentary pinnæ in the smaller one.

Plate v.—Leaves of Reversion-shoots of *A. implexa* (?).

Figs. 1-5.—Most interesting stages of the contest when the antagonists are fairly equally matched. Good pinnæ on the upper part of the axis; flattening most marked on the lower part, extending upwards, but retarded where the pinnæ are. Note the terminal setæ, with some indication of the developing pinnæ of the apical pair in the youngest euphyllodes, and the terminal seta alone in the largest one

Plate vi.—Leaves of Reversion-shoots of *A. implexa* (?).

Figs. 5-6 supplement the series shown in Plate v., and are fine specimens.

Figs. 1-3, with 11 and 10 pairs of pinnæ, the maximum number, as yet seen, show the pinnæ doing their very best. Some of the lowest pinnæ show reduction in the number of leaflets. The lowest pinnæ in all three are represented by leaflets. The presence of so many pinnæ has obviously put the brake on the flattening of the axes. Note the short petiole in Fig. 3, and the terminal seta in Fig. 5. Also, that, in the leaves of this species, the pinnæ are attached to the midrib, and not to the margin, as in *A. suaveolens* (Pl. i.).

Plate vii.—Leaves of Reversion-shoots of *A. implexa* (?).

Figs. 1-7. Six decadent stages of the waning pinnæ, variously located, and a complete euphyllode The common petioles or primary leaf-axes show more or less flattening from base to apex. The distal portion of No. 1 is missing; but note the retardation of the flattening in the lower portion of this and No. 6, where the reduced pinnæ, or leaflets are; and how the flattening increases distad of the distal pinna or pair of them. Note also the short petiolar portion of No. 6, in which the two proximal pairs of pinnæ are represented by leaflets

Plate viii.

Figs. 1-4.—Four, developing half-euphyllodes of *A. podalyriaefolia* with two pairs of pinnæ; some flattening of the internode; and the broad flap-like flattening of the axis below the second pair of pinnæ, with a loose end, which, but for the presence of the lower pair of pinnæ, would be joined up with the apex by the fully flattened, internodal portion.

Figs. 5-7.—One half-phyllode, and one nearly complete, with one pair of pinnæ, and a rudimentary, leafless, terminal pinna and terminal seta, of the same species.

Fig. 7.—Young euphyllodes of the same species, showing the conspicuous terminal setæ.

Fig. 8.—Three very young leaves of *A. discolor*, showing the terminal setæ of both the rhachis, and of the partial rhachises.

Fig. 9.—Upper portion of seedling of *A. myrtifolia* with the fifth leaf apparently tripinnate. The middle one and the one on the right, with the terminal seta between but behind them, are the apical pair. The one on the left represents an incomplete second pair next below, the internode not having lengthened.

Fig. 10.—Upper portion of a leaf of *A. decurrens*, showing the same sort of thing, the middle pinna and the one on the left being the apical pair. The rest of the leaf, together with eight pairs of pinnæ have been removed.

Fig. 11.—Upper portion of a not mature remarkable leaf of *Jacaranda* (the rest of the leaf, with eleven pairs of pinnæ having been removed), showing four pairs of pinnæ towards the apex, and the terminal pinna, all represented by leaflets, some with serrated edges; and the pinnæ with terminal leaflets.

Mr. J. H. Campbell, Hon. Treasurer, presented the balance sheets for the year 1919, duly signed by the Auditor, Mr. F. H. Rayment, F.C.P.A., Incorporated Accountant; and he moved that it be received and adopted, which was carried unanimously.

No valid nominations of other Candidates having been received, the President declared the following elections for the ensuing Session to be duly made:—

PRESIDENT: Mr. J. J. Fletcher, M.A., B.Sc.

MEMBERS OF COUNCIL (to fill six vacancies):—Messrs. J. E. Carne, F.G.S., H. J. Carter, B.A., F.E.S., Prof. T. W. E. David, C.M.G., D.S.O., D.Sc., F.R.S., Prof. W. A. Haswell, M.A., D.Sc., A. H. S. Lucas, M.A., B.Sc., and J. H. Maiden, I.S.O., F.R.S.

AUDITOR: Mr. F. H. Rayment, F.C.P.A.

It was resolved, on the motion of Miss S. Hynes, seconded by Mr. A. G. Hamilton, "that it is the opinion of Members of this Society that in the interests of Science, the Rowan Collection of paintings should be retained in this the Mother State."

On the motion of Mr. A. G. Hamilton, a very cordial vote of thanks to the retiring President, Mr. J. J. Fletcher, was carried by acclamation.

Linnean Society of New South Wales.

GENERAL ACCOUNT. Balance Sheet at 31st December, 1919.

LIABILITIES.	£ s. d.	£ s. d.
Capital: Amount received from Sir William Macleay during his lifetime	14,000 0 0	
Further sum bequeathed by his will	6,000 0 0	
		20,000 0 0
Contingencies Reserve A/c		700 0 0
Income A/c at 31st December, 1919		610 16 8
		£21,310 16 8

ASSETS.	£ s. d.	£ s. d.
Investments:—		
War Loan	7,045 0 0	
N.S.W. Treasury Bills	4,000 0 0	
Loans on Mortgage	9,900 0 0	
		20,915 0 0
Society's Freehold		105 0 0
Cash: Government Savings Bank	250 16 8	
,, In Hand	10 0 0	
		260 16 8
		£21,310 16 8

INCOME ACCOUNT, Year ended 31st December, 1919.

	£ s. d.	£ s. d.
To Salaries, Wages, and Retired Allowances		863 0 0
,, Printing Publications	253 9 3	
,, Illustrations	126 1 10	
		379 11 1
,, Rates	35 14 3	
,, Insurance	7 17 9	
		43 12 0
,, Postage, Advertising, and Petty Cash	63 5 9	
,, Printing (sundries) and Stationery (including typewriter)	15 15 3	
,, Audit Fee	5 5 0	
,, Legal Expenses	1 1 0	
,, Gas	3 6 4	
,, Telephone	5 1 0	
,, Maintenance Fee, Sir Wm Macleay's grave	1 10 0	
,, Bank Charges	1 2 11	
,, Removal Expenses (Allowance to Secretary)	25 0 0	
,, Repairs	15 1 10	
		196 9 1
,, Contingencies Reserve A/c		30 0 0
,, Balance to 1920		610 16 8
		£2,123 11 10

	£ s. d.	£ s. d.
By Balance from 1918		392 16 2
,, Subscriptions—		
1919	121 16 0	
Arrears	24 3 0	
In Advance	1 1 0	
		147 0 0
,, Entrance Fees		5 5 0
,, Interest on Investments		1,022 7 6
,, Sales (including 100 copies of Proceedings purchased by Government of N.S.W.)		113 3 0
,, Rent (Bacteriology A/c)		16 0 0
,, Fellowships A/c (surplus income transferred)		397 0 2
		£2,123 11 10

Examined and found correct. Securities produced.
F. H. RAYMENT, F.C.P.A., Auditor.
17th February, 1920.

J. H. CAMPBELL,
Hon. Treasurer.
Sydney, 19th January, 1920.

BACTERIOLOGY ACCOUNT.

BALANCE SHEET at 31st December, 1919.

LIABILITIES.

	£ s. d.	£ s. d.
Capital: Amount bequeathed by Sir William Macleay..	12,000 0 0	
Accumulated Income capitalised ..	2,000 0 0	
		14,000 0 0
Income A/c at 31st December, 1919		366 7 0
		£14,366 7 0

ASSETS.

	£ s. d.	£ s. d.
Investments: War Loan		14,000 0 0
Cash—		
Current A/c	111 3 8	
In Hand	6 0 0	
Government Savings Bank	249 3 4	
		366 7 0
		£14,366 7 0

INCOME ACCOUNT, Year ended 31st December, 1919.

	£ s. d.
To Salary	475 0 0
,, Rent	16 0 0
,, Rates	11 18 1
,, Insurance	1 6 0
,, Petty Cash and Sundries	11 7 10
,, Gas	6 8 3
,, Balance to 1920	366 7 0
	£888 7 2

	£ s. d.
By Balance from 1918	72 15 6
,, Interest on Investments	815 11 8
	£888 7 2

Examined and found correct. Securities produced.

F. H. RAYMENT, F.C.P.A., Auditor

17th February, 1920.

J. H. CAMPBELL, Hon. Treasurer

Sydney, 19th January, 1920.

LINNEAN MACLEAY FELLOWSHIPS ACCOUNT.

BALANCE SHEET at 31st December, 1919.

LIABILITIES.	£ s. d.	£ s. d.	ASSETS.	£ s. d.
Capital: Amount bequeathed by Sir William Macleay		35,000 0 0	Investments—	
Surplus Income capitalised	10,250 0 0		War Loan	16,955 0 0
Less Probate Duty written off	1750 0 0		N.S.W. Inscribed Stock	1,615 0 0
		8,500 0 0	Loans on Mortgage	21,930 0 0
		£43,500 0 0		£43,500 0 0

INCOME ACCOUNT, Year ended 31st December, 1919.

	£ s. d		£ s. d
To Salaries of Linnean Macleay Fellows	1,400 0 0	By Interest on Investments	2,260 0 1
" Cost of publishing Fellows' Papers	252 8 8		
" Fellows' Subsidies	10 11 3		
" Capital A/c	200 0 0		
" General A/c	397 0 2		
	£2,260 0 1		£2,260 0 1

Examined and found correct. Securities produced
F. H. RAYMENT, F.C.P.A., Auditor

17th February 1920.

J. H. CAMPBELL, Hon. Treasurer

Sydney, 19th January, 1920.

ORDINARY MONTHLY MEETING.

31st MARCH, 1920.

Mr. J. J. Fletcher, M.A., B.Sc., President, in the Chair.

The Donations and Exchanges received since the previous monthly meeting (26th November, 1919), amounting to 40 Vols., 486 Parts or Nos., 51 Bulletins, 18 Reports and 15 Pamphlets, received from 106 Societies and Institutions and 5 private donors, were laid upon the table.

ROPINESS IN WATTLE BARK INFUSIONS.

By R. Greig-Smith, D.Sc., Macleay Bacteriologist to the Society.

(With Plate ix.)

The development of ropiness in tan liquors is occasionally met with and probably would be of more common occurrence but for the fact that tanners have learnt by experience how to treat their liquors in order to avoid this objectionable fermentation. The phenomenon does not appear to have been examined, or at least no information about such ropiness has been published. Doubtless the reason for this lies in the difficulty of isolating an organism, capable of producing ropiness, from such a population of diverse organisms as must be present in a fluid with the history of tan liquor. But, beyond this fact, there is something about the subject that is peculiar, as was shown before this investigation was begun. A tan liquor claimed to be ropy was sent to the laboratory and upon being examined no ropiness could be detected. It was quite limpid and, upon being tested for viscosity, showed a water ratio of 1.0714 at 19°. When allowed to flow through a fine capillary, 100 *c.c.* of the reputed ropy liquor ran through in 210 seconds as against 196 seconds for distilled water. The liquid was plated and the bacteria examined, but no ropy organisms could be detected.

The Isolation of the Bacteria.

On account of the diversity of the tan liquor flora and the difficulty of obtaining a good specimen of ropy liquor at the time, the writer considered that the problem could best be attacked from the side of the wattle bark. There promised to be more chance of obtaining an organism capable of causing the ropy fermentation of raw bark infusions than of isolating a similar organism from a ropy tan liquor. As a matter of fact, during some experimental work, ropiness did develop in a bark infusion and a search showed, among many colonies, one possessing a ropy consistency upon a plate of dextrose medium. The organism also caused a fluid medium containing dextrose to become ropy. It was reserved until occasion permitted its further examination.

Some months later, it was decided to isolate fresh races of the ropy organism. Fragments of wattle bark (*Acacia pycnantha*) were put into bottles and covered with water and sometimes with nutrient liquids. Two bottles out of many showed ropiness. One of them had received raw tap water, the other boiled tap water with 0.25 % meat-extract. It was evident that the bacterium was to be found in the bark and was not derived from an outside source such as the tap water and, from the great number of bottles that were prepared, it was shown that the bacteria were not to be found on every bit of bark. A further test as to the absence of the bacteria in tap water was made by filtering a quantity of water and using the slime that adhered to the candle in conjunction with sterilised and raw barks. No ropiness developed in either case.

It was noted, but this may be of no importance, that the ropy infusions were slow to show growths of moulds on the surface of the fluids, while all the non-ropy tests soon became covered with mould. Possibly the ropy bacterium utilised all the available carbohydrate.

The ropy fluids in both of the positive tests contained many bacteria capable of forming slime on dextrose media, but only one of the numerous forms produced ropy colonies and the same organism was found in both positive tests. It gave a canary-coloured, loose, slightly raised growth on nutrient agar, and under the microscope appeared as a round yellow colony with central granules and homogeneous periphery. The bacterium was grown in bouillon and after some time another bacterium of identical form but with different cultural characters appeared. This was at first supposed to be an impurity in the original colony but the same supposed impurity appeared in both races and in others obtained at a later date from bark. The supposed impurity was subsequently recognised as a phase of the original organism, A1.

The ropy organism first isolated and set aside for future examination will be referred to as B., the most active phase of which is B2. The organism isolated later and obtained several times from wattle-bark will be called A. Both bacteria exist in phases best recognised by the appearance of the colonies growing on the surface of nutrient agar. There is the primary phase, such as A1, a weak rope-producer, which can be altered into the strong rope-producer, A2. The change of phase is not abrupt and transition phases are met with. Some of these, generally yellow in colour by transmitted light, are closer related to A1, others, grey or smoky, are nearer akin to A2. The phase B1 was occasionally noted but, as compared with A2, B2 is remarkably stable.

The ropy bacterium, mixed possibly with the altered phase, readily developed ropiness in nutritive solutions containing dextrose, but did not have any apparent action upon a sterilised infusion of wattle bark. In case the infusion had been altered by the sterilisation and become unsuitable for the development of the ropy substance, the bacteria were grown in pasteurised infusion, then in infusion sterilised by filtration through porcelain and finally in raw infusion, but in none of these was there any trace of ropiness. This was rather aggravating but quite in keeping with certain earlier attempts to transfer the ropiness of the original infusion to bottles containing healthy infusions. Unless a mass infection were made, the ropiness could not be transferred, and one had the suspicion that the ropy substance had not increased, but had simply become more diffuse.

The explanation of the apparent anomaly was found after it had been shown that the slime or ropy material was coagulated by tannic acid. It follows from this observation that in the original case the ropiness had developed before much tannin had passed into the water, otherwise the slime produced by the bacteria would have been coagulated upon the bodies of the bacteria, and would have prevented them becoming distributed in the bulk of the liquid. To prove the reasoning, wattle bark, sterilised at 130°, was covered with water, seeded with the bacterium, B2, and incubated at 28°. In sixteen hours a ropy infusion was obtained. A repetition gave the same result.

So far we have arrived at the stage that ropiness is developed in weak infusions of bark substance and not in strong, and it remained to determine the amount of tannin which would permit or prohibit the production of slime.

On account of the inability to obtain a pure tannin, tannic acid was employed in the experimental work with synthetic media. Wattle bark infusion contains tannin with certain nutritive substances. These consist partly of salts, partly of nitrogenous bodies, probably amido-acids akin to asparagin and partly of sugar. The latter is either free or so loosely combined with the glucosidal tannin as to be readily fermentable by yeasts or by *B. coli communis*.

A saline solution containing 2 % dextrose, 0.2 % asparagin and mixed salts was treated with increasing quantities of tannic acid and portions were seeded with the phase B2. The portion with 5 % of tannic acid showed a growth of bacteria but there was no evidence of ropiness. The portions with 2 % and less were ropy in 16 hours. Twenty-five days afterwards, the portion with 1 % was ropy, the others were not and contained flocculent sediments. This experiment indicated that the organism could develop ropiness in fluids containing dextrose and up to 2 % of tannic acid. This amount seemed to be the limit, as in course of time it slowly coagulated the ropy substance.

Experiments with Infusions of Bark.

An infusion of wattle bark was sterilised by filtration through porcelain. It had a Sp.G. of 1.026 at 22° which is roughly equivalent to 5 % of tannin. Portions of this infusion were diluted and seeded with bacterium A, subsequently found to be a mixture of A1 and A2. Ropiness appeared in 16 hours with the quarter strength while the half strength was unaltered. An extension of this experiment with more graduated strengths was made with the results as shown in the table.

Table i.—*Diluted Infusion of Bark.

Days at 28°	1	2	3	6
Bark infusion, diluted. Sp. G., 1.026.				
10 to 100	S	S	O	O
15 to 100	–	–	S	O
20 to 100	–	–	–	O
25 to 100 . .	O	S	–	O
30 to 100	O	S	–	O
35 to 100	O	S	–	O

*In this and subsequent tables, "S" indicates a slight ropiness, the fluid giving threads varying from one-sixteenth to one-eighth of an inch in length. "–" indicates threads of one quarter of an inch or longer. "O" means no apparent ropiness and, in some cases, no growth.

The small amount of ropiness obtained with water containing 10 % of the infusion may have been due to the paucity of nutrients and the slower appearance of the ropiness with 25 % and over was possibly caused by the retarding action of the tannin which appeared to have coagulated the ropy material by the 6th day. The disappearance of the ropiness may not have been entirely due to the coagulation of the ropy substance, for other experiments with acids and with salts, which will be described later, gave indications of a digestion or solution taking place.

Some time afterwards, eighty days to be exact, the filtered extract which had thrown a deposit was diluted with water in the proportion of three parts of extract to seventeen of water, thus bringing the original approximately 5 % of tannin down to about ¾ %. The solution was divided into three sets, each set containing a control and two other portions, one with 0.2 % and one with 0.4 % of calcium lactate. The sets were seeded with phases A1, A2 and B2. Phase A1 did not become ropy. Phase B2 developed ropiness in the control only, while phase A2 showed ropiness in all tests. In these, the ropiness did not appear until the third day at 28° and it had disappeared by the sixth, giving place to cobwebby growths consisting of bacteria enmeshed in coagulated slime. The experiment showed that ropiness may develop in dilutions of old extract of wattle-bark and that it soon disappears. It also seemed to show that calcium lactate, a substance probably occurring in old tan liquors, has little or no influence in assisting the ropy fermentation.

During the investigation the bacteria were tested to see if they retained the power of making infusions of wattle bark ropy. Their physiological activities were being tested in synthetic solutions, and in these the characteristic ropiness was being produced, but it was considered advisable to prove that this also happened in bark infusions. Thirty gram portions of raw bark were put into sterile 4-ounce bottles and 50 c.c. portions of sterile water were added. The water just covered the bark. The liquids were seeded with the bacteria and incubated at 28°. Upon the first occasion of this routine testing, phase A1 produced the characteristic ropiness in a day and phases B2 and A2 in two days.

Twelve days later the test was repeated. Phases B2 and A2a developed the ropiness in two days, a duplicate race of B2 in three days. By the fourth day, phase A2 had developed ropiness. Phase A1, which had given a positive result twelve days before, was negative.

Other tests made from time to time showed, like the above, a certain variability in the activity of the phases. This was to be expected, for a stock culture could not be kept on account of the alteration of one phase into another. The bacteria were carried over from colony to colony, that is, plates were smeared every few days and from these, colonies were picked out and seeded into bouillon. It was only by proceeding in this way that the phases A1 and A2 could be maintained in a pure state.

When infected bark is covered with water and allowed to stand, the bacteria grow and produce the ropy substance, while the solution increases in strength. The bacteria apparently grow in clumps of slime, that is to say, they form a coherent slime and remain imbedded in this slimey environment. This is demonstrated when the bacteria are grown in saccharine nutrient solutions containing chalk; the blobs of cohesive slime can be seen upon rotating the flask, and they are incapable of being broken up by the rotation of the flask. Once the blob of slime around the bacteria is admitted, it becomes a matter of question as to the diffusive speed of the tannins and non-tannins through the slimes, just as it is a question about the diffusive speed of the non-tannins and tannins from the bark.

If in making an extract, the non-tannins, which we will presume are chiefly bacterial nutrients are the first to diffuse, or preponderate in the initial diffusion, the bacteria will grow and, in doing so, form a protective slime envelope which may be protective until the tannins become sufficiently concentrated to coagulate it. Such a coagulation occurs experimentally in dilute infusions of bark, but it has not been observed to occur in cases where the bark has been covered with water, and the infusion allowed to remain in contact with the bark.

In an endeavour to throw some light upon this matter, portions of raw bark were treated with water in the ratio of three of bark to five of water, and after contact for varying times, the infusions were filtered. The following were the Specific Gravities of the extracts:—15 minutes, 1.010; 30 minutes, 1.013; 1 hour, 1.016; 2 hours, 1.020; 3 hours, 1.024; 4 hours, 1.027; 5 hours, 1.029; 1 day, 1.048; 3 days, 1.052. The infusions were portioned into tubes and seeded with phases of the bacteria.

Phase A1: no ropiness in any of the extracts.
A2: ropiness in all up to three hours.
B2: ropiness in all up to 24 hours.

The experiment was repeated with new extracts up to five hours.

Phase A1: no ropiness in any of the extracts.
A2: ropiness in all extracts.
B2: ropiness in all extracts.

From the earlier tests with bark extract, it appeared probable that tannin when present in excess will prohibit the formation of the ropy substance. But we are in doubt as to just how much will constitute an excess. Tannic acid seemed to act differently from the tannin in bark extract, and it is possible that ropiness occurs when there is a balance between the tannins and non-tannins of the extracts. Several experiments were made with the idea of feeling the way in this direction.

A quantity of bark was infused for two days at 28° with twice the weight of water. The infusion had a Sp. G. of 1.053. Portions were seeded with the various phases of the bacteria and in no case was ropiness obtained. The extract was probably too rich in tannin to permit the formation of the slime. It was then progressively diluted down to one-tenth the strength and seeded with phases A2 and B2. No ropiness became apparent. Bearing in mind the earlier experiment with the timed infusions of bark, in which the five hours' infusion having a Sp. G. of 1.029 became ropy, it seems that this longer infusion, after dilution to an approximate Sp. G. of 1.005, failed to produce ropiness because the tannins overwhelmed the activity of the nutrients.

In another experiment bark was treated for two hours with twice its weight of water and filtered. A quantity of water equal to that removed was added to the residual bark and allowed to remain in contact for 22 hours. The two infusions were called "A" and "B" respectively. Infusion "A" contained 5 % of solids and 0.232 % of ash; infusion "B," 7 % of solids and 0.245 % of ash. The two infusions were mixed in descending and ascending proportions from 5 to 0 and from 0 to 5 and seeded with A2 and B2. The tests with B2 did not become ropy.

Table ii.—Medium and Strong Infusion of Bark.

Phase		A 2		
Days at 28		1	2	3
"A"	"B"			
5	0	0	.	.
4	1	0		S
3	2	0	S	S
2	3	0	S	0
1	4	0	0	0
0	5	0	0	0

The experiment seems to indicate that as the water lies in contact with the bark, the nutrients and tannins diffuse out and the proportion of these is such that ropiness can develop. But after a time, the tannins begin to preponderate and the development of ropiness is prevented.

Infusion "A" was treated with increasing amounts of tannic acid and seeded with A2. Ropiness developed in the control, but not in the portions containing 0.5 % and over.

The Change in Reaction.

During the growth in synthetic media, the bacteria produce a small but definite amount of acid from the sugar. In the presence of glycerine the medium may remain unaltered or it may become less acid. For example, a ropy dextrose fluid showed +3.4° while the control was +1.7°. A bulk culture with glycerine had at the start +2° to methyl red, +5.5° to litmus and +8.5 to phenolphthalein. On the 6th and 12th days, when quite ropy, the same respective acidities were determined. This however is unusual, for in other cases the glycerine medium became alkaline, as will be seen in some experiments given in the pages that follow.

The effect of varying the original acidity upon the development of ropiness was tested in a few experiments.

A fluid containing glycerine, meat extract and salts was divided into 50 c.c. portions, and these were given progressive quantities of phosphoric acid before being seeded with the bacterium A which was probably a mixture of the phases A1 and A2. Ropiness appeared on the fourth day at 28° in the portions containing originally an acidity of from −3° to methyl-red (=+2.5° to phenolphthalein) to +6° (=11.5°) but not in those containing +16° (=21.5°) and over. The conditions were unchanged on the sixth day.

A similar test was made with dextrose in place of glycerine. After sterilisation the fluid showed −9° to methyl-red and +6° to phenolphthalein. The portions were acidified progressively and seeded with the mixed phases, A1 and A2.

Table iii. Dextrose with increasing acidity.

Phase	A1 + A2				
Days at 28°	1	2	3	4	7
Acidity to methyl-red					
−1° and under	O	+	+	S	O
−1	O	+	+	+	O
+5	O	—	+	+	S
+8°	O	—	+	+	+
+12°	.	+	+	+	O
+15° and over	floccules				

Portions in which the phosphoric acid was replaced by sulphuric and hydrochloric acids gave similar results.

The experiment shows that there is a certain range of original acidity from about +5° to +12° as shown by methyl-red which conditions a rapid production of ropiness. When the acidity is greater the ropy material assumes the flocculent condition. In most cases the ropiness was evanescent and soon disappeared, a circumstance which was subsequently traced to the presence of the phase A1. The acidity in the presence of dextrose probably increased, for the portions with +15° of original acidity showed +20° at the end of the experiment.

Another test was made with glycerine, using 0.5 % of the hydrated phosphate of soda instead of the usual mixture of salts. The medium as prepared was neutral to methyl-red and portions were acidified with phosphoric acid.

Table iv.—Glycerine with increasing acidity.

Phase	A1			A2			Acidity to methyl-red
Days at 28°	2	4	11	2	4	11	17
Acidity to methyl-red							
+5°	O	—	·	—	·	—	+3°
+7.5°	S	—	+	—	·	·	—
+10°	—	·	—	—	·	·	+5°
+12.5°	—	·	·	+	+	·	—
+15°	O	S		+	·	·	—
+20°	—	·	+	O	S		+7

On the eighth day the portions infected with phase A1 showed, in the case of the 12.5° and of the 15°, the presence of transition forms. The original acidity decreased as time went on; on the seventeenth day, the test with an original acidity of +5° had become +3°, +10° had become +5°, and +20° had become +7° to methyl-red.

The original acidity of a glycerine medium does not seem to have much influence upon the production of ropiness, but this may be explained by the fact that the acidity is reduced during the growth of the organism.

The acidity of spent tan liquors seems to vary from +12.5° to +20° by Procter's lime water test, and one which was tested showed +10.4° by this test and +5° by methyl-red. So far as mere acidity is concerned, the organism should produce ropiness in such an end-liquor, but when tested it did not do so.

The Disappearance of Ropiness.

The disappearance of the ropiness in culture fluids was noted first in the case of B2 when growing in a medium containing saccharose 2 %, meat extract 0.5 % and mixed salts (KH_2PO_4, 0.2 %; $MgSO_4$ Aq. 0.1 %; $CaCl_2$, 0.02 %) made neutral to methyl-red. The fluid was ropy on the fourth day at 28° and quite limpid on the 6th when the acidity had risen to +8°. Again the experiment with varying amounts of acid noted on p. 57 showed a solution or digestion of the ropy material in the case of A, a mixture of A1 and A2.

The speed in the digestion of the ropy substance was tested upon several occasions by growing the phases of the bacteria in medium containing 2 % of dextrose with meat extract and mixed salts at 28°. The bacterial phases had been picked from agar plates and were typical, that is to say, they were the phases known as A1, A2 and A2a. From the plates they were seeded into nutrient broth and transfers were made daily. In this medium they doubtless altered in the one direction or the other, but the change was very much slower than when a sugar or glycerine was present. The first test with the dextrose medium was made one day after isolation from the plate, and during the growth the medium became ropy and then, after an interval, the ropiness disappeared and the liquid became limpid.

A1 became limpid on the 3rd day.
A2 15th day.
A2a 26th day.

The second test was made six days after the isolation of the phase.

A1 became limpid on the 3rd day.
A2 20th day.
A2a was still ropy on the 26th day.

The third test was made thirteen days after the isolation.

A1 became limpid on the 6th day.
A2 was limpid on the 22nd day.
A2a was still ropy on the 22nd day.
A1 + A2 was limpid on the 8th day.
A1 + A2a was limpid on the 8th day.

In this test the purity of the phases was examined in a few cases. On the 12th day, A1 contained a few pure typical colonies, and on the 19th day no bacteria were found in a large loop of the culture. The digestion of the slime is apparently a prelude to the disintegration or death of the bacteria. On the 12th day both A2 and A2a contained bacteria which grew as colonies with the tint of A1 but much more granular; the granular lumps radiated to the margin and became larger as they approached the edge. This was the transition stage between phase A1 and A2. On the same day, large loops taken from the mixed growths of A1 with A2 and A2a were found to be sterile. Phase A2 consisted of A1 with a few of A2.

Other instances of the solution of the ropy material will be seen in the experiments dealing with the saline and carbonaceous nutrients.

The phase A2a gives a more ropy colony on nutrient agar than A2 which is somewhat gelatinous and is not so elastic when touched with the needle. It is, however, difficult to discriminate between the two as, when free to grow, the phase A2 often preponderates. That is to say, a plate when smeared with a reputed culture of either A2 or A2a may show a preponderance of A2a in the comparatively thickly sown parts and A2 in the areas with few colonies. At times, the two phases seemed to be remarkably consistent in remaining true to phase. In the majority of the experiments, A2a, has been classified under the phase A2 for the sake of simplicity but where both A2 and A2a have been simultaneously tested, the original designations have been retained to indicate a duplicate test.

The earlier observations led to the belief that the disappearance might result from the formation of acid from the sugar but this was negatived by an experiment made with the idea of determining the nature of the acids formed in the presence of sugar. The medium contained dextrose, meat-extract, potassium chloride and chalk; it was seeded with a mixture of A1 and A2 then known as Bact. A. The liquid never became acid and the particles of chalk were freely suspended when the flask was rotated. It was first incubated at 37°, at which temperature no ropiness developed. Then the flask was transferred to an incubator at 28° and the culture became strongly ropy, the brownish ropy blobs, one of which was about two inches in diameter, were clearly shown against the milky chalk suspension. The flask was returned to the incubator at 37° when the ropiness disappeared. Once more the ropiness appeared at 28°. These observations clearly show that a digestion of the ropy substance occurs at 37° in a neutral solution. An acid reaction of the medium is not essential for the digestion of the slime but it is possible that it may assist.

That the temperature has much to do with the speed of the digestion of the slime was shown in a test in which phase A1 was grown at 22° and at 28°. Both were ropy on the second day, the 28° test was limpid on the 5th and the 22° test on the 8th day.

The experiment with chalk suggested the secretion of a slime-dissolving enzyme by the phase A1. Probably this is so but when experiments were made in which old fluid cultures of A1 were added to lumps of the purified gelatinous slime of A2 in presence of an antiseptic, no solution of the slime was obtained.

It became evident that phase A1 was capable of forming and eventually digesting the ropy substance. It also rapidly dies out and it may be noted in this connection that it produces a more rapid liquefaction of gelatine. If the A2 phase is used originally, the ropy substance may persist, while if a mixture of the phases is initially present, digestion occurs, but at a later period than in the case of the pure A1 phase. It seemed to be entirely a question of the relative numbers of the two phases during the period of bacterial growth. Instances of the autodigestion of the ropy material will be found in the experiments with the various sugars and salts.

Change of Phase.

These observations led to testing the reversion or alteration of the phases. It had been noted that glycerine favoured the production of ropiness from phase A1 and that dextrose did not or, if it did, the ropy fluid subsequently became limpid. This was confirmed in experiments subsequently recorded with sugars, etc., where ropiness slowly developed and persisted in the presence of glycerine but did not persist when other sources of carbon were used.

A specific test was made with cultures of the phases A1 and A2 taken from pure colonies and grown in broth for one day before being seeded into the test bottles. Phase A1 was sown in a fluid containing glycerine, meat-extract and sodium phosphate while phase A2 was grown in dextrose with mixed salts as on p. 58. Both tests were ropy on the third day, and on the thirteenth day, phase A1 in the glycerine was quite ropy, while phase A2 in the dextrose was limpid. Plates were prepared on the thirteenth day and these showed that phase A1 consisted of a mixture of typical colonies of phases A1 and A2, and that phase A2 had been altered into more or less vacuolated colonies of phase A1.

The experiment conclusively showed that the phases were reversible.

The Action of Tannic Acid.

The bacterium B2 was peculiar in giving pronounced ropy solutions when seeded into infusions of wattle bark of increasing strength and little ropiness in synthetic liquids. The reason for this could only be explained by testing the various nutrients in the presence of the nearest approach to the tannins available, namely tannic acid. It may be that the tannins in wattle bark infusions behave differently to commercial tannic acid and this should be kept in mind when interpreting the results obtained in testing the commercial acid.

A solution of dextrose, meat extract and mixed salts was prepared, and to portions quantities of tannic acid rising from zero up to 0.6 % were added before the addition of B2. That with 0.1 % gave a faint ropiness and those with 0.2 % to 0.5 % contained sliney strings. There was no pronounced ropiness in any of them.

As meat extract forms a precipitate with tannic acid, it was replaced by asparagin. In this solution, B2 produced ropiness in the presence of 0.1 % and 0.2 % of tannic acid. The control test and those with quantities greater than 0.2 % gave a good growth of bacteria but no slime.

The experiment was repeated with a slightly greater percentage of asparagin (0.2 %) and dextrose (3 %) with mixed salts. Phase A2 gave ropy liquids with the control and 0.1 % of tannic acid, but not with larger quantities. Phase B2 only produced feebly gelatinous surface rings with quantities of tannic acid up to 0.2 %.

A medium containing levulose, 3 %, asparagin, 0.2 % and potassium citrate, 0.1 %, was prepared and seeded with phases A2 and B2. The former was a very active slime producer when used and produced ropiness in the presence of quantities of tannic acid up to 0.5 % and a slight ropiness with 1 %. Phase B2 gave an evanescent ropiness in the flask containing 0.5 per cent only, and not in any of the others.

The influence of the original acidity of the medium was tested by means of a solution containing dextrose, asparagin and mixed salts. One set had an acidity to phenolphthalein of +17°, another was neutralised until the acidity was +2.5°. Both were seeded with phase B2. That with +17° gave no ropiness in the control, a slight ropiness with 1 % of tannic acid and a distinct ropiness with 0.2 %; larger amounts were negative. With +2.5°, ropiness developed in the control test only. Thus the production of ropiness was irregular. Phase B2 gave ropiness in the control with +2.5° and not with +17°; with +17° and a small quantity of tannic acid it produced a ropy fluid.

In these experiments with tannic acid, either dextrose or levulose had been used and with them a certain irregularity of effect had been obtained. It was therefore deemed advisable to test the effect of other sources of carbon. As will be seen later, the experiment with nitrogenous nutrients seemed to indicate that a maximum amount of ropy substance would be formed in the presence of asparagin or ammonium sulphate. Similarly, the saline experiments indicated that sodium succinate was a favourable salt. Accordingly, media were prepared containing asparagin or ammonium sulphate 0.25 %, sodium succinate 0.2 % and a source of carbon 2 %. Tannic acid to the extent of 0.5 % was added to each flask after infection, by which procedure a coagulation of the infecting droplet was avoided. When a drop of infected bouillon is added to a solution of tannic acid, the drop is coagulated and the contained bacteria are probably prevented from being dispersed freely in the liquid. It is possible that much of the irregularity in the previous experiments may have been due to this imprisonment of the bacteria.

The groups of flasks were seeded with A2 and B2. Another group was seeded with B1 but as a plate, smeared at the time of infection showed that the phase had become altered to B2, the group became a duplicate of B2. Phase B2 was pure, while A2 at the time of seeding contained 90 % of A2 and 10 % of A1.

Table v. Sugars, etc. with 0·5% Tannic Acid.

Phase	A2								B2							
Source of Nitrogen	Asparagin				Ammonium Sulphate				Asparagin				Ammonium Sulphate			
Days at 28°	3	4	6	10	3	4	6	10	3	4	6	10	3	4	6	10
1. Dextrose	—	—	—	—	—	—	—	—	—	—	—	O	—	—		O
2. Levulose	—	—	—	—	—	—	—	—	{ — / O }	O / O	O / O	O / O	{ O / O }	— / O	— / O	S / O
3. Saccharose	—	—	—	—	—	—	—	—		S	S	S	{ O / S }	O / S	O / S	O / S
4. Maltose	O	O	O	O	—	—	—		O	O	O	O	O	O	O	O
5. Galactose	—	—	—	—	—	—	—	—		—	—	—			—	
6. Raffinose	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
7. Mannit		—	—		—		—			—		S	O	O	O	S
8. Control	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O

On the 4th day, the ammonium sulphate tests of A2 were plated to see how far the phases had altered.

Table va.—Percentage of Phase A2 in Ammonium Sulphate at 28°

	Start.	4 Days.	10 Days.
Mannit ...	90	90	15
Saccharose ...	90	65	15
Maltose ...	90	35	25
Raffinose ...	90	30	5
Galactose ...	90	20	0
Dextrose	90	10	0
Levulose } Control } ...	90	0	0

In all cases, except mannit, the cohesive phase A2 had become, by the fourth day, more or less altered to the diffuse phase A1, and it is rather extraordinary that those with a maximum proportion of the diffuse phase should have been ropy. It is possible that the ropy substance was formed before the alteration to the diffuse phase occurred and the gradual suppression of the phase A2 as shown by the relative numbers on the 10th day, bears out this idea. Another peculiarity is that while the maltose test with asparagin gave no ropiness, and with ammonium sulphate a pronounced ropiness on the 4th day, smears made on that day showed the same proportion of A2, viz. 35%. From these proportions it would appear that ropiness has less to do with the phase of the organism than the previous tests had led one to believe, but as on the 10th day, the asparagin test contained 1% of A2, and the ammonium sulphate test 25%, there is still the suspicion that some relation exists.

The duplicate tests of phase B2 were fairly concordant; differences were obtained with levulose and saccharose in conjunction with ammonium sulphate. With asparagin, a slight difference occurred in the case of levulose.

Phase B2, in this experiment, was shown to possess considerable activity in producing ropiness in the presence of tannic acid as compared with the preliminary tests, but it is possible that the saline constituents had much to do with the differences obtained.

In the experiment the media contained 0.5 of tannic acid and, as ropiness was obtained with this percentage, it was deemed advisable to see to what extent the most active phase could tolerate this acid. A medium containing dextrose 2 %, asparagin or ammonium sulphate 0.25 % and sodium succinate 0.2 % was portioned out and seeded with phase A2 taken from a colony two days previously. Then the various quantities of tannic acid were added.

Table vi. Dextrose with increasing Tannic Acid.

Phase	A2							
Source of Nitrogen.	Asparagin.				Ammonium Sulphate.			
Days at 28°	1	3	6	10	1	3	6	10
Tannic Acid per cent.								
0·2	−	+	+	−	+	+	+	−
0·4	+	+	+	+	−	+	+	+
0·6	+	+	+	−	S	+	+	+
0·8	·	+	−	−	S	·	+	+
1·0	S	S	−	S	S	+	S	0
1·5	S	S	S	0	0	0	0	0
2·0	0	0	0	0	0	0	0	0

On the 6th day certain of the cultures were smeared on agar. With 0.2 % and 0.6 % of tannic acid, in the presence of asparagin, the colonies were of a novel type. They appeared as round, raised, glistening, buff-coloured colonies with a glutinous consistency. Microscopically they had dark centres from which dark tufted fibres radiated through a yellow matrix to near the margin. In 10 % of the colonies this structure blended into that of phase A2, part of the colony showing the fibrous structure at one side and that of A2 at the other. They were clearly a transition phase of A2 more nearly related to A2 than to A1. With 1 % and 2 % of tannic acid the colonies consisted entirely of the phase A1.

By the 12th day, the medium containing asparagin with 0.2 % of acid showed 96 % of A1, 2 % of the fibrous transition form of A2, and 2 % of A2. With larger amounts of acid the cultures contained very few living bacteria but they were of the kinds noted on the 6th day.

The cultures containing ammonium sulphate were tested on the 12th and 16th days. They contained few bacteria; with 0.2 % of acid, they consisted of the introduced phase A2 and, with larger quantities, they were the A1 phase.

The tendency of the tannic acid is to alter the phase A2 to A1 but this probably occurs after the ropy substance has been formed in the medium.

The experiment showed that a fairly active culture of the phase A2 could produce ropiness in the presence of quantities of tannic acid up to 1 % with ammonium sulphate, and up to 1.5 % with asparagin.

The sugar test with 0.5 % of tannic acid showed that galactose was a useful sugar for inducing the formation of ropiness, and an experiment was made to see the effect of increasing quantities of tannic acid in the presence of this sugar. The medium contained galactose 2 %, asparagin 0.25 %, sodium succinate 0.1 %, and sodium phosphate, anhydrous, 0.2 %. The phases were plated at the start and found to be pure.

Table vii.—Galactose with increasing Tannic Acid.

Phase	A1					A2					B2				
Days at 28°	2	4	6	9	13	2	4	6	9	13	2	4	6	9	13
Tannic Acid per cent.															
0·25	O	O	O	O	O	+	+	+	+	+	O	S	S	O	O
0·5	O	O	S	S	O	+	+	+	+	+	O	S	O	O	O
0·75	O	O	S	S	S	+	+	+	+	+	S	S	S	S	O
1·0	S	S	S	S	S	+	+	+	+	+	+	+	S	S	S
1·25	S	S	S	S	S	+	+	+	+	+	S	S	S	S	S
1·5	O	O	O	O	O		+	+	+	+	S	S	S	S	O
1·75	O	O	O	O	O	+	+	+	+	+	O	O	S′	S	O
2·0	O	O	O	O	O	O	S	S	S	O	O	S	S	S	O
2·25	O	O	O	O	O	O	O	O	O	O	O	O	O	S	O
2·5	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O

The flasks with 0.5 % and 1 % of tannic acid were examined several times by the plate method on nutrient agar with the following results:

Table vii*a*. Change of Phase.

Phase	A1		A2		B2	
Tannic Acid	0·5%	1%	0·5%	1%	0.5%	1%
Start	A1	A1	A2	A2	B2	B2
Four days	A1	A1	A2	A2	B2	B2
Nine days	A1 with 5% A2	A1	A2, 40% ; A2, trans. 30% ; A1, 30%	A1	B2, trans.	B2, trans.
Fourteen days	A1	A1	A2, 30% ; A2, trans. 60% ; A1, 10%	A1	B2	B2

It is clear from the experiment that the phase A1 is capable of producing ropiness in the presence of from 0.5 % to 1.25 % of tannic acid in a medium containing galactose. With 0.25 % there was no ropiness formed, and as the acid increased, so did the viscosity. Tannic acid or, possibly, acidity seems therefore to be a *sine qua non* for the formation of ropiness by this phase of the bacterium A.

The phase A2 at the time of the experiment was a strong slime-former, and gave a pronounced ropy solution in the presence of amounts of tannic acid up to 1 %. The ropy substance had been formed in the early days of the experiment, and it did not alter, although the phase in the case of 0.5 % of tannic acid changed to a mixture of phases, and in the case of 1 % it changed to A1.

The phase B2 gave ropiness in amounts of tannic acid up to 2.25 %, but the viscosity of the solutions was never so pronounced as in the case of A2. The most viscous solution was obtained in the presence of 1 % of tannic acid.

The experiment shows that the three phases which were tested produced ropiness in synthetic media when the tannic acid varied in amount up to 1.25 % or 2.25 %, and that the tendency of the bacterial phase A2 is to change, in the presence of tannic acid, to A1, and for the bacterial phase B2 to remain constant.

The same galactose medium was used to determine the comparative amounts of tannic acid and of phosphoric acid necessary to prevent the formation of ropiness by phase A2

Table viii. Tannic and Phosphoric Acids compared.

Phase		A2						
Days at 28		1	3	7		1	3	7
	Tannic Acid per cent.				Phosphoric Acid in degrees.			
1	0·0	+	+		0		+	
2	0·25	+	+	+	3		+	
3	0·5	+	+	+	6		+	
4	0·75	+	+	+	9		+	
5	1·0	S	+	+	12	+	+	
6	1·25	S	+	+	15	S	+	+
7	1.5	S	+		18	S	+	+
8	1·75	S	+		21	S		+
9	2·0	0	0	0	24	S	+	
10	2·25	0	0	0	27	S	+	
11	2·5	0	0	0	30	0	0	0

Certain of the cultures were examined at the end of the first day, and they were found to contain the introduced phase, A2, in pure culture. They were again examined on the seventh day and it was found that the phase had altered to A1.

Table viii*a*. Percentage Composition of the Phases (Seventh day).

	Tannic Acid			Phosphoric Acid		
	A1	A2	A2 trans.	A1	A2	A2 trans.
1	35	25	40	80	10	10
3	0	90	10	70	20	10
5	80	5	15	85	15	0
9	Sterile			75	15	10

The indication that a moderate quantity of tannic acid tended to maintain the stability of the introduced phase A2, led to the tannic acid tests being again examined on the 10th day, when the following percentage counts of the kinds of colonies were noted.

Table viii*b*. Percentage Composition of the Phases with Tannic Acid (Tenth day)

	A1	A2	A2 (transition)
1	70	30	0
2	0	95	5
3	0	50	50
4	25	65	10
5	100	0	0
6*	90	10	0

*Scanty growth.

It appears that from 0.25 % to 0.5 % of tannic acid, when added to a synthetic medium such as was used, maintains the stability of the A2 phase and that smaller or larger quantities bring about its conversion to the less cohesive phase A1. In contrast, phosphoric acid does not appear to have much influence in maintaining the stability, for on the 7th day there was a 70 to 85 % conversion, irrespective of the amount of acid added.

The limiting amount of tannic acid in this synthetic medium for the phase A2 at the time of making the experiment was 2 % and of phosphoric acid +30° (equivalent to 30 c.c. of normal acid per litre).

The two last experiments with tannic acid in synthetic media indicated that 2 % of the acid prohibited the formation of the ropy substance. It appeared to be advisable to extend the line of experimentation and obtain some information regarding the action of tannic acid when added to an infusion of wattle-bark capable of giving ropiness. With this object in view an infusion was prepared by mixing three parts of water with two parts of bark, and filtering the liquid at the end of two hours. Portions were seeded with A2 and B2, and were treated with progressively increasing quantities of tannic acid. The portions seeded with A2 did not develop ropiness and when examined on the 4th day they were found to contain from 85 % to 95 % of A1. The portions seeded with B2 developed a pronounced ropiness with quantities of tannic acid up to 0.4 % and a slight ropiness with 0.7 %. On the 4th and 9th days these contained a pure culture of B2.

The experiment was repeated a fortnight later with a similarly prepared infusion. It had a Sp. G. 1.023 at 21° and an acidity of +24° by Procter's lime water test. A similar infusion made on the following day at 21° had a Sp. G. 1.022. +22.5° by Procter's test and +7° to methyl-red. Procter's test seems to indicate the acids other than tannic acid that are present, for tannic acid in pure solution is precipitated at once by the lime water.

Table ix.—Bark Infusion with Tannic Acid.

Phase	A1				A2				B2			
Days at 28°	2	3	5	9	2	3	5	9	2	3	5	9
Tannic Acid per cent.												
0·0	O	O	O	O	+	+	+	+	S	+	+	+
0.1	O	O	O	O	O	O	S	S	S	+	+	+
0·2	O	O	O	O	O	O	O	O	S	+	+	+
0·4	O	O	O	O	O	O	O	O	O	+	+	+
0·6	O	O	O	O	O	O	O	O	O	O	O	O

We see that an infusion of wattle-bark having a Sp. G. of 1.023 is immune to the phase A1 and that the derived phase A2 is able to develop ropiness, but the addition of a small quantity of tannic acid, 0.2 %, prevents the formation. A smaller quantity, 0.1 %, permits a slight ropiness to appear. Phase B2 is more tolerant of tannic acid, the limiting amount of which lies between 0.4 % and 0.6 %.

Larger amounts of tannic acid were used but these are omitted from the table. The portions containing over 0.4 % showed cobwebby growths, doubtless consisting of bacteria bound up with coagulated slime.

As a bark liquor of Sp. G. 1.010 may contain 1.8 % of tannin and 0.5 % to 0.7 % of extractives (non-tannins), the infusion of Sp. G. 1.023 presumably contained about 4 % of tannin. The experiments show that this reputed 4 % of tannin had much the same effect in prohibiting the formation of ropiness as 1.75 % of pure tannic acid.

A stronger infusion of wattle bark of Sp. G. 1.054 when seeded with A2 and B2 did not develop ropiness, even when the infusion was strengthened by quantities of dextrose and ammonium sulphate rising to 5 % and 0.5 % respectively. This seems to indicate that the tannins are the prohibiting agents, and when they are present in sufficient amount, bacterial nutrients have little influence in assisting the development of ropiness.

A few tests had been made in the earlier part of the research to see if the quantity of sugar in synthetic media had any effect in increasing the formation of ropiness, but it was not definitely shown that the amount of ropiness was proportional to the sugar in the medium, or that any advantage would be gained by increasing the quantity over the usual 2 %. It seemed possible, however, that sugar might to some extent modify the action of tannic acid, and that an increase in the sugar content might enable the organism to withstand a higher amount of tannic acid. To test the matter portions of fluid containing asparagin 0.5 %, and sodium succinate 0.2 %, were given increasing amounts of dextrose and of tannic acid. The portions were seeded with a drop of a bouillon culture of A2 which at the time of inoculation contained A2, 85 %, and A1, 15 %, as shown by plate culture.

Table x.—Increasing Dextrose and Tannic Acid.

Dextrose %	2			4			6		
Days at 28°	3	7	11	3	7	11	3	7	11
Tannic Acid									
1·0	S		—	—	—		—	—	—
1·25	S	S	S	S	—	S	—	—	S
1·5	S	S	O	S	S	O	S	—	O
1·75	S	O	O	S	S	O	S	—	O
2·0	O	O	O	S	S	O	S	S	O
2·25	O	O	O	O	O	O	O	O	O

The portions with 1.5 % of tannic acid were examined on the 8th day. That with 2 % of dextrose contained A1 with 5 % of A2, with 4 % of dextrose had A1 with 20 % of A2, and 6 % of dextrose had A1 with 25 % of A2.

To judge by the pronouncedly ropy tests, an increase in the sugar does appear to mask, to some extent, the action of the acid, for on the 3rd and 7th days the "+" indications rise with the amount of acid, but so far as slight ropiness is concerned, there is little difference between the 4 % and the 6 %. The increased sugar also prevents, or rather hinders, the conversion of the phase A2 to A1, and thus masks the action of the acid by enabling more ropy substance to be formed by the cohesive phase.

Sources of Nitrogen.

An early attempt to determine the most favorable source of nitrogen was made with solutions of dextrose and mixed salts containing amounts of nitrogen approximately equivalent to 0.2 % of asparagin. On the sixth day a mixture of phases A1 and A2 had produced ropiness to a greater or less degree with asparagin, meat-extract, peptone, and ammonium sulphate, but potassium nitrate gave little growth and no ropiness. A second test using one-sixth the quantities of nitrogen and replacing the dextrose by glycerin showed that ropiness had developed by the fifth day in the presence of all the above sources of nitrogen, and also of potassium ferricyanide. Thus in the presence of glycerin and mixed salts any of these sources of nitrogen will serve.

At a later date, a more comprehensive experiment was made with phases A1, A2 and B2, using 2 % of dextrose or glycerin, 0.3 % of potassium citrate and 0.25 % of the various nitrogenous substances.

Table xi.—Sources of Nitrogen.

Phase	A2										B2									
Carbon source	Dextrose					Glycerin					Dextrose					Glycerin				
Days at 28°	3	6	9	13	19	3	6	9	13	19	3	6	9	13	19	3	6	9	13	19
Meat-extract	+	+		+	–	+	+	+	+	+	+	–	O	O	O	O	O	O	O	O
Peptone	+	–	.		O	O	O	+	+	–	S	S	O	O	O	S	O	O		–
Asparagin	–	+	–		+	+	+	–	–	S	–	–	–	S	O	S	–	–		S
Ammonium sulphate	–	–			+	–	+	+		–	S	–	–	+	–	–	+	–		–
Potassium nitrate	+	O	O	O	O	+	+	+	–	–	O	O	O	O	O	–	–	–	O	O
Potassium ferricyanide	O	–		O	O	O	+	+	–	S	O	O	O	O	O	O	O	O	O	O

Phase A1 is omitted from the table as all the tests were negative with the exception of peptone plus glycerine which became ropy on the 13th and was still ropy on the 24th day. On the 19th day a smear showed that the liquid contained 95 % of A2 and 5 % of A1.

On the 11th (B2) and 13th (A2) days the fluids were smeared on plates of nutrient agar and counts were made of the approximate proportions of the phases.

Table xi*a*. Percentage Proportion of Phases.

Phase added	A2						B2					
Source of Carbon	Dextrose			Glycerin			Dextrose			Glycerin		
Phases determined	A1	A1 (tr.)	A2	A1	A1 (tr.)	A2	B1	B1 (tr.)	B2	B1	B1 (tr.)	B2
Meat-extract		100	–		90	10		dead		10	25	65
Peptone	30	70	–	25	40	25			100	75		25
Asparagin		25	75	–	65	35	15		85			100
Ammonium sulphate	80	10	10	–	90	10		100	–	70	30	
Potassium nitrate		dead		–	45	55		no growth		20	10	70
Pot. ferricyanide	10	80	10	–		100		nearly dead	100			

It is difficult to see any relation between the ropiness as determined on Table xi*a*. with the proportion of the phases. Even when the transition phases of A1=A1(tr.) and of B1=B1(tr.) are included with the cohesive phases, there appears to be no reason for connecting ropiness with a particular phase of the organisms. One is, therefore, inclined to the idea that in most cases the ropy substance is formed first and the alteration of phase occurs subsequently (compare p. 64). The altered phase may in some cases digest the preformed ropy substance. The untabulated tests with phase A1 showed that the nature of the infecting phase largely determines the formation of ropiness.

Confirmatory tests were made with phase A1, a mixture of A1 with A2, and with A2 using levulose 2 % and sodium chloride 0.3 %. They bore out the results obtained with dextrose and citrate.

The work has shown that the phase A2 can produce ropiness from dextrose or glycerin in the presence of meat-extract, peptone, asparagin or ammonium sulphate, and from glycerin with nitrate but not from dextrose with nitrate. Doubtless this is due to the formation of an acid reaction in the medium containing sugar and the concomitant production of free nitric acid. Ferricyanide produced ropiness, but the quantity was scanty as compared with the other sources of nitrogen.

The phase B2 acted best with asparagin and ammonium sulphate. Meat-extract gave an evanescent ropiness with dextrose, but none at all with glycerin. The behaviour with nitrate was much the same as with A2 and probably for the same reason. Ferricyanide was an unsuitable source of nitrogen.

The Influence of Various Sugars, etc.

The activity of the bacteria in the presence of various sources of carbon was tested with a saline asparagin solution containing various sugars, etc. Ropiness was produced in the presence of saccharose, dextrose, levulose, galactose, glycerin and mannit. It was not produced from maltose, lactose, dextrin or gum-acacia.

In testing the most suitable amount of glycerin, a solution containing 1 % showed ropiness first, but in time the higher percentages made headway. On the eighth day the order of ropiness seemed to be 5 %, 1 %, 10 % and 2 % when the slimes were coagulated and weighed. With 1 %, 100 c.c. of media gave 86 milligrams, 2 % gave 64, 5 % gave 88, and 10 % gave 96 milligrams. The 2 % test was probably low, in which case all quantities gave much the same amount of ropy substance.

The ropiness seemed to become more abundant when grown in deep layers of fluid; in shallow layers there appears to be a greater growth of cells and less slime.

An experiment was made with carbohydrates when considering the subject of acidity. A solution containing sugar or glycerin 2 %, KH_2PO_4 0.2 %, $MgSO_4Aq.$ 0.1 %, $CaCl_2$ 0.02 % was made neutral to methyl-red and seeded with a mixture of A1 + A2 and with B2.

Table xii. Change of Reaction with Sugars and Glycerin.

Phase	A1 A2				End acidity to methyl-red	B2				End acidity to methyl-red
Days at 28	1	2	3	4	4	1	2	3	4	4
Dextrose	O	S			8	O	O	O	O	9·5
Levulose	O				9	O	O	O	O	9
Saccharose	S				6·5	O	S	S	O	8
Glycerin	S				9·5	O	O	O	O	6·5

The experiment showed a distinct advance of from +6° to +9° in the acidity with the sugars and a reduction of about the same number of degrees with glycerin during the four days' growth at 28°.

A more comprehensive test was made into the effect of various sources of carbon upon the production of ropiness. A medium containing 2 % of sugars, etc., 0.25 % meat extract and 0.5 % of crystalline sodium phosphate was prepared and portions were seeded with the phases.

Table xiii. Sources of Carbon (1).

Phase	A1					A2					A2a					B2				
Days at 28°	1	2	4	6	9	1	2	4	6	9	1	2	4	6	9	1	2	4	6	9
Dextrose	O	S	O	O	O	O	+	–	+	O	O	O	S	O	O	O	O	O	O	O
Levulose	O	·	S	O	O	O	·	·	–	S	O	+	+		–	O	O	S	O	O
Saccharose	O	O	O	O	O	–	·	·	+	+	+	–	+			O	O	O	O	O
Glycerin	O	O	S	+	·	+	·	·	+	+	+	·	+	+	+	O	O	O	O	O
Lactose	O	O	O	O	O	O	S	S	S	S	O	S	+	S	O	O	O	O	O	O
Galactose	O	S	S	S	O	O	+	–	–	–	O	–	·	·	–	O	O	S	S	O
Mannit	O	O	O	O	O	·	–	+	+	+		·	·	+	–	O	O	·		+
Maltose	O	S	O	O	O	+	·	+	+	+	O	+	S	S	S	O	O	O	O	O
Dextrin	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
Gum acacia	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
Control	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O

When the experiment was well under way, it was found that phase A2 and (A2a) had altered and contained more or less of A1, a fact that should be taken into account in considering the disappearance of the ropiness. It had also been discovered that the growth of phase A1 in glycerin caused some of the bacteria to assume the phase A2, possibly on account of the medium becoming alkaline in contrast to the acidification in the presence of sugars. The results of this experiment engender the belief that glycerin is the only substance of those tested which can alter A1 into A2 and that dextrose can rapidly alter A2 into A1. The role these substances play is presumably in the suppression or exaltation of the power of the bacteria to secrete a slime dissolving enzyme.

Meanwhile it had been determined that the saline constituents of the medium had an influence in the production of the ropiness, especially with phase B2. In a saline test, Table xvi., A1 gave a ropy medium in the presence of sodium chloride and with no other salt, while potassium citrate was most favourable with phase B2 and as good as several others with phase A2 (A2a). A medium was accordingly prepared containing 2 % of carbohydrate or other nutrient, 0.25 % meat extract and 0.2 % of common salt for phase A1 and of potassium citrate for the others. The bacteria had been picked from plates three days previously.

Table xiv.—Sources of Carbon (2).

Phase	A1 (NaCl)						A2 (Citrate)						B2 (Citrate)					
Days at 28	1	2	4	5	7	11	1	2	4	5	7	11	1	2	4	5	7	11
1. Dextrose	O	O	O	O	O	O									S	S	O	O
2. Levulose	O	O											O	O				
3. Saccharose	O	O		S	O	O							O	S				
4. Glycerin	S						S						O	O	O	O	O	O*
5. Lactose	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
6. Galactose				O	O	O							O					
7. Mannit	O	O					S						O	S				
8. Maltose	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
9. Raffinose	O	O	O	O	O	O	O	S	O	O	O	O	O	O	O	O	O	O
10. No Sugar	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O

* Confirmed by a separate test.

On the first day of the experiment, A1 (6), when plated, showed a pure culture of phase A1. On the eleventh day, B2 (1) contained no living bacteria in a large loop of the medium; tests A1 (2, 4 and 7) contained a mixture of the two phases, A1 and A2, as well as transition colonies.

A consideration of the last two experiments leads to the conclusion that in the presence of glycerin the phase A1 tends to become A2 irrespective of whether the salt is present as a phosphate or a chloride. With phosphate of soda and the various sugars the tendency is for it to remain unaltered. The case is different with sodium chloride, for levulose, and mannit (and also glycerin) change the phase to A2, the predominance of which gives a permanent ropiness within the limiting time of the experiment.

The phase A2 tends to change to A1 in the presence of dextrose and phosphate, but not so much with the other sugars, while in the presence of citrate it seems to remain unaltered.

Phase B2 (Table xiv.) is peculiar in giving no ropiness in the presence of glycerin and in the ropiness dissolving in the presence of dextrose. Dextrose appears to have caused the reversion to a phase B1 akin to A1 before assisting in the death of the organism.

The quantity of sugar has an influence in determining the ropiness of fluid media. For example a solution containing 0.25 % each of meat extract and sodium phosphate and 1, 2 and 5 % of dextrose showed the following with two cultures of A1. Phase A1(1) showed a colony with a granular centre. Phase A1(2) had a stippled centre. These had been picked from a plate thirteen days previous to the beginning of the experiment, and had been transferred daily in bouillon.

It is clear that 2 % and 5 % of dextrose are best for obtaining ropy solutions with races of A1 showing colonies with granular centres. The colonies with stippled centres have lost much of their slime-forming power. The stippling is

Table xv. Increasing Amounts of Sugar.

Dextrose	1%						2%						5%					
Days at 28°	1	2	3	4	6	9	1	2	3	4	6	9	1	2	3	4	6	9
Phase A1(1)	S	S	O	O	O	O	—	—	—	—	O	O	—	—	—	—	—	O
Phase A1(2)	O	O	O	O	O	O	O	O	O	O	O	O	O	O	—	—	O	O
Acidity to methyl-red						3·5						4						6

caused by the presence of clusters of microscopic crystals of magnesium ammonium phosphate and these are not in evidence in the granular colonies. Large crystals, however, develop slowly in the agar, and are found in the old plates. It would appear that the development of ammonia runs *pari passu* with the formation of slime-digestive ferments, for it seems reasonable to consider that the ropy substance was digested as soon as it formed in the case of phase A1(2) with 1 % and 2 % of sugar. With 5 %, the increased sugar resulted in the slime-forming power temporarily overbalancing the slime-digesting power of the bacterium.

A synopsis of tables v., xiii., and xiv. gives a clearer view of the effects of the various sources of carbon than a detailed reference to the tables themselves. In this synopsis dextrin and gum-acacia have been omitted because under no circumstances did they ever assist in the formation of ropiness.

Table xiv*a*. Synopsis of Sugar, etc., Experiments.

Phase	A1		A2				B2			
	Meat Extract with		Tannic Acid with		Meat Extract with		Tannic Acid with		Meat Extract with	
	phosphate	chloride	ammon. sulph.	asparagin	phosphate	citrate	ammon. sulph.	asparagin	phosphate	citrate
Galactose	S								S	
Levulose								S	S	
Saccharose	S								S	
Mannit	O						S			
Dextrose	S	O							O	
Glycerin									O	O
Lactose	O	O				O			O	O
Maltose	S	O		O		O	O	O	O	O
Raffinose		O	O	O		S	O	O	•	O

Of all the sources of carbon, galactose seems best fitted to produce the ropy material. This is to be expected since the ropy substance is essentially a galactose anhydride and one would naturally think that the bacteria could form it most easily from this sugar. But the other sugars are not far behind in their capacity for assisting in the production. Levulose and saccharose are goodseconds. There is a suggestion that sucrase or invertase is secreted by the bacteria as saccharose is the only biose that is utilised to any extent, but a search for this enzyme did not show its existence.

It is curious that the hexatomic alcohol, mannit, should be so good, but it seems to be peculiarly suitable for the production of many kinds of slime and is very frequently used in bacteriology for the nutrition of slime-forming bacteria.

Dextrose probably acts quite as well as the other substances, but it seems to be specially adapted to form a slime dissolving enzyme and on this account the rope-producing action of the sugar is not so clearly shown.

Glycerin is peculiar. It acts as a source of carbon for the phase A2 and alters A1 to this phase. It does not serve as a favourable nutrient for B2; indeed, it is not only unfavourable, but it also slowly changes B2 to the phase B1, and therefore acts in opposite directions with the two bacteria. Like mannit, it is a general nutrient for the production of slime from the majority of slime-forming bacteria, as will be seen from a perusal of my papers upon slime-forming bacteria.

Maltose, raffinose and lactose may be considered as being incapable of utilisation by the bacteria A and B. It is true that A2 can utilise them to some extent, but this phase is very active, and is able to make bouillon ropy, a fact which should be considered in connection with the production of ropiness in the presence of meat-extract.

It is probable that with suitable nitrogenous and saline nutrients and suitable conditions as regards acidity, the bacteria A and B are capable of forming ropy solutions from any source of carbon, and that the absence of the bacteria, rather than an unsuitable pabulum, should be the object aimed at in preventing ropiness in wattle bark infusions.

The Influence of Salts.

It is customary to add salts to bacteriological fluids for the purpose of supplying all those that may be necessary for the nutrition of the bacteria and of raising the osmotic pressure. The ordinary nutrient bouillon, agar and gelatine contains ½ % of common salt together with the salts that may be contained in the meat-extract used in the preparation of the media. With this amount of saline matter, the ordinary bacteria grow very well, but it does not follow that this amount is best for all bacteria. Water and soil bacteria, for example, exist upon much less, and it is a matter of common knowledge to the bacteriologist that the saline content of bacteriological fluids can be raised or lowered considerably without harming the bacteria to any great extent.

In the earlier experiments the saline matter had been usually added to the extent of 0.3 %, and generally consisted of potassium phosphate 0.2 %, magnesium sulphate, 0.1 %, and calcium chloride, 0.02 %. As these may or may not be good for assisting the bacteria in the production of the ropy substance, a number of tests were made to get some information upon the matter.

In an early experiment, a solution of glycerin, 2 %, and meat-extract, 0.25 %, was divided into portions, and each received 0.1 % of certain salts. They were seeded with A, a mixture of A1 and A2. That with calcium nitrate seemed to give the most slime on the second day. After twenty days' incubation the slimes were coagulated with alcohol and weighed. The milligrams of ash-free slime per 100 c.c. of liquid are given below:—

Calcium nitrate, aq.	260
Calcium chloride	175
Calcium lactate	152
Magnesium sulphate, aq.	132
Potassium monohydrogen phosphate	105
Sodium acetate	88
No salt	85
Sodium succinate	82
Sodium lactate	80
Potassium-sodium tartrate, aq.	57

The influence of the salts of the earths in promoting the formation of the ropy substance is clearly shown. Potassium, as represented by the phosphate, has more influence than the indifferent salts of sodium. The weights of slime obtained from the media containing the lactates of calcium and sodium show that the base and not the acid is the active component of the salt, but that the acid has some influence is indicated by the slime obtained in the presence of sodium-potassium tartrate.

These results were obtained in a medium containing glycerin, which in other tests had been found to maintain the original reaction or to bring about an alkaline condition of the medium. Dextrose and other sugars produced an acid condition and as wattle bark extracts are acid and as the carbohydrate in such extracts is probably of the nature of dextrose, possibly as a glucoside, it was considered advisable to test the activity of the bacteria in media containing this sugar with various salts. Accordingly a fluid containing dextrose 1 %, meat-extract 0.25 %, was prepared, and portions of it received 0.1 % of anhydrous salt. After sterilisation the sets were infected with bacteria which had been taken from pure colonies upon the previous day.

Table xvi. Salts with Dextrose 1 %.

Phase	A1			A2					A2a.					B2		
Days at 28°	1	3	5	1	3	5	7	13	1	3	5	7	13	1	3	13
Magnesium sulphate	S	O	O	S	—		S	O	—	O	O	O	O	O	O	O
Calcium lactate	O	O	O	O	S	S	S	S		S	O	O	O	O	O	O
Calcium chloride	O	O	O	S				O		—	S	O	O	O	O	O
Calcium nitrate	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
Sodium chloride	—	O	O	S			O	O	—	O	O	O	O	O	O	O
Sodium acetate	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
Sodium phosphate	O	O	O					S			—	O	O	O	S	O
Sodium lactate	O	O	O	S	O	O	O	O		O	O	O	O	O	O	O
Pot. sodium tartrate	O	O	O	S	—					—	—	S	O		O	O
Potassium citrate	O	O	O	S	—	—		—			—		O		S	O
Potassium nitrate	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
No salt	O	O	O	S	O	O	O	O	—	O	O	O	O	O	O	O

Certain of the tests were examined by plate culture from time to time, and it was found that A1 was pure on the 1st and 4th days. Phase B2 was pure on the 12th day. Phase A2a appeared to be a mixture of A1 and A2. Phase A2 seemed to be influenced in its persistence by the salt. In the sodium lactate test it was pure on the 12th day, in the citrate it contained a few of A1 on the 7th day and on the same day the sodium chloride test consisted chiefly of A1.

In the presence of sodium acetate and of calcium nitrate, not only was there no slime formed, but there was a complete absence of growth, a circumstance which led to the examination of the influence of the acetate upon the production of ropiness in bark extracts infected with rope-producing organisms.

The quantity of dextrose in the medium did not seem to affect the results to any degree, for the medium was strengthend with 3 % of dextrose and seeded with A1. Calcium chloride gave a slight and fugitive ropiness on the 1st day and citrate gave a fugitive ropiness on the 2nd day. All the other tests were negative.

As the activity of the saline constituents appeared to be of importance, especially in regard to the mutation of the organism, another test was made. In this the dextrose was used in 2 % strength with meat-extract 0.25 %, and the salts as before, viz., 0.1 % of the anhydrous salt. The infecting phases had been taken from typical colonies two days before the experiment was started.

Table xvii. Salts with Dextrose 2%.

Phase	A1					A2						A2a.						B2					
Days at 28°	1	2	3	7	10	1	2	3	7	10	17	1	2	3	7	10	17	1	2	3	7	10	17
1. Magnesium sulphate,	S	-	-	O	O	O	.	-	+	O	O				O	O	O	S	.		O	O	O
2. Calcium lactate,	O	O	O	O	O	+	..	+	+	O	O	.				S	S	O		-	.	S	S
3. Calcium chloride,	S	-	S	O	O	O	..	+	-		O					O	O	.	+	+	-		O
4. Calcium nitrate,	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
5. Calcium sulphate,	+	+	..	O	O	+			+	O	O					O	O	.		-	-	S	O
6. Sodium chloride,	'O	-	.	O	O	O			.	O	O					O	O	.		:	.	S	O
7. Sodium phosphate,	O	-	+	-	O	.			+	-	-					O	O	.		.	-		O
8. Sodium lactate,	O	O		O	O	O			O	O	O	S		.	O	O	O	.	+	+	-	O	O
9. Sod. Pot. tartrate,	O			O	O	O			-	S	O					O	O	O		.	-		O
10. Potassium citrate,	O	.	.	O	O	O			+	.						+	O	O	.	+	+		O
11. Sodium succinate,	O			O	O	O			ı								+		+	-	-	-	
12. No salt,	O			O	O		-	.		O	O				O	O	O	+	.	.		O	O

On the seventh day some of the tests were plated with the following results:—

A1 (succinate), typical colonies of A1.

A2 (sod. lactate), colonies of A1 with stippled centres.

A2a (control), a mixture of colonies of A1 and A2.

B2 (magn. sulph.), colonies of B1, some with stippled centres.

On the tenth day other tests were plated.

A2 (phosphate), typical colonies of A1 as well as transition colonies of the same.

A2a (citrate), typical colonies of A1.

B2 (calc. sulph.), colonies of B1 with 2 % of B2.

B2 (phosphate), colonies of B1.

B2 (citrate), colonies of B1.

The disappearance of the ropiness in the test with magnesium sulphate first suggested the possibility of there being a phase of B2 secreting a digestive substance akin to A1, and the actual presence of this phase B1 upon the plates led to the examination of the stock culture. The latter was found to be pure B2 and the conclusion was reached that bacterium A was not peculiar in alone possessing phases or conditions with less physiological stability than races.

Part of experiment xvii. was repeated to confirm the changeability of phase B2, in media containing 1 % of dextrose, 0.25 % of meat-extract, and 0.1 % of anhydroas magnesium sulphate, sodium chloride or sodium lactate.

Table xviii. —Change of Phase.

Phase	A1					A2					A2a					B2				
Days at 28	1	2	3	6	8	1	2	3	6	8	1	2	3	6	8	1	2	3	6	8
1. Magnesium sulphate	O	S	S	O	O	+	+	+	+	S	+	+	+	+	O	+	+	+	+	O
2. Sodium chloride	O	O	S	O	O	+	+	+	+	O	+	+	+	+	+	+	+	+	+	O
3. Sodium lactate	O	O	O	O	O	S	+	+	+	O	O	+	+	O	O	+	+	+	+	S

Plates were prepared on the eighth day.

A2 (magn. sulph.), A1, coarsely granular as well as transition forms.

A2 (sod. chloride), A1 with stippled centre.

B2 (magn. sulph.), B1, some with stippled centres.

B2 (sod. chloride), phase B1.

The experiment confirms the previous one, and shows the alteration of phases A2 and B2 into phases A1 and B1, in the presence of dextrose, some aid being possibly given by the salt.

Typical colonies of phase B2 were put into bottles containing dextrose with mixed salts and into glycerin with sodium phosphate, both with meat extract as a nitrogenous nutrient. No ropiness had occurred by the third day when plates were prepared. The glycerin contained phase B1 and B2 with transition colonies. The dextrose did not alter phase B2.

Typical colonies of phase B2 were seeded into fluid media containing 3 % of levulose or dextrose with 0.2 % of potassium citrate and 0.25 % of meat-extract. In four days the dextrose medium was ropy, while the levulose was not, and both contained the introduced phase in pure culture. By the seventh day the ropiness had disappeared in the dextrose flask, but plate cultivation showed that it contained the introduced cohesive phase B2 only. The levulose medium contained the cohesive and introduced phase B2, together with 25 % of the diffuse phase B1. The diffuse phase is akin to A1, but differs in being brownish or pale buff instead of yellowish or pale straw. Furthermore, there is the suggestion of a wavy structure as if the flattened colony had an undulating surface. No further change had occurred by the sixteenth day.

The diffuse phase, B1, was grown in a glycerin phosphate medium to see in which direction an alteration would occur. On the 17th day, B2 was present, but it had disappeared by the 23rd. In another test the bacteria on the 6th day were all transition forms of B2, and on the 12th there were 75 % of B1, 15 % of B2, and 10 % of the transition form noted on the 6th.

The results seem to show that dextrose tends to maintain the phase B2 and glycerin the phase B1, but this is influenced by the nature of the salt.

Ordinary bouillon maintains the phase B2 and that is why the existence of a phase B1 was not suspected for a long time. It is different with A2 which is slowly changed to A1 in bouillon.

After finding that levulose favoured the production of the ropy substance more than dextrose, the experiment with the various salts was repeated upon two occasions using levulose as the carbohydrate. The phases A1, A2 and B2 were tested, and, for the sake of comparison, a further set of salts with dextrose was used for B2. The experiments duplicated one another, and the salient points of both are embodied in the table. Both sets of A1 (levulose) and B2 (dextrose) are omitted because they were almost entirely negative; the second set of A2 was the same as the first set.

After sterilisation, the dextrose medium in the first experiment had a reaction of -1.5° to methyl-red and $+3^\circ$ to phenolphthalein, and this was sufficiently alkaline to give precipitates in the tubes containing the salts of lime. In the course of the experiment, the reaction was tested on the seventh day in tests 4

Table xix. Levulose with Various Salts.

Phase	A2			B2					B2 (Second Experiment)			
Sugar	Levulose			Levulose								
Days at 28°	1	3	12	3	5	7	10	12	3	5	9	14
1. Magnesium sulphate	S			O	O	S	+		+	+		S
2. Calcium lactate	S			O	O	O	O	O	O	O		+
3. Calcium chloride	O			O	O	O	O	O	S	S		
4. Potassium sulphate	O			S	S			O				
5. Sodium chloride	O			S	S	S	O	O	+			
6. Calcium sulphate	S	+	+		S	S	S	O	+			
7. Sodium phosphate	O	+		O	S	O	O	O				
8. Sodium lactate	O	−		O	O	O	O	O				
9. Sodium Potas. tartrate	O	+	−	S	S	S	O	O	S	S	+	
10. Potassium citrate	O		+	O	S	S	S	O	+		−	
11. Sodium succinate	O	+	+	O	S	S	S	S	+	−	+	S
12. No salt	O	+	+	O	O			O	+			

and 5. Phase A2 with levulose showed +3° to methyl-red and +9.5° to phenolphthalein, while B2 with dextrose showed +11° and +14.5° respectively. Thus there was an approximate increase in the acidity during the seven days' incubation of +5° with levulose and +12° with dextrose. It is possible that the greater development of ropiness with levulose may be traced to the lesser production of acid favouring the stability of the cohesive phases of the bacteria.

Phase A1, in the first experiment, showed no ropiness in any of the tests until the 10th day, when that with succinate was ropy, and contained a mixture of phases A1 and A2a. In the second experiment, the tests were negative until the 5th day, when the phosphate gave a positive result. On the 13th day, the phosphate contained A2 with a few transition forms of A1. On the same day the potassium sulphate and sodium chloride tests contained the phase A1 with a few transition forms. On the 19th day, the ropiness had disappeared in the phosphate test, and the medium contained A2, 25 %, A1, 5 % and transition forms 70 %. In this case the phosphate apparently altered the phase to A2, which produced the ropy substance and, as the proportion of A2 decreased, the ropy substance dissolved. A1 has been omitted from the table.

Phase A2 produced ropiness with all the salts as well as in the control. It was apparently too active to require any assistance from the saline constituents. On the 12th day, the tests containing the salts of lime were gelatinous as well as ropy, and the media flowed like a soft jelly. In the second experiment, phase A2a was used, and all the tests were ropy on the 2nd day, and the ropiness persisted to the end of the experiment on the 19th day. Thus A2a duplicated A2.

Phase B2 with dextrose gave a slight ropiness on the first day with tartrate and succinate, but it had vanished by the 3rd day. Then all tests were negative until the 12th day, when the citrate test became ropy. In the second experiment no ropiness was obtained with any of the salts.

Phase B2 with levulose gave more favourable results, but there was a decided difference between the two experiments. That made on the later date gave a greater amount of ropiness which the control test seemed to indicate as being due to a more active condition of the infecting organism.

On the whole the saline tests, and especially those in the last two experiments, seem to indicate that given a suitable source of carbon and an active bacterium, the salts employed in the tests have little influence in producing ropiness. When the bacterium is not active, the salt may alter the phase, and thus assist in the production of a ropy liquid.

Acetates and Nitrates Check Ropiness.

The saline tests showed that nitrates and acetates prevented the development of ropiness in artificial media, and naturally this led to testing the influence of the acetate in bark infusions to see if the same prohibition occurred.

One part of bark was added to two parts of water and varying amounts of sodium acetate were added to the portions before seeding with B2. Ropiness developed in the control, but not in the portion containing 0.03 %, i.e., 3 parts per 10,000.

Another test was made with bark and water containing 0.02 % of acetate, portions being seeded with phases A1, A2 and B2. The controls became ropy.

and so did phase A2 with the acetate. The phases A1 and B2 with the acetate did not become ropy.

From these two tests, it appears that the limiting strength of the acetate for checking ropiness in bark infusions lies between 2 and 3 parts per 10,000.

Still one more test was made with bark and water containing 1, 2, 3 and 4 parts of acetate of sodium per 10,000, the liquids being seeded with phases A1, A2, and B2. Ropiness developed in the tests seeded with phases A2 and B2 containing one part per 10,000 but not in the stronger solutions. Phase A1 did not produce ropiness in the weakest solution.

The conclusion that we come to from a consideration of all the tests is that crystalline sodium acetate, when added to the water used for extracting wattle bark, in the proportion of three parts of salt to 10,000 of water or 3 pounds to 1,000 gallons will prevent the formation of ropiness in wattle bark extract.

The Nature of the Ropy Substance.

An attempt was made to obtain the slime in bulk by growing the bacterium A in fluid media containing dextrose or glycerin, but the quantities of slime were very small. This may possibly have been caused by autodigestion as noted in the various experiments with synthetic media, but of this I have no definite information to offer. More successful results were got by growing the organism on solid agar. Several drops of a broth culture of the organism was smeared on plates of a medium containing glycerin 5 %, meat-extract 1 %, potassium nitrate 0.1 % and sodium phosphate 0.2 %. The first growth obtained in a few days was yellow, loose, and was easily scraped off. The second growth that came up was translucent and elastic. It adhered with more or less tenacity to the agar, and some bits could not be removed. It was noted that the toughness increased with time, and the reason for this was explained later when it was learned that glycerin caused the phase A1 to alter progressively to A2, the more insoluble phase.

The collection of films was treated with alcohol and filtered; the coagulum was treated with water in which it simply swelled up; there was no solution. The swollen slime was heated in an autoclave at three atmospheres' pressure for half an hour when a solution and a sediment were obtained. The liquid was filtered with the aid of aluminium hydrate, and the filtrate was concentrated by evaporation. A portion sufficiently dilute to enable light to pass through was tested in the polariscope and found to give a reading of $+2.12°$ in a 200 mm. tube. Thus the gum was dextro-rotatory. The solution was further evaporated to a mucilaginous consistency and tested dropwise with various reagents.

Coagulation was effected with alcohol, basic lead acetate, ammoniacal lead acetate, ferric chloride and phosphotungstic acid, but the following had no action: lead acetate, baryta water, lime water, milk of lime, copper sulphate, the same followed by sodium hydrate, Fehling's solution, iodine, tannic acid, sodium hydrate or sulphuric acid. These are the general reactions with the autoclaved slimes, i.e., slimes which by the autoclave treatment have been separated into a soluble gummy matter and into coagulated proteid. The natural, uncoagulated ropy substance would behave quite differently. In one case where a slime was autoclaved for five and a half hours, coagulation was effected only with basic lead acetate and by phosphotungstic acid.

The soluble condition of the gummy matter does not appear to be stable, for when it was evaporated to dryness it became insoluble, and did not again form a solution with water.

The thickened mucilage which did not contain any reducing sugars, was boiled for ten hours with 5 % sulphuric acid under an aerial condenser, and during the hydrolysis it was noted that, like all the bacterial gums that I have examined, furfural was given off. The solution was neutralised with barium carbonate, filtered, treated with basic lead acetate, filtered, treated with sodium carbonate, again filtered, acidified with acetic acid, and evaporated. The solution was dextro-rotatory.

The osazone was prepared in the usual manner, and the bulk of the tar was removed by percolating the dried crystals with chloroform, then by a mixture of chloroform and alcohol, and finally with chloroform. The crystalline mass was dissolved in alcohol and allowed to stand. Successive crops of crystals deposited, and were removed, dried and tested for their melting points. These ranged from 202° to 193°. The intermediate crops were again crystallised, but in no case could crystals with a m.p. higher than 202° to 203° be obtained. Doubtless they were a mixture of glucosazone, m.p. 205°, and galactosazone, 193°, but the quantities were always too small to enable the pure glucosazone to be obtained. It is possible that the small quantity of glucose was present in the hydrolysed gums as an impurity. In testing the gum previous to hydrolysis for sugar, no positive indication was obtained, but it must be remembered that only a small portion was used and, while the impurity may not have been detectable in a small portion, it may show itself in the bulk after hydrolysis.

As an example of the relative amounts of crystals obtained, the following weights from a half portion of the hydrolysed gum are given.

1st crop—	12	milligrams,	201°
2nd ,,	—170	,,	195°
3rd ,,	—138	,,	193°
4th ,,	— 50	,,	193°
5th ,,	— 27	,,	193°
6th ,,	— 2	,,	190°

Mother-liquor evaporated and treated with chloroform, which dissolved a brownish-yellow tarry matter.

residue .. .. 22 milligrams, 181°

The second bacterium, B2, was grown on plates of levulose asparagin tannin agar and yielded a number of tough skins which were easily pulled from the agar surfaces. It was not always possible to get the ropy material upon this medium for several later attempts failed. The slime of A2 is much more readily obtained. There was, however, sufficient slime to enable a determination of the hydrolytic products to be made. The rather thick emulsion, for the gum after solution by the autoclave treatment became partly coagulated upon evaporation, was unsuitable for testing the rotary power. The osazones were precisely similar to those furnished by A2, and yielded similar fractional crops of crystals melting at temperatures ranging from 202° to 193°, showing that the hydrolytic products of the slime of B2 were precisely similar in composition to those of A2.

The evidence goes to show that the ropy substance is essentially a dextrorotatory galactan.

A crop of films of the B2 slime of B2 was subsequently obtained upon an agar medium containing agar 2 %, saccharose 5 %, ammonium sulphate 1 %, potassium citrate 0.3 % with 0.1 % of tannic acid added at the time of pouring the plates. After 17 days at 22°, the films were picked off, suspended in water overnight, and coagulated with alcohol. The water and alcohol treatment was repeated. The films suspended in water were heated in the autoclave for 15 minutes at three atmospheres pressure, but the treatment did not liquefy them. The water was acidified with two c.c. of normal sulphuric acid which produced an acidity of +5°, and the suspension was again autoclaved for an hour. The films had dissolved. The solution was carefully evaporated to smaller volume, and a portion was clarified with alumina cream and the rotation of the fluid observed. The ash-free solids had a specific rotation of $[\alpha]_D = +0.017°$. The solution gave a yellow precipitate with Fehling's solution, and it appeared that the treatment had partly hydrolysed the gum. It was treated with alcohol, and the unattacked gum was filtered off. The ash-free solids in the filtrate had a specific rotation of $[\alpha]_D = +0.002°$. The difference between these two rotations shows that the gum precipitable by alcohol is slightly dextro-rotatory.

The Acids formed by the Bacteria.

In the routine testing, the bacteria, A and B, were found to produce acid and gas from dextrose and saccharose when these sugars were present in broth. The nature of the acids was further examined. The bacteria were grown in a medium containing 5 % of dextrose, 1 % of meat-extract, and 0.5 % of sodium phosphate with the addition of chalk from time to time. The bacterium B2 used up the carbonate more quickly than A1 or A2, and naturally yielded a greater quantity of acids when the cultures were worked up at the end of a month's incubation.

The method followed in determining the nature of the acids, etc., was essentially that described in these Proceedings*

Ethyl alcohol was found in small amount in the cultures from both bacteria. It was proved by giving the iodoform test, by burning with a blue flame and by having a B.P. of 79°.

A small quantity of insoluble fatty acid was obtained from the culture of each bacterium. That from A melted at 37°, and from B at 32°. Both were probably mixtures, but the quantities were too small to separate. The softer acids of B were spread on a piece of filter paper and incubated at 28°, when the more fluid portion was absorbed, leaving a residue which melted at 40°, and became clear at 42.5°.

The volatile acids did not contain formic acid. The solutions were neutralised with baryta water, and after evaporation were dried at 140°. The A salts contained 52.36 % of barium, the B salts 53.8 %. As barium acetate contains 53.73 % of barium, it is clear that the volatile acids in both cases consisted entirely of acetic acid.

The non-volatile acids contained a small quantity of an acid giving a lime salt insoluble in 70 % alcohol. After acidification and extraction with ether, monoclinic prisms, melting at 182°, were obtained. Succinic acid under the same conditions melted at the same temperature, and thus it was proved that both bacteria form a small quantity of succinic acid.

The only other non-volatile acid was lactic. The zinc salt of lactic acid was prepared from two cultures of the A bacterium originally seeded with A1 and

*Loc. cit., 1901, 606; 1903, 114.

A2. The first, A1, was separated as the lime salt from the non-volatile acids; the second was prepared directly from the total acids. A1 contained 18.12 % of water of crystallisation, and A2 contained 18.42 %. The latter showed a specific rotation of $[\alpha]_D$ = 3.35°, and upon being acidified with hydrochloric acid in the proportion of 2 c.c. of strong acid to 20 c.c. of solution it showed no rotation. The acid was therefore inactive lactic acid with a laevo-rotatory zinc salt, and this was apparently the only form of acid present.

In preparing the zinc salt of the B2 acid, three crops of crystals were obtained. The first weighed 2.02 grams, and contained 13.26 % of water of crystallisation. Zinc paralactate contains 12.9 %, equivalent to two molecules. The zinc salt when dissolved in water had a specific rotation of $[\alpha]_D = -5.18°$, and with the addition of 2 c.c. of strong hydrochloric acid to 20 c.c., the rotation became $[\alpha]_D = +2.74°$. The first crop of crystals therefore consisted of paralactate. This acid is said to be contained in meat-extract, but in this case it was the result of the bacterial activity, because it was not found in the cultures from Bacterium A which was grown in media prepared from the same formula.

The second crop of crystals weighed 0.8 grams, and contained 15.18 % of water of crystallisation, showing it to be a mixture of two forms of acid. The third crop weighed 0.36 grams, and contained 18.75 % of water. The zinc salt of ordinary ethylidene or fermentation lactic acid contains 18.18 %, equivalent to three molecules of water, and this was undoubtedly the form of acid in the third crop of crystals.

The calcium salt was prepared from a portion of the non-volatile acids. It contained 26.56 % of water, equivalent to 4½ molecules (26.2 %), and was either a mixture of the calcium salts of the two forms of acid, or it was the more insoluble paralactate, as was indicated by the comparative quantity obtained (2.9 grams). The calcium salt of the ordinary acid would probably have been in the mother liquor from the crystals.

The acids formed by the two bacteria, A and B, from dextrose in the presence of chalk have been shown to consist chiefly of lactic and acetic acids with small quantities of succinic acid and mixed insoluble fatty acids. Ethyl alcohol was also formed in small amount, and it may be that this was the source of the acetic acid. There was a difference in the nature of the lactic acids. Both bacteria formed the ordinary fermentation lactic acid, but B2, in addition, produced the dextro-rotatory paralactic acid.

A Glucoside may be formed.—When the A2 culture was acidified with sulphuric acid and extracted with ether, a quantity of films was carried up by the ether and conveyed to the distillation flask. At the end of the extraction, the ether was shaken up with water and the supernatant ether containing the acids was used for their identification. The yellowish watery liquid was evaporated, and yielded a syrup which was assumed to be glucose carried over with the films. Upon tasting it, however, it was found to be intensely bitter. The syrup was diluted with water, acidified with acid and shaken up with chloroform. The chloroform was evaporated off, and a yellow bitter syrup obtained. The acid solution was treated with ammonia in excess and again extracted with chloroform. Upon evaporating the chloroform, a small quantity of a colourless bitter syrup remained. The presence of a glucoside is therefore indicated, and should this prove to be correct, the further examination will be dealt with in a future paper.

Cultural Characters.

BACTERIUM A, with phases A1 and A2, A2a.

Morphology.—A Gram-negative, motile, short rod with rounded ends. It appears generally as a rod $0.5 \times 1\mu$, but varies from an apparent coccus to rods up to 2μ in length. Spores were never observed. The flagella are long and vary in number. They are frequently single, and polar, but more often they are peritrichous. Up to five have been observed.

Nutrient agar stroke.—A raised, glistening, canary-coloured growth of loose consistency. The cohesive phase A2 grows as a dry rough expansion.

Nutrient agar colonies.—After a day's incubation at 28° there is little distinction between the phases beyond the tints under the microscope. A1 is yellowish, A2 is grey, and all phases are either homogeneous or have a finely granular centre. Differences are readily seen on the second day, when A1 is circular, slightly raised and yellowish, while A2 and A2a are milky white and dome-shaped. A2a maintains the dome shape, but A2 has developed or will develop a more or less flattened and corrugated base, so that the whole colony has a nipple-shape. In consistency A1 is quite loose, A2 and A2a are ropy or tough, and adhere firmly to the agar from which the colony has to be dug away. A2a is more ropy than A2. Microscopically, A1 is canary-coloured, A2 and A2a are smoke-coloured or grey. A1 has a granular centre with homogeneous outer portion. A ring of egg-shaped granules is frequently seen around the centre among the smaller granules which become finer and ultimately vanish in the homogeneous portion. The granulation may be replaced by a stippling due to the presence of small clusters of crystals of triple phosphate. In old plates, four or five days, the agar becomes studded with comparatively large aggregates of the same crystals. A2a is round, has a dark centre and a cog-wheel structure at the margin. In some cases the centre is lighter, and a rosette structure can be made out. A marginal ring shows protrusions which alternate with the points of the rosette giving rise to the cog-wheel appearance.

A2 is not rounded or circular like A2a, but is more or less roughly dentate. There are usually from five to seven lobes, more or less roughly pointed, and the rough points consist of frog-spawn-like masses of granules. The internal structure is not visible, but there is an occasional suggestion of a rosette or radial structure.

Divergences from these phases have been noted as transition forms. The main difference between A1 and A2 is in the colour, the difference between a canary colour and a smoke tint. The yellow transition colonies range from the more or less pitted forms of the stippled or granular colonies of A1 to those in which the whole colony is granular with the granules radiating to the edge and becoming more and more coarsely granular as the margin is approached. The smoke-coloured transition colonies show a fibrous structure, the coarse fibres stretching from a dark centre to near the margin. Some colonies have been seen with this fibrous structure at one side and the A2 structure at the other.

The difference in microscopical structure is closely associated with the flat, dome or nipple-shaped macroscopical structure of the colony.

When the bacteria have been quiescent for some time, as, for example, when they have been existing upon agar or in broth for a month or two without transfer, these differences may not be noted. Raised, flat-topped colonies may form, and these do not show any characteristic markings.

Nutrient-gelatin stab. In three days, A1 showed a filiform canal and sunken nail-head. In five days there was a liquefied saccate area at the top of the canal.

A2 and A2a showed a filiform canal with an upper portion waved and bearing a flat nail-head. In five days the nail-head had become a napiform softened area.

Nutrient gelatin colonies.—A1 gave colonies showing an irregular, granular, ivy-leaf-like structure in a shallow depression of softened gelatin. By the fifth day the gelatin had liquefied and the growth had broken up into irregular scattered granules. A2 and A2a liquefied the medium slowly, and the colonies remained as moruloid or frog-spawn-like masses of irregular granules.

Glucose gelatin colonies.—The phases were all much the same, and this applies to all media with sugar. A1 gave pale yellow colonies with raised centres and raised circular margins (button-shape); they were about 7 mm. diameter in four days. A2 grew as irregular moruloid masses, 3-5 mm. in diameter. Both phases softened the gelatine.

Dextrose agar.—A1 grew as a smooth raised colony of ropy consistency; A2, dome-shaped, with or without a rugose margin, and the consistency was rubber-like rather than ropy.

Bouillon.—A pronounced surface film and slightly turbid medium with a faint deposit excepting when a film has fallen down. A2 causes the upper layers of medium to be ropy. Nitrates are reduced to nitrites, indol is formed and ammonia is produced.

Potato.—A scanty, glistening, pale buff growth.

Starch.—Faint saccharification occurred.

Litmus-milk.—The medium was unaltered.

Litmus broth with sugars, etc.—Saccharose and dextrose gave acid and gas. Mannit showed a bleaching only, lactose was unaltered.

Classification number.—221.1313523.

BACTERIUM B2.

Morphology.—As A2, but a little stouter rod, 0.6 μ.

Nutrient Agar Stroke.—As A2.

Nutrient Agar Colonies.—A corrugated, dome-shaped colony smaller than A2, in appearance like a minute white raspberry. Microscopically, the colonies on thickly sown plates show a granular central area bounded by an irregular, dark, ivy-leaf shaped band outside which and half way to the edge there is a dark circular ring; otherwise the colony structure is coarsely granular. The freely-growing colonies have often rosette or spoke-like markings extending from the centre to the repand edge, but the typical structure is mesenteric.

Nutrient gelatin stab.—As A2, but the liquefaction is very slow.

Nutrient gelatin colonies.—As A2.

Glucose gelatin colonies.—As A2, but they do not liquefy the medium.

Dextrose Agar.—As A2.

Bouillon.—As A1, but the film is flakey.

Potato.—A glistening white growth.

Starch.—As A.

Litmus milk.—As A.

Litmus broth with sugars, etc.—As A.

Classification number.—As A.

The two bacteria have some resemblance to *Bac. Atherstonei*, the variable galactan bacterium described by me as having been obtained from the tissues of *Strychnos Atherstonei*.* That organism exhibited two phases. The colonies in glucose-gelatin grew as brittle transparent masses, apparently containing a brittle

*These Proceedings, 1904, 442.

transparent gum, and as loose, yellow, slimey growths. The cohesive phase was rapidly changed to the diffuse phase by growing in glucose-gelatin at 30°. The gum was a galactan, but was hydrolysed with difficulty, while the reactions of the mucilage were different from those noted with the wattle-bark bacteria.

Conclusions.

The investigation was undertaken with the idea of endeavouring to elucidate one of the problems that is occasionally met by the tanner. It is possible that every case of ropiness may not be bacterial, but it may be granted that in the great majority of cases it is a bacteriological phenomenon, and any information regarding it should be of value.

To attack the problem from the side of the tannery would be a matter of much difficulty, for one cannot always get cases of ropiness at suitable times, and, when ropiness does occur, circumstances may not be such as to facilitate the investigation. That it is not an easy problem is shown by the fact that up to the present it has not been investigated, and, doubtless, this may be traced to the multiplicity of organisms swarming in the tan-liquors and the habit which slime bacteria have of growing in clumps, while most of the other bacteria diffuse themselves. It appeared to be an easier way to attack the problem from another aspect, that of the ropiness that occurs in wattle bark infusions, and there is every reason to believe that the results obtained with the infusions will be largely applicable to tanning liquors.

In the bark of wattle trees, many bacteria may be capable of producing ropy infusions, but so far only two have been found. They are closely allied to one another and differ, not so much in their bacterioscopic characters as in their physiological properties, that is, in their power of forming the ropy substance under different conditions, especially as regards nutrition. The bacteria have been provisionally named A and B. Like several gum-forming bacteria which have been described by the writer,* each bacterium can show two phases, one forming a comparatively soluble slime, the other giving a viscous slime.

The possession of two phases is not unique and possibly a double phase may be expected to occur with many slime-forming bacteria. The alteration of phase is possibly associated with the presence or comparative absence of a gum-digesting enzyme. The soluble phase certainly possesses a larger amount of a gelatine-dissolving enzyme, and one can, at will, by altering the incubation temperature, obtain a mobile or a viscous fluid.

There appears to be something in bark infusions that induces the soluble phase to become the insoluble phase and gives rise to ropiness.

The tannins of bark infusions have a prohibiting action upon the formation of ropiness, on account of their property of coagulating the slime, and for this to occur a certain concentration is necessary. For Bacterium A this is equivalent to a specific gravity of 1.024, and for Bacterium B, 1.048. Pure tannic acid is more active, for the prohibiting amount is much under the quantities of tannin represented by the gravities of the infusions. In synthetic media, 2 % of tannic acid prevents the formation of ropiness by coagulating the slime, as it is formed, upon the bodies of the bacteria.

In view of this differential action of tannin as compared with tannic acid,

*The bacteria responsible for the production of the soluble and insoluble wattle gums were named *B. acaciae* and *B. metarabinum*, and it was shown that the one form could be altered to the other. *B. Atherstonei* (these Proceedings, 1904, 142) exists as two phases, one forming a soluble slime, the other producing an insoluble gelatinous galactan.

the liability of weak tanning end liquors to become ropy will depend upon the tannic acid, for the tannins will have become hydrolysed by bacterial action to glucose and tannic acid. Thus a fresh liquor with a sp. g. of, say, 1.024, containing about 5% of tannin will be quite different in its action to an old liquor of the same gravity containing perhaps 5 % of tannic acid. Again, it has been shown that certain salts, notably acetates, prohibit the growth of the rope-forming bacteria. Acetic acid is a very common by-product of bacterial activity, and may follow up the alcoholic fermentation should yeasts become active in the liquors. If acetates are present in the spent liquors they will have a decided influence in preventing the development of ropiness. The matter is therefore complicated; so much will depend upon the composition of the liquor.

Once the ropiness is formed in infusions still in contact with the bark, it does not disappear even although the concentration of tannin becomes greater than that necessary to coagulate the slime. Under similar conditions in synthetic media, or in infusions out of contact with the bark, the ropiness disappears either through coagulation or digestion.

The acidity of the infusion doubtless plays a part in promoting ropiness. This was the case with synthetic media which with some phases of the organisms gave most ropiness when the acidity varied from +8 to +12°, or when it contained from 0.75 % to 1 % of tannic acid. In opposition to this, the bacteria when grown in the presence of chalk and, therefore, in a neutral medium, produced ropiness at 28°, and not at 37°.

But the main condition is the presence of a sugar and of the many that were tested, galactose was the most efficient in promoting the formation of mucus. Levulose, saccharose, dextrose and the non-sugars, mannit and glycerin were nearly as good, while maltose, lactose and raffinose were incapable of assisting the slime-forming function.

The nature of the salts did not appear to have much influence when sufficient sugar was present. But with a deficiency of sugar (1 %) or with a feeble bacterium, the salt may play a part. Acetates and nitrates prevented the growth of the active bacteria, and they give us a means of preventing the development of ropiness in bark infusions and presumably in tanning liquors. Three pounds of acetate of soda to 1,000 gallons of the water used in making the extract will prevent the development of ropiness.

So far as the nitrogenous food is concerned, it did not seem to matter much whether meat-extract, peptone, asparagin or ammonium sulphate was used. Nitrates in alkaline solution will also serve, but in the presence of acid or what comes to the same thing, in the presence of sugar, they prohibit growth.

The ropy substance itself is a galactan, and by the hydrolytic action of sulphuric acid is converted to galactose. The insoluble slime swells up enormously with water, and in common with most insoluble gums, can be liquefied by heating under pressure in contact with a small quantity of sulphuric acid (+5°).

Certain by-products are formed by the bacteria when growing in solutions of dextrose and saccharose in the presence of chalk. These consist of ethyl alcohol, succinic acid, a mixture of fatty acids, all in small amounts, and acetic and fermentation lactic acids. The lactic acid preponderates. In addition to these, which are formed by both bacteria, Bacterium B produces paralactic acid.

Other differences between the bacteria A and B are that B does not seem to be able to utilise glycerin, and its insoluble phase, as compared with A, is very stable.

SUMMARY.

Two closely allied bacteria were isolated from ropy infusions of wattle bark. They caused the mucinous fermentation of bark infusions and of synthetic media containing sugar.

Fresh infusions, of Sp.G., 1.024 and less, were made ropy by A, and of 1.048 and less, by B.

The bacteria exist in two phases which can be altered at will. One produces a soluble slime, the other an insoluble mucus. The ropiness is produced chiefly by the insoluble phases.

The utilisable sugars are galactose, levulose, saccharose and dextrose, the non-sugars are mannit and glycerin.

The sources of nitrogen include meat-extract, peptone, asparagin, ammonium sulphate, and potassium nitrate in alkaline solution.

The saline constituents have little influence in presence of sufficient sugar.

A slight acidity favours the production of ropiness, the optimum ranging from + 8° to + 12°. The optimum amount of tannic acid runs from 0.75 % to 1 %. The limiting amounts are +30° and 2 % of tannic acid.

The mucus is a galactan, and is hydrolysed to galactose.

The by-products from sugar are chiefly inactive lactic and acetic acids. Ethyl alcohol, succinic acid and a mixture of non-volatile fatty acids are produced in small amounts. In addition to these, bacterium B produces paralactic acid.

I have to thank Mr. F. A. Coombs for information regarding the use of wattle-bark and for obtaining the opinions of some tanners upon the occurrence of ropiness. I am also indebted to Mr. W. W. L'Estrange for much valuable assistance given during the course of the investigation.

APPENDIX: *Opinions upon Ropiness.*

Mr. F. A. Coombs, Lecturer upon Tanning in the Sydney Technical College, circularised a number of master tanners asking their experience regarding the occurrence of ropiness in wattle bark liquors, and the replies are thus summarised

Ropiness does occur in wattle bark liquors, but as to its frequency in barks from particular places or from young or old trees no information could be obtained.

It occurs in liquors prepared from immature or freshly-stripped bark.

It is met with most frequently during the Summer months, January, February, and March, but may also occur in the Spring.

Ropiness may develop in weak or strong liquors.

If the liquors stand for a fairly long time without handling they may become ropy.

It may not be attributed to the constant use of spent colouring liquors, but this presumes that they have been treated in some way. One tanner was definite in stating that the trouble starts with the use of weak colouring liquors that ought to be run away, and added that possibly some tanners, when strengthening the spent liquors, let the bark ferment.

Ropiness occurs in liquors other than wattle-bark liquors.

The weak or spent liquors, when not run away, are either steamed, boiled, or treated with disinfectant, and in these ways the development of ropiness in the liquors is prevented.

EXPLANATION OF PLATE IX.

Colonies growing on the surface of Nutrient Agar.

1.—Colony of A1.

2.—Colonies of A1 and A2a growing side by side. The almost homogeneous character of A1 and the cog-wheel structure of A2a are brought out.

3.—Colony of A2. This was a specially translucent colony. They are generally opaque, except at the margin.

4.—Colonies of B2. Thickly sown colonies, showing the ivy-leaf structure.

5.—Colony of B2 Mature colony, showing the mesenteric structure.

6.—Ropy Bark infusion, flowing siphon-wise.

(Photographed by Mr. W. W. L'Estrange.)

AUSTRALIAN *SYLLIDAE*, *EUSYLLIDAE* AND *AUTOLYTIDAE*.

By W. A. Haswell, M.A., D.Sc., F.R.S., Emeritus Professor of Biology, University of Sydney.

(With Plates x.-xiii.)

INTRODUCTION.

This paper deals with the families *Syllidae*, *Eusyllidae* and *Autolytidae* of the section *Syllidea* (*Polychaeta Phanerocephala*), and is to some extent a continuation of one on the *Erogonea* recently* published. Unlike the latter, however, it is entirely systematic and descriptive, structural and developmental points being reserved for separate treatment. The material consists almost exclusively of specimens collected by the author about low-water mark in Port Jackson and examined in the living condition in the first instance. The types of the species described as new have been deposited in the Australian Museum.

In 1885 I published descriptions of six members of the family *Syllidae* found in Port Jackson. The original specimens have been lost, but the identity of five of the six species is definitely determined as a result of Augener's study of the Polychaeta collected by the Hamburg Expedition to South-western Australia (1), together with the present contribution. There remains in doubt *Gnathosyllis zonata* mihi. This was founded on a solitary specimen obtained with the dredge. There are indications that Augener's identification with this of a *Typosyllis* in his collection is incorrect.

The general classification here followed is that of Malaquin, and, within the extensive genus *Syllis*, the division into sub-genera proposed by Langerhans and followed by various recent writers (De Saint-Joseph, Gravier, Augener) has been adopted.

I have found some difficulty in dealing with the genus *Pionosyllis*. Malmgren's original diagnosis (11, p. 39) comprises the following points: a single pharyngeal tooth; compound setae with long slender bidentate appendages; capillary setae on the middle and posterior segments; other characters as in *Syllis*. The type species, *P. compacta*, has "palpi distantes," "tentacula indistincte articulata" and "cirri dorsuales vix articulati."

In the classification of the *Syllidea* elaborated by Langerhans (36), *Pionosyllis* is characterised as having the palpi not fused, the tentacles and dorsal cirri not articulated, and as having the pharynx armed with a single tooth which is situated anteriorly.

In Malaquin's scheme (40), *Pionosyllis* is grouped among the *Eusyllidae* – *Syllidea* possessing ventral cirri, having the palpi fused at the base only, the tentacles and dorsal cirri indistinctly articulated, and reproducing only directly without schizogamy. From the other genera of that family it is distinguished by the single, anterior, pharyngeal tooth.

* Jour. Linn. Soc. Lond., xxiv., No. 227.

The following suggested diagnosis of *Pionosyllis* assumes that the type species, *P. compacta*, has the palpi united at the base.

Syllidea with ventral cirri, the palpi united at the bases only, the tentacles and cirri devoid of segmentation or incompletely segmented, the compound setae bidentate. The pharynx with a single tooth situated anteriorly; no schizogamy.

This would exclude species such as *Syllis exilis* Gravier, *S. macroceras* Grube, *S. hyalina* Grube, *S. moniliformis* Savigny, and a number of others, which approach *Pionosyllis* in having the palpi fused at the base, or the tentacles imperfectly segmented or in the union of both of these characters, if reproduction is accompanied by schizogamy.

Family SYLLIDAE.

Genus SYLLIS Savigny.

Sub-genus TYPOSYLLIS Langerhans.

SYLLIS (TYPOSYLLIS) VARIEGATA Grube. (Plate x., figs. 1 and 2).

Syllis variegata, Grube, (19), p. 85, Taf. 3, fig. 6.
Syllis hexagonifera, Claparede, (5), p. 73, Pl. 5, fig. 2.
? *Thoe fusiformis*, Kinberg, (31), p. 249.
? *Thoe fusiformis*, Kinberg, (32), p. 61, Tab. 51, fig. 4-8.
Syllis nigropunctata, Haswell, (25), p. 12, Pl. 52, figs. 1-3.
Syllis compacta, Gravier, (16), p. 165, Pl. 9, fig. 11.
Syllis (Typosyllis) variegata, Gravier, (16), p. 158, figs. 24 to 27, Pl. 9, fig. 8.
Syllis (Typosyllis) variegata, De St. Joseph, (48), p. 22 (146).
Syllis variegata, Marenzeller, (42), 2 Beitrag, p. 19, Pl. 2, fig. 2.
Syllis variegata, Langerhans, (36), p. 532.
Syllis variegata, Marion et Bobretzky, (45), p. 22.
Syllis (Typosyllis) variegata, Augener, (1), p. 190.
Syllis closterobranchia var., Ehlers, (10), 1, p. 20, Taf. 3, fig. 1-4.

Syllis (Typosyllis) variegata is the commonest species of *Syllis* in Port Jackson, and in some situations, as among the roots of oar-weeds (*Ecklonia*), it is extremely abundant, by far the most numerous of the larger Polychaeta. It also occurs in Port Stephens. It grows to a large size, being often two or even three cm. in length in the living, fully-extended condition; but contracts to about half its length when fixed by any of the ordinary methods.*

Such large specimens, and the majority of the smaller ones, are readily recognisable owing to the very characteristic pattern of the pigment on the dorsal surface. The main feature of this pattern which was figured broadly by Marenzeller (42), is the arrangement of black or brown pigment on the dorsal surface of each segment, in such a way as to leave two, somewhat irregular, transversely elongated, colourless spaces (spectacle pattern). This pigment pattern is most pronounced in front, the pigment fading away towards the posterior end. An almost invariable feature, so far as the Sydney specimens are concerned, is the alternation of darker and lighter segments, the latter always being the segments bearing the larger, dorsally directed pairs of cirri, the more ventrally directed shorter pairs which alternate with them being borne on the darker segments.†

* By pouring over well-extended live specimens, water warmed to 70 C., immediate paralysis is produced and fixation can be effected with little contraction.

† This arrangement is most probably connected with the exceptional sensitiveness to bright light shown by this species.

Comparatively rare are specimens in which, though the dorsal surface is darkly pigmented, it wants the characteristic pattern described above, the pigment being disposed in transverse bands, two on each segment; here too there is an alternation of darker and lighter segments with the alternation of the shorter and longer cirri.

Many of the smaller specimens however, are devoid of the dark pigment. Many of these have a light red colour due to the presence of diffused particles of red pigment, some are greenish, others orange or yellow.

Apart from markings and colouration, the following points seem to be distinctive of *S. variegata*:—

Palpi in the living animal elongated, longer than the prostomium, their inner edges in contact at the base for about a fourth of their length, narrowing distally with rounded ends, with a deep hollow on the inner part of the ventral surface. Tentacles and cirri elongated, with numerous well-defined segments filled with twisted unicellular (vermiculate) glands. Dorsal cirri alternately longer and shorter, with from twenty to thirty-five segments. The anal cirri are similar to the dorsal; between them is a median narrow process.

As in other species of *Syllis*, the parapodium, when viewed from above or below, though not deeply cleft, appears divided into two lobes at the end. In anterior or posterior view these lobes are found to represent broad vertical flaps, anterior and posterior. Close to the latter on its dorsal side are the points of the acicula; between the flaps or lobes is the irregular surface through which the setae protrude.

The compound setae (Plate x., fig. 1) 8 to 12 in number in each parapodium, are of uniform character throughout; they all have the appendage (*falx*) straight, bidentate terminally, and with a strong fringe of some 20 pieces along the cutting edge of the blade.

The length of the falx is greater in the setae of the anterior region of the body than in those of the segments behind, but the difference is not great, and the transition from one form to the other is very gradual.

As pointed out by Augener, each parapodium in the extreme posterior region has, as in most species of *Syllis*, a simple seta in addition to the compound. This, which is always dorsal to all the latter, is in *S. variegata* of the gently curved, terminally bidentate type which is the commonest form of these simple setae in the majority of the species of *Syllis* which I have seen. The acicula (Plate x., fig. 2) are fairly characteristic. Usually there are three in each parapodium; but sometimes there are four or five. When three are present one—the most anterior and ventral—is almost always very slightly bent at the end, and slightly knobbed; the other two, which are very stout, are straight to the end and obtusely or acutely pointed.

The position of the parts of the proboscis in the usual retracted state is usually regarded as important in the diagnosis of the species of *Syllis*; it is fairly constant in the individuals of a species, but is subject to some modification owing to the occasional occurrence of states of incomplete retraction. More important is the *length* of the pharynx and proventriculus in terms of the number of segments through which each runs. Within a limited range of variation this appears to be constant for each species—except in the comparatively rare instances of regeneration.

In *S. variegata* both pharynx and proventriculus are comparatively long, each running through eight, twelve or fourteen segments.

SYLLIS (TYPOSYLLIS) PECTINANS, n.sp. (Plate x., fig. 3-6).

When alive and fully extended this is a slender, almost thread-like worm, measuring, in the case of the larger specimens, about 1.5 to 2 cm. in length. The colour varies considerably, the differences being due mainly to differences in the colour of the intestine as described below. The body-wall may be transparent and colourless, but usually there are widely-diffused minute particles of reddish-brown pigment, most abundant in the dorsal integument in the anterior region, where, in some cases, they tend here and there to become arranged in very irregular transverse lines stronger towards the anterior and posterior limits of the segment. The pigment may be scattered also through the tentacles, palpi and cirri, but sometimes these appendages are completely colourless.

The tentacles and cirri contain numerous sausage-shaped glands which are usually extremely bright and conspicuous in the living animal. Sensory cilia are abundant on the tentacles, palpi and dorsal cirri, less abundant on the ventral cirri. Vibratile cilia run along the sides of the segments between the parapodia.

The prostomium is broader than long, elliptical in general outline. The pigment which it usually bears dorsally, is irregularly distributed. The eyes are always comparatively small, and a frontal pair is rarely present. The palpi are entirely separate, though in close contact in their basal portions. The median tentacle is the longest—about five times the length of the prostomium, with about 35 well-defined joints; the lateral about thrice the length of the prostomium, with about 25 joints.

The peristomium appears on the dorsal surface for a narrow space only. The dorsal peristomial tentacles are about equal in length to the median, and have about the same number of joints; the ventral are a little shorter.

There are about 60-70 segments in the body before stolonisation begins.

The parapodia (Plate x., fig. 4) are not very prominent, less than half the breadth of the body, slightly bilobed, the anterior lobe much the more prominent. Each contains about 10 or 12 compound setae (Plate x., fig. 5) which vary little in character throughout. Their falces are all relatively short, unidentate, with a fringe of unusually strong, pointed processes along the cutting edge, those towards the apex becoming very rudimentary. There is a simple seta (Plate x., fig. 6) on the dorsal side of the compound in all the posterior parapodia: in a specimen of 67 segments without definite stolonisation these begin on the 26th segment, and are continued to the posterior end; in a female specimen of about 60 segments with a stolon, they begin four segments in front of the stolon (on the 40th segment); in another similar specimen they begin nine segments in front of the stolon. They are similar to the simple setae of *S. variegata*—gently curved towards the free end, pointed, obscurely bidentate, and with four or five cilia on the concave edge of the terminal curved region. In three or four of the last segments a simple bidentate seta occurs on the ventral side of the bundle of compound setae: this is finer and shorter than the dorsal simple seta, and does not seem to be always present.

In specimens with mature stolons, bundles of capillary setae occur on all the segments of the stolon; when fully developed these are twice or thrice the length of the compound setae.

There are four acicula (Plate x., fig. 4) in each of the most anterior parapodia, three or two in the rest; all are knobbed at the ends with the knob usually sharply bent, but towards the dorsal side, so that the bend is not readily perceptible.

Of the dorsal cirri there is an alternation of longer and shorter, the longer in the anterior region more than twice as long as the breadth of the body, and composed of about forty segments. The ventral cirri are short, not extending as far as the ends of the parapodia. The anal cirri are similar to the larger dorsal; between them is a well-developed, narrow median process.

The pharynx, which is brownish or reddish, extends as far as the 9th segment. An important feature is that the tooth is situated some little distance behind the anterior margin of the pharynx (Plate x., fig. 3). The proventriculus is rather variable, lying in the 10th to 14th or 15th or 9th to 14th or 10th to 18th segments—five to eight segments. Brown pigment runs in the raphes and the annular bands of non-striated muscles, of which there are about 35. The ventriculus, light brown or red in colour, has the usual T-shaped caeca, the anterior branch the larger. The intestine is deeply constricted, usually of a dark green colour, or yellow or orange mixed with green, or orange throughout.

In ripe females, the ovaries, purple in colour, are developed from about the 30th to the 40th segments, backwards—the stolon, of about 20 to 25 segments, beginning about the 40th or 50th. In the male, the ripe stolon is of a bright red, pink or scarlet colour, and consists of about 20 segments with dilated nephridia packed with sperms in rounded groups.

T. pectinans occurs very abundantly between tide-marks in Port Jackson, and is particularly numerous among the tubes of the common Serpulid, *Galeolaria hystrix*.

Relying on Langerhans's account (36, p. 530, Taf. 31, fig. 3) of the species which he identified with *S. prolifera* Krohn, I was at first inclined to regard the form above described as referable to that species. One of the chief reasons for this view was the exceptional position in both of the pharyngeal tooth. A careful comparison showed, however, that such a determination could not be maintained. Langerhans refers to the compound setae in *S. prolifera* as "bidentate" without any qualification. Moreover, *S. armandi*, which Langerhans regards as identical, is described by Claparede (5, p. 70) as having setae with bidentate appendages; and the same holds good of *S. lussinensis* Grube (20, p. 46), also regarded by Langerhans as synonymous with the same species.* McIntosh's figures (39) of the compound setae in *S.* (*Pionosyllis*) *prolifera* also all represent them as strongly bidentate. On the whole the evidence seems to be in favour of the conclusion that the Australian species is a hitherto undescribed species of *Typosyllis*, characterised by the combination of two unusual characters—the backward position of the tooth and the presence of unidentate compound setae.

SYLLIS (TYPOSYLLIS) TRUNCATA, n.sp. (Plate x., figs. 7-11.)

This, like *T. pectinans*, is a slender elongated *Syllis*, which, when alive and fully extended, becomes a narrow thread. There are over a hundred segments (110-120) in a full-grown specimen. The general colour is reddish without definite markings, darkened behind by the intestine. The length is from 1 to 2 cm. The tentacles and dorsal cirri are full of twisted (vermiculate) unicellular glands similar to those of *S. variegata*.

* Langerhans regards *S. fiumensis* of Ehlers as also identical with *S. prolifera*; if that view be well-founded, Ehlers's figure (6, Taf. ix., fig. 4) of a compound seta must be incorrect.

The prostomium is nearly twice as broad as long, with four very small eyes. The median tentacle is about thrice the length of the prostomium, with about 25 joints: the lateral a little shorter, with about 17 joints. The palpi are ovate, very little narrower at the apex, with the inner edges, in close contact with one another at the base but not fused, diverging very slightly distally.

The dorsal peristomial tentacle is nearly as long as the median, with about 18 joints: the ventral a little shorter.

The parapodia are relatively long; nearly half the breadth of the body in length, and in general outline resemble those of *S. pectinans*. Each has about 8-10 compound setae. These (Plate x., figs. 8 and 9) are all of the same type, the only difference between them being a gradual reduction in length of the falx from the dorsal to the ventral side; all are bidentate with a small secondary tooth and a row of fine cilia along the cutting edge. A simple seta (Plate x., fig. 10) lies on the dorsal side of the compound seta in a variable number of the most posterior segments. It differs from the simple setae of *S. variegata* and *S. pectinans* in being truncate. A shorter, simple, pointed seta lies on the ventral side in the last two or three segments. There is sometimes a single aciculum in each parapodium, sometimes two or three: they are sharply bent forwards at the ends. (Plate x., figs. 11-14.)

The dorsal cirri are long and thick, the first being the longest, with about 28 segments. The rest are alternately longer and shorter, the longer (about 25 joints) longer than the breadth of the body, the shorter (about 17 joints) about equal to it. The ventral cirri scarcely reach as far as the ends of the parapodia. The anal cirri have about 16 joints. There is a narrow median process between them as in *S. pectinans*.

The pharynx is red in colour. When the proboscis is fully drawn back it is long and narrow, extending from the fourth segment, in which the tooth is situated, to the thirteenth. The proventriculus is relatively short, extending through only about four to six segments.

Syllis truncata has been found in Port Stephens as well as Port Jackson.

Many specimens of *S. truncata* bear either one or two white spots on the dorsal surface over the proventriculus or its junction with the intestine. When two are present they may occur on the 16th and 17th or on the 17th and 18th segments; when one only occurs it is usually found on the 18th segment. These white bodies lie in the substance of the dorsal body-wall between the epidermis and the muscular layers, and extend across a considerable part of the breadth of the segment. Contained in each are a large number of rounded masses of an average diameter of about .05 mm., each made up of innumerable minute corpuscles of an approximate diameter of 0.002 mm.

That these bodies are encysted *Sporozoa* appears to admit of little doubt. The constancy of their position would appear to be accounted for by the position of the ventriculus and caeca—the walls of the latter being comparatively thin and easily traversed by the trophozoite in its migration outwards from the lumen of the alimentary canal.

In his description of the Polychaeta of the Canaries Langerhans (35) gives an account of a species of *Typosyllis*, which he calls *T. pulvinata*, characterised by the presence of cushion-like elevations of the dorsal surface of the 18th, 19th, and 20th segments. There can be little doubt that in this species the swellings are due to the same cause as in *T. truncata*. *T. pulvinata* is described as having the setae distinctly unidentate, and thus appears to differ in a definite way from *T. truncata.*

SYLLIS (TYPOSYLLIS) PUNCTULATA, n.sp. (Plate xi., figs. 1-16.)

The length of this very well-marked species is about 1 cm. and the breadth .75 mm. There are about 70 segments in all. The prevailing colour of the dorsal surface is dark red, usually lighter behind, with innumerable minute colourless dots marking the position of integumentary glands. The prostomium and peristomium are much lighter than the body, of a bright orange, the prostomium with an irregular pattern of a darker colour concentrated in front in the position in which frontal eyes usually occur. Vibratile cilia occur on the sides of the segments between the parapodia.

The prostomium (Plate xi., fig. 1) is broader than long; the presence of frontal eyes is inconstant: the ordinary eyes are rather small, the posterior nearer together than the anterior. The palpi are divergent from the base, slightly narrowed distally, longer than the prostomium. The median tentacle is more than twice the length of the prostomium, of about 20 to 30 segments: the lateral tentacles are twice the length of the prostomium, of about 12 to 20 segments. Of the peristomial tentacles the dorsal, which is slightly the longer, is of about the same length as the median. All the tentacles are very distinctly segmented, as are also the dorsal and anal cirri.

The parapodia (Plate xi., fig 2) are not deeply divided. There are 10-12 compound setae (figs. 3 and 4), all of one type, with bidentate falces, which are slightly longer in proportion in the more anterior segments. There are two simple setae in all the posterior parapodia. One of these (figs. 5 to 10) is dorsal to the compound setae: it first appears about the twenty-eighth segment and continues to the posterior end; it is obscurely bidentate; the other (fig. 11) which occurs only on the last few segments, is ventral to the compound setae and is very strongly bidentate, its extremity closely corresponding to the end of the appendage of one of the compound setae. The acicula (figs. 12-16), of which there are three or four in each parapodium, vary a little in shape, but one (the most anterior, (figs. 12 and 13) is always strongly bent forwards at the end, and another (fig. 16) symmetrically pointed.

The dorsal cirri are very distinctly articulated. The first are the longest, as long as the median tentacles, with about 25 to 35 segments. The remainder are shorter than the breadth of the segments and contain 18 to 35 segments; there is no regular alternation. The ventral cirri are short, not extending beyond the ends of the parapodia. The anal cirri are of about the same length as the average dorsal. The pharyngeal tooth is not quite anterior. The pharynx extends to the 7th segment; the proventriculus lies in the 8th to the 13th.

One specimen has a buff-coloured female stolon; the ova extend forwards several segments in front of the head of the stolon.

S. punctulata occurs about the bases of Algae growing on rocks about low-water mark in Port Jackson and Botany Bay.

SYLLIS (TYPOSYLLIS) CLOSTEROBRANCHIA Schmarda.

Syllis closterobranchia, Schmarda, (49), 2 Theil. p. 72.
Syllis closterobrenchia, Ehlers (10), I., p. 19, Taf. iii., fig. 1-4.
Syllis (Typosyllis) closterobranchia, Augener, (1), p. 201. Text-fig. 23.
(For some additional synonyms, see Augener.)

Ehlers in 1904 identified specimens of a *Syllis* received from New Zealand with Schmarda's *S. closterobranchia,* the types of which (from S. Africa) he had the opportunity of examining.

Augener found specimens in the collection from S.W. Australia, and gives some additional particulars. The species thus defined is quite common a little below low-water mark in Port Jackson. The largest specimens measure 4 cm. in length and 1.5 mm. in breadth.

A simple, pointed seta, obscurely bidentate, is present on the dorsal side of the compound setae in the last nine or ten parapodia, disappearing at the point where the characteristic thick, "pseudoypsiloid," compound setae begin to make their appearance. A very similar simple seta lies on the ventral side in a few of the terminal segments.

In a male specimen of 147 segments, the segments are filled with sperms from the 120th backwards, but there is no definite indication of a stolon. Another specimen of 95 segments had no sign of gonads.

SYLLIS (TYPOSYLLIS) GRACILIS Gravier. (Plate x., fig. 15.)

Syllis gracilis, Gravier, (16), p. 150, Pl. 9, figs. 4-6.

(?) *Syllis longissima*, Gravier, *l.c.*, p. 154.

Syllis (Typosyllis) gracilis, Augener (1), p. 206.

For further synonymy, see Langerhans (36) and McIntosh (39).

This widely-distributed form, found by Augener in the Hamburg collections from South-west Australia, occurs frequently among Algae etc. brought up from below low-water mark in Port Jackson.

Dorsal simple setae, pointed and obscurely bidentate like the corresponding setae in *S. closterobranchia*, occur on a few of the last segments. The acicula (Plate x., fig. 15) are peculiar, each having a slight rounded terminal enlargement from which a peg-like process projects obliquely.

SYLLIS (TYPOSYLLIS) PARTURIENS, n.sp. (Plate xi., figs. 17, 18.)

This small *Syllis*, of which I have only obtained a single specimen, differs from all the other members of the group, with the exception of *S. vivipara*, in being viviparous.

It is only 4-5 mm. in length, and colourless but for a mottling of bluish green in the epithelium of the middle part of the intestine. There are 32 segments. The prostomium is slightly broader than long, and bears four very small eyes in addition to a minute frontal pair. The palpi are about equal in length to the prostomium; they are sub-conical, divergent from near the base, where they are in contact for a short distance. The median prostomial tentacle is about six times the length of the prostomium, and has about 35 segments; the lateral about four times. The dorsal peristomial tentacle is much longer than the ventral, nearly as long as the median prostomial. All the tentacles, with the dorsal cirri, are very distinctly segmented. The parapodia are not deeply divided. Each bears about 10 compound setae with bidentate falces. In a few of the last segments there is a single simple seta on the dorsal side of each parapodium. There is a single aciculum which is slightly enlarged and slightly oblique at the end.

The dorsal cirri are alternately longer and shorter, the longer containing about 35 segments, and their length much exceeding the breadth of the body. The ventral cirri are slender, and scarcely extend as far as the extremity of the parapodia. The anal cirri resemble the longer dorsal.

The pharynx extends to the 5th segment, the proventriculus to the 9th.

There are two advanced embryos, one in the 14th and the other in the 15th segment. In the 12th and 13th segments there is a single ovum on either side.

Hitherto, as already stated, *Syllis vivipara* Krohn has been the only viviparous Syllid known.* From that species the present form differs in the bidentate character of the compound setae, as well as in the presence of frontal eyes and the greater length of the dorsal cirri.

Though it seems probable that *S. parturiens* is hermaphrodite, and that testes are present in most of the segments, the specimen does not afford conclusive evidence of this.

SYLLIS (TYPOSYLLIS) AUGENERI, n.sp. (Plate xi., figs. 19 to 22.)

Syllis (Typosyllis) kinbergiana Haswell, Augener, (1), p. 197, Text-fig. 22. Taf. iii., fig. 38.

Syllis (Typosyllis) Kinbergiana Haswell, Fauvel, (13), p. 194.

The species of *Syllis* which Augener described under the name of *S. kinbergiana* Haswell, while expressing some doubts as to the correctness of the determination, is not very rare in Port Jackson, and, as it appears to be unnamed, I have given it the above name. Augener's wrong determination is doubtless partly due to my having given insufficient data; but there are at least two points given in my original account which are entirely incompatible with Augener's conclusion—viz the very indistinctly articulated cirri and the transverse intrasegmental lines. Augener's description is very adequate, and I will merely add the following brief notes:—

There are frequently no markings, but sometimes there is a pair of grey transverse lines on the dorsal surface of each segment in the anterior region. Frontal eyes are present in most if not all cases, but they are sometimes represented by minute dots which may not be symmetrically placed.

The ordinary compound setae resemble those of *S. variegata* in shape, but the fringe of processes along the cutting edge of the falx is less developed. These are the only compound setae in the posterior region. But in the anterior and middle regions the two most dorsally placed in each parapodium (Plate xi., fig. 20) have the appendage relatively long and narrow—longer and narrower than is represented in Augener's fig. 22a. The obscurely bidentate simple setae of the posterior region which are similar to those of *S. variegata*, may extend forwards as far as about the 20th segment from the anterior end. The acicula (figs. 21 and 22) are one to four; when there are two, the more anterior (fig. 21) is very slightly bent forward at the end, with an oblique terminal (posterior) face which is slightly concave; the more posterior (fig. 22) nearly symmetrically pointed. When only one aciculum is present it is of the former type; when there are three or four, two or three are of the latter.

SYLLIS (TYPOSYLLIS) KINBERGIANA Haswell. (Plate xi., figs. 23-27; Plate xii., figs. 1 and 2).

Syllis kinbergiana, Haswell, (25), p. 7, Pl. 51, figs. 1-3.

Non Syllis (Typosyllis) kinbergiana Hasw., Augener, (1), p. 167, Taf. iii., fig. 38, Text-fig. 22 *a-e*.

Nec Syllis (Typosyllis) kinbergiana, Fauvel, (13), p. 194.

* *See* Goodrich (14), and Potts (47).

In the living condition the colouring of this species renders it readily capable of recognition. In preserved specimens in which the colour is lost, the most striking features are:—(1) the presence in the anterior region of the body of an impressed line or narrow groove running transversely across the dorsal surface of each segment; (2) the deeply bi-lobed character of the parapodia; (3) the imperfect segmentation of the dorsal cirri.

In the living condition the body is greenish-yellow or light yellow with greenish transverse lines. On the dorsal surface just behind the head is a patch of white, and on each segment is a pair of very light yellowish- or greenish-white dots. The head and the palpi are red, the eyes crimson.

The length of the largest specimens is 6 cm., the breadth in the uncontracted state only 2-3 mm. In all the anterior part of the body, as far back as the beginning of the intestine, are the transverse grooves above referred to, appearing in contracted specimens as notches in the lateral edges of the segments (Plate xii., fig. 1).

Sensory cilia are present on the tentacles and cirri and the ends of the palpi. Vibratile cilia occur on the palpi and on the sides of the segments. The whole integument is full of small oval glands.

The peristomium is bilobed, the lobes rounded on the dorsal aspect. The eyes are rather small, the posterior much the smaller. The palpi are twice the length of the prostomium when fully extended; they are fused together at the base for a short distance. The prostomial tentacles are usually sub-equal, a little longer than the palpi, segmented, but not very distinctly.

The parapodia (Plate xii., fig. 2) are very deeply divided into anterior and posterior lobes. There are about 20 compound setae (Plate xi., figs. 23 to 26), all with long and rather narrow falces which are bidentate and have extremely minute teeth along the cutting edge. On the posterior segments there is a very fine, truncate, simple seta on each parapodium dorsal to the compound setae. There are two, sometimes three, acicula of which one, the most anterior (fig. 27), is sharply bent forwards at the end and the others are obliquely truncate or obliquely pointed. No capillary setae have been seen. The dorsal cirri are rather short, very imperfectly segmented.

The pharynx runs through only three to six segments, the proventriculus usually only through three or four.

SYLLIS (TYPOSYLLIS) CORUSCANS Haswell. (Plate xi., figs. 28-31).

Syllis corruscans, Haswell, (25), p. 734, Pl. l., fig. 1-3, and lv., fig. 5.

? *Syllis corruscans* Hasw., Augener, (1), p. 208.

This is the largest of the Australian Syllids, attaining a length of as much as 14 cm. with a maximum breadth of about 5 mm. There are 150 to 200 segments. The colour of the dorsal surface is usually dark green, sometimes dark brown; that of the ventral surface and of the parapodia and cirri light red or orange. The prostomium is bright crimson. On the dorsal surface of the peristomium appears a bright green spot or band.

The integumentary glands are so arranged and developed as to give a corrugated appearance to the darkly-pigmented dorsal surface, the corrugations being sometimes arranged in transverse rows, two or three on each segment with narrow furrows between.

The breadth of the prostomium is nearly twice the length. It becomes partly withdrawn under the prostomium when the animal is touched or irritated. The palpi are broad at the base, fused with one another for a short distance, longer than the prostomium, usually directed downwards, hollowed out below and internally. The eyes are rather small, those of the anterior pair larger and wider apart than those of the posterior. The three prostomial tentacles are subequal, a little longer than the palpi, indistinctly segmented or entirely unsegmented. The peristomial tentacles which are also indistinctly ringed, are subequal, the dorsal a little longer than the ventral, shorter than the prostomial.

The parapodia are relatively short. Each bears 15 to 20 compound setae. These (Plate xi., figs. 29-31) are all of the same essential character, with bidentate falces, but the most dorsally situated (fig. 29) have the falces long and slender, a gradual transition taking place towards the most ventral setae which have the falces short and comparatively broad. In a few of the most posterior segments there are also simple setae—one dorsal to the compound setae of each parapodium, slender and hair-like, the other ventral, very short, terminating like the compound setae but without the articulation. There are 5 to 7 or more pointed acicula in each parapodium, one sharply bent forwards at the end. The dorsal cirri are alternately longer and shorter, about equal in length to the breadth of the body, not very distinctly segmented, smooth and unsegmented at the base, indistinctly segmented towards the apex.

In the original description I stated that in this species male stolons are given off from a female stock. In my more recent notes I can find no confirmation of this. Female stolons are very rare, but they occur. In the case of the female, as in that of the male, stolon, sexual elements similar to those in the stolon occur also, as in other species of *Syllis*, in the posterior region of the stock. It may be that in certain circumstances, or at certain seasons, the formation of a female stolon may so rapidly follow that of a male that the posterior region of the stock contains well formed ova before the male zooid becomes detached. But I have been unable to find any such case among recently examined specimens, which all show evidence of normal schizogamy without hermaphroditism.*

S. coruscans is far from being a typical *Syllis*. Structurally, in fact, it is closely connected with various species of *Eusyllis*, and it might quite well be described as a *Eusyllis* which reproduces with schizogamy. Apart from the superficial features of connection between the palpi at their bases and imperfect segmentation of the tentacles and dorsal cirri, *S. coruscans* is *Eusyllis*-like in having the rim of the cuticle of the pharynx occasionally divided in an irregular way into a number of lobes, which can hardly be termed teeth.† Moreover the arrangement of the radial muscles of the wall of the proventriculus corresponds completely with that which characterises *Eusyllis*, and differs from that which occurs generally, if not universally, in typical species of *Syllis*.

Sub-genus HAPLOSYLLIS Langerhans.

SYLLIS (HAPLOSYLLIS) SPONGICOLA Grube.

Syllis spongicola, Grube, (18), p. 104, Pl. 4, fig. 4.
Syllis djiboutiensis, Gravier, (16), p. 147, Pl. 9, fig. 3, 1900.
Syllis djiboutiensis, Augener, (1), p. 213.
(For additional synonymy *see* McIntosh, (39), p. 197.)

* See F. A. Potts (47).

† De Saint-Joseph (48) states: "Chez beaucoup de *Eusyllis*, et cela indifféremment dans chaque espèce, le bord de la trompe, au lieu d'être dentelé n'est que déchiqueté et s'éloigne peu du bord uni et quelquefois aussi un peu déchiqueté de la trompe des *Pionosyllis*."

I have only obtained in Port Jackson two or three small specimens of this very widely-distributed species.

Sub-genus EHLERSIA Langerhans.

SYLLIS (EHLERSIA) FERRUGINEA Langerhans. (Plate xii., figs. 3-10.)

Ehlersia ferruginea, Langerhans, (35), p. 104, fig. 10.

Syllis (Ehlersia) ferruginea, Augener, (1), p. 211. Text-f.g. 26.

The two specimens from Port Jackson which I refer to this species were not seen alive; in the preserved condition they have a dull yellowish-grey colour. Their length is about 8 mm., and each contains some ninety to a hundred very short segments the length being less than a tenth of the breadth.

The prostomium (Plate xii., fig. 3) bears six pairs of eyes—the frontal mere dots of pigment, the others also very small. The palpi are sub-triangular when viewed from above; behind they bulge out beyond the lateral edge of the prostomium. The median tentacle is over four times the length of the prostomium and is made up of about forty-five articuli; the lateral are three-fourths of the length of the median. Of the peristomial, the dorsal, as usual the longer, is a little longer than the lateral prostomial. The parapodia are not deeply divided. In the anterior region there are in each parapodium dorsally three or four compound setae (fig. 4) of the *Ehlersia* type with long and slender falces, feebly bidentate: ventrally the rest of the compound setae (figs. 5-7), about ten in number, have relatively short bidentate falces with the secondary tooth more strongly developed than the terminal. Posteriorly the setae of the latter type become gradually replaced by setae (fig. 7) with very short, strongly curved falces with the secondary tooth much larger than the terminal. In the posterior segments there is a simple seta with a rounded extremity dorsal to the compound setae in each parapodium. In the last two or three segments there is also a ventral simple seta (fig. 8) in each parapodium, similar to the adjoining compound setae, but without the joint. There are usually two acicula (figs. 9 and 10), slightly knobbed and bent forwards at the end, in each parapodium.

The anterior dorsal cirri are distinctly segmented, but in both specimens segmentation completely disappears before the middle of the body is reached. The first is longer than the rest, rather longer than the breadth of the body. The ventral cirri are cylindrical and not as long as the parapodia.

The pharynx extends to the 10th segment; its tooth is anteriorly situated. The proventriculus extends to the eighteenth segment; it contains about 30 annular bands.

Genus TRYPANOSYLLIS Claparede.

TRYPANOSYLLIS ZEBRA Grube.

Syllis zebra, Grube, (19), p. 86, Taf. iii., fig. 7.

Trypanosyllis krohnii, Claparede, (5), p. 98.

T. krohnii, De St.-Joseph, (48), p. 56 (180).

T. zebra, McIntosh, (39), p. 169, Pl. l., figs. 9 and 10; Pl. li., fig. 1; Pl. lxx., fig. 8; Pl. lxxix., fig. 18.

? *Eurymedusa picta*, Kinberg, (31), *non* Ehlers, (10).

Syllis taeniaeformis, Haswell, (25), p. 9, Pl. l., figs. 4 and 5.

Trypanosyllis Richardi, Gravier, (16), p. 168, Pl. ix., figs. 12, 13.

Trypanosyllis taeniaeformis, Augener, (1), p. 230.

Whether Kinberg's *Eurymedusa picta* is the same as *Trypanosyllis zebra* must remain somewhat uncertain until the type specimen has been re-examined. The original diagnosis of the former is not very adequate; nor are the figures of it in the "Eugenies Resa" of much value in distinguishing the species. But the name. and the locality afford some indication "Port Jackson, Novae Hollandiae, summa aqua." On the other hand, the New Zealand and South Australian species which Ehlers put down as *Eurymedusa picta* Kinberg, after examining Kinberg's original specimen, is quite distinct, and has been determined by Benham as a species of *Odontosyllis* (see *Odontosyllis suteri* Benham).

T. zebra is not at all rare a little below low-water in Port Jackson, frequenting especially the roots of the Laminarian *Eklonia radiata*. It is one of the larger Syllids, attaining a length of as much as 6 or 7 cm. Both male and female stolons are white with two pairs of red eyes.

The mode of stolonisation in the Port Jackson form is that described by Marion and Bobretsky (45), and De St.-Joseph (48) as characterising *T. zebra* [See Potts (47), p. 13]. When the stolon is ready for separation the stock bears ventrally a small prolongation terminating in a pair of anal cirri.

Family EUSYLLIDAE.

Genus Syllides Oersted.

Syllides longicirrata Oersted.

Syllides longicirrata, Oersted, (46), p. 11, Tab. ii., fig. 2 *a-b*.
Syllides longicirrata, Malmgren, (41), p. 39.
Syllides longocirrata, Langerhans, (36), p. 548.
Anoplosyllis fulva, Marion et Bobretzky, (45), p. 28, Pl. ii. and iii., fig. 8.
? *Syllis ochracea*, Marenzeller, (42), p. 27, Taf. iii., fig. 1.
Syllides longocirrata, De Saint-Joseph, (48), p. 165 (41).
Syllides longocirrata, Augener, (1), p. 229.

The three specimens of *Syllides* which I have obtained in Port Jackson agree very closely with Marion and Bobretzky's description and figure of *Anoplosyllis fulva* except in one point, which may be of some importance. My specimens have well-developed lenses in the frontal eyes—a condition rarely met with. The posterior eyes have no lenses. I have not been able to see the *ventral* simple setae referred to by Langerhans. The *dorsal* simple setae, which are gently curved and blunt, occur singly on all the parapodia except the first three.

The yellow corpuscles which are distributed over the whole dorsal surface of the peristomium correspond very closely with the constituent elements of the "yellow bodies" of the *Exogoneae*. In a female specimen ovaries occur from the ninth setigerous segment backwards.

Genus Eurysyllis Ehlers.

Eurysyllis tuberculata Ehlers.

Eurysyllis tuberculata, Ehlers, (6), p. 264, Taf. 11, figs. 4-7.
Polymastus paradoxus, Claparede, (5), p. 109, Pl. viii., fig. 3.

I have seen only two specimens of this remarkable form, obtained at Point Piper, Port Jackson, among Algae.

Genus Pionosyllis Malmgren.

Pionosyllis melaenonephra, n.sp. (Plate xii., figs. 11-16; Plate xiii., fig. 1.)

Complete, sexually mature specimens reach a length of about 1.4 cm. with a breadth of about 1 mm., and contain 65 to 75 segments. But many specimens show evidence of having lost a part of the fragile posterior region, which has become imperfectly regenerated. Thus a number of specimens contain only about 25 to 50 segments of normal character, with or without a narrow posterior continuation of 3 to 12 small segments, obviously formed by a process of regeneration.

The general ground-colour in the living animal is yellowish, or greenish, or light pink. On the prostomium, just behind the eyes, is a transverse black line concave forwards; this sends forwards a median longitudinal band which bifurcates in front between the eyes. Usually the dorsal surface of the palpi is dark with a narrow oblique light line. Each of the first few segments has a simple transverse black band across its dorsal surface. On a few segments (usually the fifth to the eighth, sometimes a larger number) there is a second transverse black band. Further back again each segment has a single band, broad in the middle, narrowing laterally. These bands become shorter posteriorly and disappear altogether towards the middle of the body the posterior part being either devoid of markings or with lighter grey transverse lines. Some black pigment also occurs on the ventral surface of a few of the most anterior segments of the body Similar pigment is also present in the pharynx, in the proventriculus and in the walls of the nephridia.

Vibratile cilia are present on the palpi, on the lateral borders of the segments and in groups on the parapodia. Non-motile (sensory) cilia are abundant on the tentacles and cirri.

The prostomium (Plate xiii., fig. 1) is broader than long. The peristomium is visible dorsally for a short distance only. The eyes vary greatly in development, but are usually large and may touch or overlap: small frontal eyes are present. The palpi are large, entirely separate, divergent from close to the base, with an almost oblong outline: but frequently their shape is disguised by various degrees of flexion. In the active living animal they are usually extended almost vertically downwards and folded inwards at the ends, so as frequently to touch one another ventrally in front of the mouth. The prostomial and peristomial tentacles are segmented, but the segmentation is less distinct towards the base. The median prostomial tentacle is longer than the lateral, longer than the prostomium and palpi together. The dorsal peristomial tentacle, longer than the ventral, is about equal in length to the median prostomial.

The long, narrow, pointed parapodia are about equal in length to half the breadth of the segments. At about the 23rd segment, a distinct notopodial rudiment with a small aciculum makes its appearance, and persists throughout the rest of the segments. Each neuropodium has one, two, or sometimes three, acicula and about fifteen to twenty long and slender compound setae. The acicula (Plate xii., fig. 16) have a conical extremity surrounded at the base by a ring-like thickening. In the compound setae of the anterior region (Plate xii., fig. 11), the falces, very long and narrow in the case of the most dorsal, decrease in length ventrally, becoming quite short, but are all of the same essential character: bidentate with the two terminal teeth nearly equal, the cutting edge convex, finely ciliated. Posteriorly (Plate xii., figs. 12-15) a change takes place: the falces become shorter, and the secondary tooth comes to preponderate over the terminal. In the parapodia of the most posterior region there are two sets of simple setae, one of the first set on the dorsal side of each bundle of compound setae, and one of the second set on the ventral side. The dorsal simple setae are slender hairs like the capillary swimming setae; the ventral resemble the shortest and most ventral of the compound setae except in the absence of the articulation. In sexually mature specimens the segments containing the ripe genital products, and usually a few in front of them, have notopodial bundles of capillary setae; but these are very short, much shorter than the compound setae.

The dorsal cirri are alternately longer and shorter; the longer are in general about as long as the breadth of the body or a little longer; all are very slender and indistinctly segmented. The ventral cirri are short, rarely extending as far as the ends of the parapodia, and usually falling far short of it. In shape they are elongated compressed cones, the terminal portion comparatively slender. These ventral cirri are mobile to a quite unusual degree, the slender tip moving about freely. The anal cirri are entirely unsegmented.

When the proboscis is retracted, the ring of pharyngeal papillae lies in the fifth segment. In the eighth segment lies the single dorsal tooth, which is thus well behind its usual position, though it is still in front of the middle of the pharynx. The pharynx extends back as far as the thirteenth segment; the proventriculus lies in the fourteenth to the twentieth. The latter has about twenty-five rows of muscle-columns.

There is no trace of schizogamy. Mature males have the segments full of sperms from about the twentieth segment backwards, except in a limited region at the posterior end. The females, when mature, have numerous small ova in each of the segments from about the twenty-third to about the fifty-fifth. Gestation apparently does not occur.

The nephridia are very conspicuous in most specimens owing to their walls containing much black pigment.

In spite of the fact that the union between the palpi is absent, and in spite of the presence of the limited degree of segmentation in the tentacles and dorsal cirri, this species seems to find its nearest allies in the members of the genus *Pionosyllis*. The position of the tooth, though it is not further back than in certain species of *Syllis*, such as *S. prolifera*, seems to separate it from the other described species of *Pionosyllis*. Apparently it comes nearest to *P. weissmanni* Langerhans [(36), p. 246, fig. 11] and *P. weissmannoides* of Augener [(1), p. 223, text-fig. 30].

P. melaenonephra is not rare among the roots of oar-weeds (*Eklonia radiata*) in Port Jackson. It is very alert and active and very fragile, so that complete specimens are not easily obtained.

PIONOSYLLIS DIVARICATA Keferstein. (Plate xiii., figs. 2 and 3).

Syllis divaricata, Keferstein, (30), p. 111.

Syllis normannica, Claparède, (4), p. 40, Taf. xiii., fig. 24.

Pionosyllis divaricata, Langerhans, (36), p. 545.

Pionosyllis ? divaricata, McIntosh, (38), p. 164, Pl. lix., fig. 12; Pl. lx., fig. 7; Pl. lxxix., fig. 17.

The only specimen of this species which I have obtained is about 8 mm. in length in the preserved condition and less than 1 mm. in greatest breadth. It was almost colourless in front when alive, but for black pigment in the protoplasmic cores of the radial muscle-fibres of the proventriculus; but throughout the greater part of its length it was strongly coloured with dark brown, almost black, pigment, not collected into transverse lines, but distributed over the dorsal surface and the parapodia, with a tendency to the formation, in places, of irregular longitudinal lines. There are 43 segments, but some have been lost. Towards the middle, where the body is broadest, the length of the segments is about one-fourth of the breadth.

The prostomium is a little broader than long, and bears four rather large eyes, the two of each side in close contact. The tentacles and dorsal cirri are entirely devoid of segmentation. The median tentacle is about three to four times the length of the prostomium, the lateral scarcely twice that length. The palpi diverge widely from one another, and their basal junction is of very slight extent. The dorsal peristomial tentacle is longer than the median prostomial, about five times the length of the prostomium.

The dorsal cirri are longer than the breadth of the segments in front; shorter behind. The parapodia are simple and undivided, much shorter than the breadth of the segments.

The setae (Plate xiii., figs. 2 and 3) usually about 12 in each parapodium, are very long and slender, and are all of one type, though decreasing as usual in the length of the falx from the dorsal towards the ventral side. The falx terminates in two teeth situated close together, the secondary tooth rather more pronounced than the terminal, and strongly hooked. No simple setae are present, but this may be due to the loss of the posterior segments. The acicula, two or three in number, are simple and straight and sharp-pointed or blunt. The ventral cirri are shorter than the parapodia, long, conical, but with a suddenly narrowing terminal part.

The pharynx extends to the tenth segment: its median tooth, which is blunt, lies just behind its anterior margin in the 5th segment. The proventriculus extends to the 15th segment, and has about 30 rows of muscle-columns.

Though there are one or two points (such as the absence of frontal eyes) in which the single specimen does not agree with the description of the European species, the correspondence on the whole is very close.

Genus Odontosyllis Claparède.

Odontosyllis detecta Augener.

Odontosyllis detecta Augener (1), p. 236, Taf. iii., fig. 33 and text-fig. 34.

I have obtained five specimens which seem to be referable to this species—three mature males and two mature females. Since Augener had only a single incomplete specimen before him, I am able to supplement his account with sundry additional particulars.

The largest specimens are about 6 mm. in length and contain 35 to 40 segments. There is no definite colouration apart from the colours of the internal organs. Vibratile cilia are widely distributed on the surface—on the palpi, on the prostomium, on the peristomium, on the borders of the segments, and on the parapodia. Non-motile (sensory) cilia are also abundant, and are specially elongated on the inner borders of the palpi.

In the males the enormous eyes occupy a large part of the dorsal portion of the prostomium, and posteriorly those of opposite sides are only separated by a very narrow interval; in one specimen they bulge out beyond the normal limits of the prostomium. In the specimen last referred to there is no clear indication that there are two eyes on each side, and only one lens is distinguishable; but in the remaining males the anterior and posterior eyes, though intimately united, are to be distinguished by their separate lenses and by slight fissures. In the female, on the other hand, the eyes are quite small and separate; in front of each anterior eye is a small frontal eye which appears to have a small lens.

The palpi are quite conspicuous both in the living and fixed specimens. Their basal parts are fused to form a transverse bridge in front of the mouth. From this bridge, the anterior edge of which is slightly in front of the anterior border of the prostomium, separated from one another by a wide interval, arise the free portions of the palpi as ovate processes projecting forwards in front of the prostomium, or doubled back on the ventral side. There is no trace of a nuchal prominence.

The tentacles and cirri present no trace of definite segmentation, though irregularly annulated. The median tentacle is about twice the length of the prostomium, the lateral a little shorter than the median. Of the peristomial tentacles the dorsal is, as usual, the longer, and is, approximately, of the same length as the lateral prostomial. Of the dorsal cirri the first is much longer than the others, and is about the length of the median tentacle or a little longer. The rest are alternately longer and shorter; on the average their length is about equal to half the breadth of the body.

The parapodia are bilobed, the posterior (dorsal) lobe being the larger. There are ten or twelve compound setae in each parapodium. These, which are figured by Angener (Text-fig. 34), have short, unidentate falces. On the dorsal side of the compound setae in each parapodium there is, in all but the first 8 to 16 segments, a very fine capillary simple seta; no ventral simple setae were found.

Capillary swimming setae are present in one of the male specimens from the 14th segment backwards, absent in the others. There is a single aciculum with a slightly knobbed extremity which is distinctly bent backwards. The ventral cirri are broad, ovate, shorter than the parapodia.

The pharynx extends as far back as the 6th segment; the proventriculus to the 10th. The pharyngeal teeth are somewhat difficult of analysis. But there seem to be six teeth and two jaw-pieces, two of the teeth being closely connected with the latter, and the remaining four free between them. This is very near what is described and figured by Marenzeller [(42), Taf. iv., fig. 2D] for *Odontosyllis virescens* (*O. ctenostoma*).

In the females, ovaries occur from the 6th or 7th segments backwards. In the male, testes begin about the 6th segment. A limited region, comprising the 11th to the 14th segments, is in all three specimens specially developed, with large testes in the 13th and 14th, and the body-cavities distended with ripe spermatozoa which are absent in the rest of the body.

The specimens were found among Algae at Watson's Bay, Port Jackson.

Augener, on the strength of the enlarged eyes, compares his *O. detecta* with *O. hyalina* Grube; but there seems to be sufficient evidence to prove that the feature in question is a sexual and not a specific character. Apart from this, the affinities of *O. detecta* are much more with *O. ctenostoma*, with which Augener makes no comparison. In fact, the only differences to be detected are the absence of the nuchal lobe, and also of the dorsal, simple, hooked setae, which, according to Langerhans [(36), p. 556, fig. 15*a*, *b*.] and St.-Joseph [(47), p. 53, 177], occur on the more posterior parapodia in the latter species.

ODONTOSYLLIS FULGURANS Aud. et Edw.

Odontosyllis fulgurans, Audouin et Edwards, Ann. Sci. nat., t. xxix., p. 229

Odontosyllis fulgurans, McIntosh, (39), p. 178, Pl. xlix., fig. 5; Pl. lix., figs. 15 and 15 *a* and *b*; Pl. lxx., fig. 11; Pl. lxxx., fig. 4.

For further synonymy *see* McIntosh.

I have obtained only two specimens of an *Odontosyllis* which, if not identical with the European and North American species above named, is very nearly related to it. *O. fulgurans* seems to be characterised by the great length of the proventriculus, running through ten or eleven segments, the hooked falces of the compound setae with a minute tooth near the middle of the cutting edge, and the absence of nuchal or occipital lobe.

In the living condition the Port Jackson specimens were of a brownish colour with irregular whitish flecks; the eyes were red. The only complete specimen is about 7 mm. long, with about 50 segments. In one the pigment of the two eyes on either side is to some extent coalescent; in the other the two are close together but clearly separated; in the former a pair of frontal eyes are represented by a pair of ventrally placed minute specks of pigment.

The teeth in the retracted condition of the proboscis lie in the fourth segment. As far as can be made out they are six in number. A striking feature is the presence in the wall of the pharynx, just behind the teeth and immediately in front of the anterior end of the proventriculus, of an opaque ring which appears quite black in the cleared specimen. A similar appearance on a smaller scale is observable at the posterior end of the proventriculus. These two dark bodies are evidently the proventricular glands, anterior and posterior, which I described in the *Exogoneae*. They, or at least the anterior, occur in all *Syllidea* so far as I have observed; but they are usually very inconspicuous and only recognisable in sections* or, in the case of some of the *Exogoneae*, in favourably stained entire specimens.

ODONTOSYLLIS SUTERI Benham.

Odontosyllis suteri, Benham, (2), p. 161, figs. 1 and 2.

Eurymedusa picta, Ehlers, (10), p. 21.

Non *Eurymedusa picta*, Kinberg, (31).

Odontosyllis suteri has been found by Benham at various points on the coast of the South Island of New Zealand, and also occurs at the Kermadec Islands. I have only hitherto found two specimens in Port Jackson. Ehlers's confusion of this species with *Eurymedusa picta* of Kinberg is referred to under *Trypanosyllis zebra*.

O. suteri is characterised (1) by the presence of a wellmarked nuchal lobe, (2) by the falx of the compound setae terminating in a single tooth, but having a "secondary tooth" about the middle of the concave edge, and (3) by the very long proventriculus running through 15 segments. As in *O. fulgurans* the proventricular glands are very conspicuous in the cleared specimen.

I am indebted to Professor Benham for New Zealand specimens.

ODONTOSYLLIS FREYCINETENSIS Augener.

Odontosyllis freycinetensis, Augener, (1), p. 234, Pl. ii., fig. 7; text-fig. 33.

I have obtained only one specimen of an *Odontosyllis* which is certainly identical with Augener's *O. freycinetensis* from Western Australia. It is 4 mm.

*A trace of the anterior glands is distinguishable in Augener's figure of *O. glandulosa* (Taf. iii., fig. 37).

long, and comprises only 24 segments, but is obviously incomplete. It is of a general grey colour, darker in the region behind the proventriculus than in front. The colouration proves under the microscope to be due to the presence of irregular patches of black pigment partly arranged in broken transverse lines. This occurs not, as is usually the case, in the dorsal integument, but deep within the muscular layers—presumably in the peritoneum.

The pharynx and proventriculus are displaced owing to rupture; the teeth and jaw-pieces, so far as they can be seen, closely resemble those of *O. detecta*. The acicula do not end in a simple point, but are sharply bent forwards at the extremity.

Genus Amblyosyllis Grube.

Amblyosyllis spectabilis Johnston. (Plate xiii., figs. 4-10).

Pterosyllis (Gattiola) spectabilis, Johnston. (29), p. 195, Pl. xvi*a*, figs. 1-7.
Pterosyllis formosa, Claparede, (4), p. 46, Pl. xiii., figs. 30-34.
Pterosyllis plectorhyncha, Marenzeller (42), p. 47, Pl. 5, fig. 3.
Amblyosyllis Madeirensis, Langerhans, (36), p. 561, Pl. 32, fig. 19.
Pterosyllis (Gattiola) spectabilis, St.-Joseph, (48), p. 63, Pl. 9, figs, 64-67.

This small Syllid occurs sparingly among the roots of *Eklonia* a few feet below low-water mark in Port Jackson.

The length is about 1 cm. and the number of segments 14 to 30. Some specimens are colourless or nearly so, or have only the dorsal cirri pigmented; others, in addition to the pigment in the cirri, have an elaborate pattern formed of dark pigment on the dorsal surface of the segments; others have a system of transverse violet lines. In some female specimens, two longitudinal violet lines run throughout the intestinal region. In some the only internal colouration is due to the orange intestinal epithelium. The tentacles and cirri, including the ventral, are full of mulberry-shaped glands which discharge fine thread-like bodies. All the tentacles and the dorsal cirri are alike in not being distinctly segmented at their bases. The prostomium, (Plate xiii., fig. 4) rounded in outline, bears two pairs of eyes of variable size dorsally and a third, very minute, pair in front of them, but on the ventral surface, and therefore directed downwards. The median tentacle is about ten times the length of the prostomium, the lateral about four or five times. The palpi (Pl. xiii., fig. 5) are very short, scarcely visible from above, united together for a short distance in front of the mouth to form a sort of upper lip with a median suture; laterally each extends outwards so as to project slightly beyond the lateral border of the prostomium.

The peristomium, small and closely united to the prostomium, bears dorsally and laterally, widely separated from one another, a pair of ciliated lobes which represent the "ailerons occipitaux" or nuchal wings of other species. These may be short and globular, or may be elongated so as to extend back over the first setigerous segment. The dorsal peristomial tentacle is longer than the ventral, about the length of the lateral prostomial.

The parapodia (fig. 6) have a very distinct anterior lobe or lingula. Each bears some 5 to 12 stout, bidentate, compound setae (figs. 7 and 8) with very fine and short cilia on the cutting edge. The acicula, usually five or six in each parapodium, are straight and pointed. The dorsal cirri are much longer than the breadth of the body in the living and active condition; they are not definitely segmented towards the base. The broad ventral cirri are longer than the parapodia. The penultimate segment has two pairs of jointed cirri, the dorsal the longer, considerably longer than the breadth of the segment, the ventral composed of only two or three joints. The anal cirri are similar to the dorsal.

The oral end of the pharynx is provided with a circlet of six well-separated teeth (figs. 9 and 10), each of which is divided into five sharp cusps, the central one larger than the others.

The Port Jackson *Amblyosyllis* is very nearly related to that found at Dinard by St.-Joseph and regarded by him as being identical with *Gattiola spectabilis* of Johnston (29), *Pterosyllis plectorhyncha* of Marenzeller (42), and *P. madeirensis* of Langerhans (36). The apparent greater lateral extension of the palpi in the Australian form, together with the variability in the length of the nuchal wings and the presence of the ventral eye-spots, are probably not of crucial importance, while the correspondence of the setae and acicula and the peculiar glands in the tentacles and cirri, with the threads which they discharge, correspond closely with St.-Joseph's descriptions. The only discrepancy that appears to be of importance is with regard to the teeth. Marenzeller's figure [(42), Taf. v., fig. 3D] of the teeth of his *Pterosyllis plectorhyncha* is much nearer what is to be seen in the Port Jackson specimens than St. Joseph's description and figures [(48), p. 65, Pl. 9, fig. 66]. In spite of these apparent differences it appears probable that the European and Australian forms will prove to be identical.

Augener (1) found only fragments of an *Amblyosyllis* in the Hamburg Expedition's collection. These he considered to agree well with Ehlers's *A. granosa* from Magellan (7).

Family AUTOLYTIDAE.

Genus AUTOLYTUS.

AUTOLYTUS PACHYCERUS Aug.

Autolytus pachycerus, Augener, (1), p. 257, fig. 11 and 12; Text-fig. 40.

The Port Jackson species of *Autolytus* which I refer to the above species is characterised by its extremely brilliant colouration, but alcohol-preserved specimens after a time completely lose all trace of this, and Augener's statement "Die Farbung ist eintönig gelblich weiss ohne besondere zeichnung" becomes applicable to them.

The most striking superficial feature of thee living worm is the presence in the middle of the dorsal surface of each segment of a bright blue or purple spot, usually rounded, but sometimes produced into a transverse streak. This occurs both in the stock and in the stolons at all stages. The ground colour is red or orange.

The stock is about 5 mm. in length and contains about 50 segments. The proventriculus lies in the 7th and 8th, or 8th and 9th segments; in one specimen it was more elongated, extending from the 8th to the 12th. The first stolon is produced by schizogamy. Later a chain results from gemmation. The separated off female stolons containing each about 30 segments at first swim about actively and are provided with capillary swimming setae on all the segments except the first seven or eight. Afterwards the capillary setae become lost, and a little before or shortly after this takes place the ova are discharged, to be subsequently carried about enclosed in a capsule on the ventral surface of the parent.

A male stolon has about the same number of segments as the female and has capillary setae on all the segments except the first three.

In all stages the first pair of dorsal cirri are much longer than any of the rest except the second which approaches it in length.

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EXPLANATION OF PLATES.

Plate x.

Fig. 1. *Syllis variegata.* One of the compound setae. (x 1500).
Fig. 2. *Syllis variegata.* Acicula. (x 440).
Fig. 3. *Syllis pectinans*, n. sp. Dorsal view of head and anterior region of body. (x 80).
Fig. 4. *S. pectinans.* Outline of parapodium in the anterior region seen from the dorsal side, with the acicula.
Fig. 5. *S. pectinans.* One of the compound setae. (x 1040).
Fig. 6. *S. pectinans.* Dorsal simple seta. (x 1040).
Fig. 7. *S. truncata*, n. sp. Dorsal view of anterior region. (x 100).
Figs. 8-9. *S. truncata.* Compound setae. (x 1040 and 1400).
Fig. 10. *S. truncata.* Dorsal simple seta. (x 1400).
Figs. 11-14. *S. truncata.* Acicula. (x 1400).
Fig. 15. *S. gracilis.* Acicula. (x 1040).

Plate xi.

Fig. 1. *Syllis punctulata*, n. sp. Dorsal view of anterior region, magnified.
Fig. 2. *S. punctulata.* Outline of parapodium from above.
Fig. 3. *S. punctulata.* Compound seta of the anterior region. (x 1040).
Fig. 4. *S. punctulata.* Compound seta of the posterior region. (x 1040).
Figs. 5-10. *S. punctulata.* Dorsal simple setae. (x 1040).
Fig. 11. *S. punctulata.* Ventral simple seta. (x 1040).
Figs. 12-16. *S. punctulata.* Acicula (x 1040).
Fig. 17. *S. parturiens*, n. sp. Anterior region. (x 140).
Fig. 18. *S. parturiens.* Most dorsal compound seta.
Fig. 19. *S. augeneri*, n. sp. Dorsal view of parapodium (x 440).
Fig. 20. *S. augeneri.* Most dorsal compound seta. (x 1400).
Figs. 21-22. *S. augeneri.* Acicula. (x 1400).
Figs. 23-26. *S. kinbergiana* Haswell. Compound seta (x 1040).
Fig. 27. *S. kinbergiana.* Acicula. (x 1000).
Fig. 28. *S. coruscans* Haswell. Head, magnified.
Figs. 29-31. *S. coruscans.* Compound setae. (x 600).

Plate xii.

Fig. 1. *Syllis kinbergiana.* Anterior region, dorsal view.
Fig. 2. *S. kinbergiana.* Outline of parapodium as seen from above. (x 240).
Fig. 3. *S. ferruginea* Langerhans. Dorsal view of anterior extremity, magnified.
Fig. 4. *S. ferruginea.* One of the most dorsal of the compound setae. (x 1040).
Figs. 5-7. *S. ferruginea.* More ventrally situated compound setae. (x 1040).
Fig. 8. *S. ferruginea.* Ventral simple seta. (x 1040).
Figs. 9-10. *S. ferruginea.* Acicula. (x 1040).
Fig. 11. *Pionosyllis melaenonephra*, n. sp. One of the most dorsal compound setae of the anterior segments. (x 1040).
Fig. 12. *P. melaenonephra.* One of the most dorsal setae of the posterior segments. (x 1040).
Figs. 13-14. *P. melaenonephra.* Compound setae of posterior segments. (x 1040).
Fig. 15. *P. melaenonephra.* Ventral simple seta of posterior segments. (x 1040).
Fig. 16. *P. melaenonephra.* Aciculum.

Plate xiii.

Fig. 1. *Pionosyllis melaenonephra.* Anterior region, magnified.
Fig. 2. *P. divaricata* Keferstein. Most dorsal of the compound setae. (x 1040).
Fig. 3. *P. divaricata.* More ventral compound seta. (x 1040).
Fig. 4. *Amblyosyllis spectabilis* Johnston. Anterior region, dorsal view.
Fig. 5. *A. spectabilis.* Ventral aspect of head in outline to show the palpi and the ventral eyes.
Fig. 6. *A. spectabilis.* Outline of parapodium from above. (x 240).
Fig. 7. *A. spectabilis.* Most dorsal compound seta. (x 1040).
Fig. 8. *A. spectabilis.* More ventrally situated compound seta. (x 1040).
Fig. 9. *A. spectabilis.* Circlet of six composite teeth round the rim of the pharynx.
Fig. 10. *A. spectabilis.* One of the teeth. (x 1040).

THE CARABIDAE OF TASMANIA.

By Thomas G. Sloane.

(With four text-figures.)

This paper is founded on the Carabidae from the collection of the late Mr. Augustus Simson, of Launceston, which has recently been acquired by the Trustees of the South Australian Museum. In addition, I have been able to examine the large collection of Carabidae made by Messrs. H. J. Carter and A. M. Lea in northern and western Tasmania during the month of January, 1918, which consisted of 51 species; 14 of these were new species, of which 11 were not represented in the Simson collection. The Tasmanian species in my own collection, some belonging to Mr. Lea, and some sent by Mr. F. M. Littler from Launceston have also been seen.

The type specimens of the new species described in this paper have been sent to the South Australian Museum.

Synopsis of Paper.

(1) Introduction.
- Scutellar striole of the Carabidae.
- Tarsal vesture of the Carabidae.
- Umbilicate punctures of the elytra of the Carabidae.
- Anterior cotyloid cavities of the Carabidae.
- Middle cotyloid cavities of the Carabidae.
- Anterior tibiae and tibial spurs of the Carabidae.
- Components of the Tasmanian Carabideous fauna.
- Key to tribes of Carabidae in Australia and Tasmania.

(2) The Carabidae of Tasmania and islands of Bass Straits.

(3) Appendix. List of species not dealt with in the body of the paper.

Introduction.

Scutellar striole. In the Carabidae the elytra have usually nine striae and a short striole at the base of the first or second stria known as the scutellar striole.* There are many variations from this normal pattern; sometimes the elytra are without any striae, while in *Planetes australis* Macl., there are twenty-five striae; probably every number from one to twenty-five occurs, but I only know of more than seventeen as occurring in some species of *Planetes* and in the genus *Polystichus*. Only the scutellar striole will be considered, in order to obtain an idea of its taxonomic value; for, though it has been used as a classificatory character, its morphology and origin do not seem to have been given attention. The Carabidae must originally have had the elytra 10-striate, the scutellar striole

*Sometimes in the tribe Pterostichini a well developed tenth stria occurs, but in such cases the series of umbilicate punctures is found in the usual position on the ninth interstice, so that in these cases it seems evident that the extra stria has been developed on the ninth interstice.

being the rudiment of a stria now more or less lost. The clue to the original striation of the elytra may be found in the tribe Migadopini of the Southern Hemisphere, and in the Holarctic genus *Pelophila*, where an extra second stria is found basad from the apical declivity. The text figures given below show the four distinctive forms of the normal Carab striation with regard to the scutellar striole.

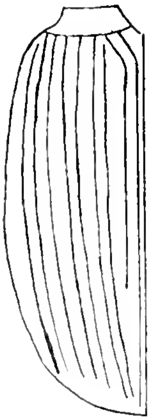
Fig. 1 is the pattern of the striation in *Calyptogonia ater* Sl., a Migadopid from Tasmania, viz., ten striae on the basal two thirds, and nine towards the apex as a result of the abbreviation of the second stria.

Fig. 2 shows the junction of the first stria with the remnant of the second stria as exemplified by *Dicrochile ventralis* Blackb.

Fig. 3 gives the second stria reduced to a striole at the base of the second interstice as occurring in *Gnathaphanus herbaceus* Sl.

Fig. 4 is drawn from the elytra of *Catadromus elseyi* to show the commonest form of striation in the Carabidae; here the base of the first stria has become the scutellar striole owing to the capture of the first stria by the second.

It may be assumed that a strong tendency towards the reduction of the original second stria by shrinking away from the apex must have developed very early in the history of the Carabidae, and that in many cases the reduced second stria became united with the first; this union of the first and second striae has then been the means of the tendency for the elimination of one stria having been transferred to the basal part of the first stria. Often the second stria has been completely lost where the reduction has continued on the second interstice, but it is very rarely that when the base of the first stria has become the striole, it has been altogether atrophied.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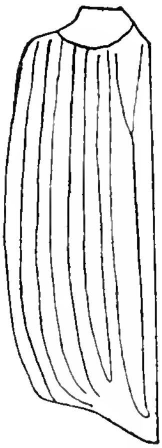
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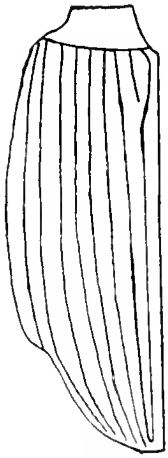
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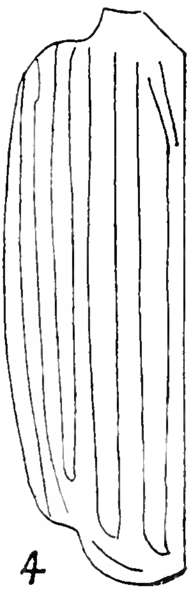
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Fig. 1. *Calyptogonia ater* Sloane. Fig. 2. *Dicrochile ventralis* Blackburn.
Fig. 3. *Gnathaphanus herbaceus* Sloane. Fig. 4. *Catadromus elseyi* White.

Vesture beneath joints of anterior tarsi in ♂. The vesture of the undersurface of some of the joints of the anterior tarsi (also of the middle tarsi in some cases where the anterior tarsi are clothed beneath) has long been recognised as an important character for the classification of the Carabidae, but I have seen no notice of its probable course of development. To have the underside of some joints of the tarsi clothed beneath is essentially a character of the male; very rarely the basal joint of the female is dilatate and clothed beneath, *e.g.*, in the American genus *Stenomorphus*, and in the Australian species *Notonomus eques* Cast., and *N. parallelomorphus* Chaud. The vesture assumes two main forms, viz., the spongiose and the biseriate forms. The spongiose vesture is older than the biseriate vesture, and is that from which the latter is derived; it alone is found in the Carabidae-disjunctae; the tribes Migadopini and Hiletini of this division have four anterior tarsi dilatate and clothed beneath. Most of the tribes of the Carabidae-conjunctae have the biserate form of the tarsal vesture, but spongiose vesture occurs in the Broscini and Pelecini of the Carabidae-uniperforatae, and in the Chlaeniini, Oodini, Licinini, Agriini, Dryptini, and Brachynini of the Carabidae-biperforatae. The Harpalini are the only tribe known to me in which both the spongiose and biseriate types of tarsal vesture occur, and here is found the clue to the derivation of the biseriate from the spongiose vesture. In the genus *Amblystomus* the brushes of squamae beneath the joints of the four anterior tarsi are dense with a longitudinal line dividing them in the middle, so that actually the squamae are arranged bilaterally. Any bilateral form would have an equal number of rows of squamae on each side of the joints; this can be seen in the American genus *Anisotarsus*, and in some species of *Diaphoromerus*. At any decrease in the number of rows of squamae which occurred, one row would go off on each side, and so the biseriate type of vesture would develop. That this might be the case may be seen by examining *Anisodactylus discoideus* Dej., a North American species, which has eight rows of squamae on the second joint of the anterior tarsi, but only four on the second joint of the middle tarsi. If this view of the origin of the biseriate type of tarsal vesture be accepted, the fact that this form occurs in one division of the tribe Harpalini and in the tribe Pterostichini, is to be considered a case of analogous variation, and not as any evidence of affinity; the occurrence of spongiose tarsal vesture in the Harpalini suggests that this tribe is more ancient than the Pterostichini, a tribe with only the biseriate form. Seeing that the tendency to reduction has only to be carried one step beyond the biseriate form of vesture to result in the tarsi becoming naked beneath, it is not astonishing that naked tarsi in the male appear in all directions throughout the Carabidae; genera have been proposed only on the character of unclothed tarsal joints but it may be confidently asserted that this negative character is not of generic value.

Umbilicate punctures of elytra. It seems evident that the interstices of the elytra represent the longitudinal veins, and the striae the interspaces of the upper wings of the insect-group from which the Coleoptera are derived. In the Carabidae, on one or more of the odd interstices of the ordinary 9-striate elytron, may be found sensitive setae rising from umbilicate punctures. Dr. G. H. Horn has used the terms "ocellate" or "dorsal punctures" for these setigerous punctures; but, seeing that they have often considerable taxonomic value in the family Carabidae, it seems necessary to have one definite and unvarying term for them: the name *umbilicate punctures*, which has been applied to them already, might with advantage be restricted to them when describing Carabidae. Umbilicate punctures are often wanting from all the odd interstices except the ninth. Dr. G. H. Horn has said that they are wanting from the ninth interstice in the genera *Panageus*, *Micrixys*, and *Apotomus*, but I am not sure that such is the case; in *Panageus* and *Micrixys* they seem to be hidden by the setosity of the interstice, but I considered I detected umbilicate punctures in *Panageus*; *Apotomus* shows, in fresh specimens, at least one long sensitive seta near the base and another near the apex of the ninth stria; if these setae are not rubbed off, the punctures from which they rise may be discerned. I regard these sensitive setae of the odd interstices of the elytra as homologous with the "macrotrichia" found by Dr. Tillyard on the wings of the Mecoptera; and this gives a reason for their position and taxonomic value.

Anterior cotyloid cavities. In the first division of the Carabidae, or subfamily Carabinae (here called Carabidae disjunctae) the anterior coxal cavities have one opening inwards; in the second division, or subfamily Harpalinae (here called Carabidae conjunctae) there may be either one or two openings inwards; therefore I have further divided the Carabidae conjunctae by this character into Carabidae uniperforatae and Carabidae biperforatae. The division of the inward opening of the anterior cotyloid cavities into two foramina is caused by a chitinous crosspiece which extends at right angles from each side of the antefurca.

Attention may be drawn to an aberrant modification of the biperforate form of the cavities found in the genus *Silphomorpha*, where the point of each epimerum has moved forward and become attached on each side to the chitinous crossbar of the cavity; this results in *Silphomorpha* showing but one opening inwards, which is not homologous with the single opening of the uniperforate cavity, but with the anterior foramen of the biperforate cavity. *Silphomorpha* has the antefurca very short, the posterior part of the anterior coxae more exposed than usual, and the posterior opening of the ordinary biperforate cavity completely lost owing to the shifting forward of the epimera. Our other Pseudomorphid genus *Adelotopus* has the ordinary biperforate form of the cotyloid cavities, and the antefurca of usual length. It may be noted, as a case of analogous variation, that the anterior coxal cavities in the family *Hydrophilidae* resemble those of *Silphomorpha*.

The results obtained by the use of the different forms of the anterior cotyloid cavities in the classification of the Carabidae are satisfactory, and a great help in determining the position and affinities of many genera in the family; but their use causes the arrangement of the tribes to differ greatly from the system now generally recognised. Taking the "Catalogus Coleopterorum Europae" (1906) as a standard of the present arrangement of the tribes the plan here adopted brings about the following changes of position. The Scaritinae, Elaphrinae and Loroceerinae would come first, followed by the Omophroninae and the Carabinae; the position of the tribes from Morioninae to Perigoninae would remain the same; Granigerinae, Harpalinae, Zabrinae, Amarinae, Pterostichinae, Masoreinae, and Odacanthinae would follow as members of the Carabidae uniperforatae (but my arrangement of the tribes of this division would not be the same as in the Catalogus). Apotominae, Panageinae, Chlaeniinae, Oodinae, Licininae, Lebiinae, Dryptinae, and Brachyninae would be placed in the Carabidae biperforatae. The position of the following tribes in my system may be indicated: Anchonderini and Egini to be included in the Odacanthini as suggested by Schaum; Cratocerini (as typified by the genus *Basolia*) comes into the Carabidae uniperforate; Mormolycini, Agriini, Anthiini, Graphipterini, and Orthogonini, all of which I have examined, belong to the Carabidae biperforatae.

With regard to the plan of having names for the six great sections into which the system here advocated divides the Carabidae, it has seemed to me that an undoubted benefit of definiteness results from its use, therefore I hope it will prove acceptable to Carabophiles.

Middle coxal cavities. As a matter of some interest it may be placed on record that in the Carabidae generally (including *Metrius*) the middle coxal cavities are confluent, the mesosternum being arched to cover the opening between the cavities by its meeting with the metasternum between the coxae; but, in the tribe Ozaenini, as far as I have observed, each coxal cavity is completely defined, and separated from the other by a chitinous partition, as a result of the close and continuous attachment of the mesosternum and metasternum. Further investigation on this subject is required, both in the Carabidae generally, and in the Ozaenini, where my observations have been confined to two species, viz., *Pseudozaena orientalis* Klug., and *Mystropomus subcostatus* Chaud.

Anterior tibiae.—The spurs and their position. Hitherto authors seem to have recognised practically only two plans, as far as the position of the two spurs of the anterior tibiae are concerned, viz, (1) both terminal (as in *Carabus*), (2) one above the other (as in the Scaritini); but there is a want of exactness about this statement of the case, as may be readily seen by anyone who will examine the position of the spurs in the tribes Ozaenini, Carabini, and Scaritini, not to mention others. One of the spurs never varies in its position throughout the Carabidae, it is always at the inner side of the apex of the tibia; in the tribes Metriini and Ozaenini, the other spur is opposite the inner one at the outer side of the apex; here there can be no question as to both spurs being terminal, nor as to which is the inner, and which the outer. An examination of any member of the tribe Carabini will show that it is the spur corresponding to the outer one in the Ozaenini that is the one which, by a change in position, becomes placed on the lower side of the tibia, a little obliquely above the inner spur; it is far more distant from the apex in the Scaritini and other tribes. Dr. G. H. Horn habitually used the term "inner" for the spur which varies in position; this is evidently an erroneous term, and seeing that in every case where it is not opposite the inner spur at the outer side of the apex, it is more or less above the apex, the term upper would seem more suitable for it; also I think the words "both spurs terminal" can only accurately be applied to the tibiae in the tribes Metriini and Ozaenini. Whether the position of the spurs in Metriini and Ozaenini implies any relationship between these tribes I am not prepared to say, but I believe the form of the anterior tibiae found in these two tribes is the most archaic now existing, and I attach a high value to it.

Components of the Tasmanian Carab-fauna.

The Carab-fauna of Tasmania includes 18 tribes, 60 genera, and 183 species [and there are, besides, 1 tribe (Chlaeniini), 1 genus (*Chlaenius*) and 9 species reported from the islands of Bass Strait; also, the introduced *Laemostenus complanatus* Dej.] Two tribes, 8 genera, and 59 species have not yet been found on the mainland of Australia; this endemic part of the fauna is essentially

Antarctic. On the whole the Carab-fauna of Tasmania is an Australian one modified by the presence of a greater proportion of Antarctic forms than occur in the fauna of the continent, and by the absence of the numerous oriental tribes, genera and species that are such a conspicuous character of the Carabidae of Australia.

Keeping in view accepted geological opinions, it is evident there may well be three component parts in the insect fauna of Tasmania, viz., (1) an original Mesozoic fauna similar to that of Australia in the Mesozoic era; (2) an Antarctic element introduced along with the Marsupials not later than the Miocene; (3) an inflow of immigrants from Australia in late Pliocene and Pleistocene times. Of these, the Antarctic will be the most easily discernible, for the other two components are parts of one fauna, as it appeared before and after the long Eocene-Miocene separation between Australia and Tasmania. It is obvious that the glaciation of Tasmania during the Kosciusko epoch (Pleistocene) must have profoundly affected both the original (Pre-Tertiary) and Antarctic (Eocene-Miocene) faunas, for only on the low lands could any insects have survived. This glacial period must also have prevented the access to Tasmania of many warmth-loving Australian groups during the last union of Tasmania with Australia, and it will have helped the spread of Antarctic species along the cordillera of Eastern Australia.

I take the present opportunity to draw attention to a striking fact which is disclosed by studying the present distribution of dragonflies. In the list of genera of dragonflies given by Dr. R. J. Tillyard in his book, "The Biology of Dragonflies," p. 300, he enumerates for the order Odonata, 362 genera belonging to the different zoogeographical regions of the world. These are distributed between the different regions in the following numbers:—Neotropical region, 111 genera; Nearctic, 24; Palaearctic, 14; Ethiopian, 70; Oriental, 82; Australian, 1. These figures show 242 genera in the three southern land masses of the globe, as against 120 genera in the three northern land masses. In 1896 I obtained a similar result for the tiger beetles, my figures showing 30 genera found in the three southern land areas, as against 8 in the three northern areas. This question requires to be treated in a similar way for other orders and families of insects before any inferences of value can be drawn from it, but the results obtained from these two widely-separated groups of insects have led me to suppose (1) that the present distribution of insects may have been mainly from the south, and (2) that the present distribution of animals may be, even in such an ancient class as the Insecta, largely a matter of the Tertiary period; this latter inference would mean that the northern lands had undergone more vicissitudes in the destruction of their animal life during the Tertiary period than southern lands, and had been since the beginning of Tertiary times largely stocked from the south.

Family CARABIDAE.

Table of Tribes found in Australia and Tasmania.

1. (10) Middle coxal cavities not entirely enclosed by the sterna, epimera of the mesosternum attaining the coxae . . . . CARABIDAE DISJUNCTAE.
2. (7) Anterior coxal cavities closed behind. . . . . CARABIDAE CLAUSAE.
3. (4) Anterior tibiae emarginate on inner side, both spurs terminal . OZAENINI.
4. (3) Anterior tibiae emarginate on inner side, one spur above apex

5. (6) Body not pedunculate, bases of prothorax and elytra in contact with one another. (Elytra 10-striate basad from apical declivity.) MIGADOPINI.
6. (5) Body pedunculate, bases of prothorax and elytra remote from one another .. .. SCARITINI.
7. (2) Anterior coxal cavities open behind .. .. CARABIDAE APERTAE.
8. (9) Mandibles strongly dentate on inner side. Outer apical angle of anterior tibiae prolonged .. .. PAMBORINI.
9. (8) Mandibles unarmed on inner side. Outer apical angle of anterior tibiae not prolonged .. .. CARABINI.
10. (1) Middle coxal cavities entirely enclosed by the sterna, epimera of the mesosternum not attaining the coxae .. .. CARABIDAE CONJUNCTAE.
11. (32) Anterior coxal cavities with a single opening inwards CARABIDAE UNIPERFORATAE.
12. (17) Head with one supraorbital seta on each side. Posterior marginal seta of prothorax, if present, distant from basal angle. Anterior tarsi in ♂, if with vesture beneath, usually with fourth joint clothed —often intermediate tarsi also with vesture beneath
13. (16) Posterior marginal seta of prothorax present, distant from basal angle.
14. (15) Antennae with three basal joints glabrous; also fourth joint, at least near base. Vesture of tarsi in ♂, if present, spongiose BROSCINI.
15. (14) Antennae with three basal joints glabrous; fourth joint setulose. Four joints of anterior tarsi in ♂ biseriately squamose beneath. AGONICINI.
16. (13) Posterior marginal seta of prothorax wanting. ♂, if with tarsal vesture, usually with fourth joint clothed (vesture either spongiose or biseriate) .. .. HARPALINI.
17. (12) Head normally with two supraorbital setae on each side. Posterior marginal seta of prothorax, if present, near basal angle. Anterior tarsi in ♂, if with vesture beneath, never with more than three basal joints clothed—intermediate tarsi never with vesture beneath.
18. (23) Mandibles with a sensitive seta in scrobe of outer side. Antennae with not more than two basal joints glabrous. Anterior tarsi in ♂ not clothed beneath on more than two basal joints.
19. (22) Palpi not subulate.
20. (21) Elytra with margin interrupted posteriorly by an internal plica. Maxillary palpi with penultimate joint setulose. (Tarsi hairy above.) MERIZODINI.
21. (20) Elytra with margin not interrupted posteriorly by an internal plica. Maxillary palpi with penultimate joint glabrous .. .. .. TRECHINI.
22. (19) Palpi subulate .. .. BEMBIDIINI.
23. (18) Mandibles usually without a sensitive seta in scrobe of outer side. Antennae with three basal joints glabrous. (If mandibles with a sensitive seta in scrobe, then three joints of antennae glabrous—except genus *Pterogmus* with third joint setulose, but with three basal joints of anterior tarsi biseriately squamose beneath in ♂.)
24. (25) Prosternum with intercoxal declivity of prosternum projecting backwards in the form of a wedge. Paraglossae corneous, small, triangular, much shorter than ligula. (Large black species 29-34 mm. in length.) .. .. CUNEIPECTINI.
25. (24) Prosternum with intercoxal declivity not triangularly produced backwards. Paraglossae membranous
26. (27) Elytra with an inner plica near each side, usually visible at apical sinuosities .. .. PTEROSTICHINI.

27. (26) Elytra without an inner plica.
28. (29) Head not constricted at base to a condyliform neck. Prothorax depressed, wider than head. (Pro-episterna not visible at sides from above.) .. .. ANCHOMENINI.
29. (28) Head—except very rarely—narrowed behind eyes. Prothorax narrow, very rarely wider than head.
30. (31) Tarsi with ungues simple .. .. ODACANTHINI.
31. (30) Tarsi with ungues pectinate .. .. CTENODACTYLINI.
32. (11) Anterior coxal cavities with two openings inwards CARABIDAE BIPERFORATAE.
33. (58) Head without antennal grooves beneath.
34. (37) Mandibles with a sensitive seta in scrobe of outer side.
35. (36) Elytra truncate. Prothorax bordered at sides; sutures of prosternum visible .. .. BRACHYNINI.
36. (35) Elytra entire at apex. Prothorax constricted to a narrow base, lateral border and sutures of prosternum not visible. (Body pedunculate, scutellum on peduncle. Maxillary palpi very long and narrow.) .. .. APOTOMINI.
37. (34) Mandibles without a sensitive seta in scrobe of outer side.
38. (39) Clypeus emarginate, or excised, exposing basal membrane of labrum.
39. (38) Clypeus entire, not exposing basal membrane of labrum. LICININI.
40. (45) Elytra with an inner plica near each side visible at apical sinuosities.
41. (42) Head with two supraorbital setae on each side. Apical joint of maxillary palpi obliquely set on to penultimate joint .. PANAGEINI.
42. (41) Head with one supraorbital seta on each side. Apical joint of maxillary palpi normally set on to penultimate joint.
43. (44) Elytra with ninth interstice variable in width, never linear or situated in a furrow below plane of eighth interstice .. .. CHLAENIINI.
44. (43) Elytra with ninth interstice linear and placed in a furrow .. OODINI.
45. (40) Elytra without an inner plica on each side.
46. (47) Tibial spurs long, serrulate on lower edge of outer side. TETRAGONODERINI.
47. (46) Tibial spurs short, not serrulate.
48. (51) Penultimate joint of labial palpi bisetose on anterior margin.
49. (50) Mentum supported at base by a raised submentum .. .. .. LEBIINI.
50. (49) Mentum not divided from gulae by a raised submentum PENTAGONICINI.
51. (48) Penultimate joint of labial palpi plurisetose on anterior margin.
52. (55) Antennae with basal joint very long, longer than two succeeding joints together.
53. (54) Mentum narrowly united to submentum, base of maxillae unusually exposed. Prothorax not bordered. Elytra without usual border and inflexed margin .. .. DRYPTINI.
54. (53) Mentum widely united to submentum. Prothorax and elytra with lateral borders .. .. ZUPHINI.
55. (52) Antennae with basal joint not of unusual length, not as long as two succeeding joints together.
56. (57) Ligula corneous; paraglossae well developed, free, membranous PHYSOCRATOPHINI.
57. (56) Ligula wide corneous, paraglossae adherent to ligula, often rudimentary .. .. HELLUONINI.
58. (33) Head with distinct, usually long antennal grooves beneath PSEUDOMORPHINI.

CARABIDAE DISJUNCTAE.

CARABIDAE CLAUSAE.

Tribe Migadopini.

Form elongate; prothorax subquadrate, widest before middle, anterior angles obtuse, not prominent; head not deeply set in prothorax .. .. CALYPTOGONIA.
Form short oval; prothorax widest at base, anterior angles acute, projecting forward to base of eyes; head deeply set in prothorax .. .. .. STICHONOTUS.

CALYPTOGONIA, gen. nov.

Apterous. Head large, convex, not narrowed behind eyes, one supraorbital seta on each side; eyes round, convex, not inclosed behind, distant from buccal fissure; gular sutures wide apart. Labrum wide, emarginate, 6-setose. Clypeus wide, truncate; angles rounded; sides covering upper basal angles of mandibles. Mandibles short, wide, strongly rounded externally; scrobe short, asetose; inner side with a triangular denticulate prominence behind middle; apex acute. Maxillae with outer lobe 2-jointed, stout; inner lobe slender, strongly falcate, apex acute, inner side pluridentate (about six or eight teeth equally distant from one another, the odd teeth spiniform). Maxillary palpi rather long; second joint stout; two apical joints slender, apical a little longer than penultimate, truncate. Mentum short, trisinuate, median sinuosity wide, shallow; sinus strongly bordered in middle; lobes rounded at apex. Ligula corneous, wide, convex, truncate, bisetose; paraglossae cartilaginous, of same length as and adherent to ligula; external angles rounded and bearing about four minute setules. Labial palpi with penultimate joint rather short, bisetose; apical joint long (a half longer than penultimate joint), club-shaped, compressed, truncate. Antennae setaceous; four basal joints glabrous, first stout, hardly as long as second and third together, unisetigerous, second a little shorter than fourth, third a little longer than second and fourth; joints 5-11 about equal, longer than third. Prothorax transverse; base emarginate, wider than apex; lateral margins asetose; lateral border thick. Elytra connate, truncate-oval, convex, bordered at base, striate; ten striae before apical declivity, second stria extending backwards to beginning of apical declivity; no dorsal umbilicate punctures; apical margin rounded, not sinuate or interrupted by an internal plica on each side. Scutellum short, wide. Prosternum with anterior coxal cavities closed; intercoxal declivity not prominent, narrow. Mesosternum with epimera reaching coxae. Metasternum short; episterna short, wide, posterior margin oblique; epimera not visible. Legs moderate; posterior coxae contiguous; anterior tibiae short, incrassate, two short stout spinules externally at apex, inner side strongly emarginate, inner spur distant from apex; posterior tibiae elongate, slender. Tarsi: posterior long, slender; anterior in ♂ with four basal joints dilatate and with spongiose tissue beneath, second and third joints much wider than first and fourth; intermediate about as long as tibiae, two basal joints dilatate and spongiose beneath. Genotype, *C. ater* Sl.

CALYPTOGONIA ATER, sp. nov.

Oblong, convex, black. Head large, convex (2.7 mm. across eyes), without sculpture. Prothorax broader than long (2.7 × 3.6 mm.), widest about middle, lightly narrowed to base, smooth; sides lightly arcuate; apex (2.5 mm.) narrower than base (3 mm.) truncate, bordered on each side, angles obtuse, hardly prominent; base emarginate, not bordered, angles obtuse; lateral border thick, sharply defined by a narrow sulcus; median line lightly impressed. Elytra ovate (7 × 4.8 mm.), convex; ten well marked striae on each elytron becoming obsolescent just before apex, second obsolete on apical declivity; interstices lightly convex, lateral interstice seriate-punctate. Under surface impunctate. Length 11—13.5, breadth 4.15—5.2 mm.

Hab.—Magnet (Lea), Cradle Mountain, Strahan (Carter and Lea). A numerous series of specimens has been examined, collected by Messrs. Carter and Lea in January, 1918, but Mr. Lea first found this species at Magnet many years ago.

Genus STICHONOTUS.

STICHONOTUS PICEUS Sloane.

Hab.—Mount Wellington (Lea), Cradle Mountain (Carter and Lea).

Two specimens from Cradle Mountain, sent by Mr. Carter, are of shorter and more oval form than the others, resembling in shape *S. leai* Sl. more than *S. piceus*, with which I consider it conspecific.

STICHONOTUS LEAI Sloane.

Hab.—Magnet (Lea), Waratah (Carter).

Tribe Scaritini.

Ligula small, prolonged, narrow and bisetose at tip; paraglossae free, small, narrow, pointed. Base of maxillae not covered by mentum. Basal joint of antennae unisetose .. .. *Group* CLIVINIDES.

Ligula broad, corneous; paraglossae corneous, ciliate at apex. Mentum broad and concealing at sides base of maxillae. Basal joint of antennae asetose *Group* CARENIDES.

Group *Clivinides*

Genus CLIVINA.

Table of Tasmanian species.

1. (2) Elytra with four inner striae free at base, fifth joining sixth at base. (Elytra with a black sutural stripe.) .. .. *suturalis* Putz.
2. (1) Elytra with three inner striae free at base, fourth joining fifth at base.
3. (4) Clypeus with median part projecting beyond lateral parts, angular at sides. Anterior tibiae 4-dentate externally .. .. *heterogena* Putz.
4. (3) Clypeus with anterior margin emarginate, lateral parts not divided from median part. Anterior tibiae 3-dentate externally.
5. (6) ♂. Upper external tooth of anterior tibiae well developed. Prosternum without pectoral nodules .. .. *vagans* Putz.
6. (5) ♂ Upper external tooth of anterior tibiae obsolete. Prosternum with a distinct pectoral ridge on each side ending anteriorly in a nodule *dilutipes* Putz. var. *tasmaniensis* Sl.

CLIVINA SUTURALIS Putzeys.

[= *C. verticalis* Putz.; = *C. dorsalis* Blackb. (1889).]

My view is that the three names mentioned above have all been given to one species. By an error I cited it as *C. discoidalis* Blackb. in 1904.

Hab.—Hobart, Sandford (Lea). Also found in Southern and S.W. Australia.

Clivina heterogena Putzeys.

(= *C. angustula* Putz.; = *C. deplanata* Putz.)

Hab.—Swansea (Simson); Latrobe (Lea). Widely spread in S.E. Australia.

Clivina vagans Putzeys.

In 1904 I applied the name *C. vagans* Putz., to a specimen from Tasmania sent to me by Blackburn, and I still support this identification. It differs from *C. dilutipes* Putz., var. *tasmaniensis* Sl. by ♂ with anterior tibiae more strongly dentate, prosternum without pectoral nodules.

Hab.—Strahan (Lea).

Clivina dilutipes Putzeys, var. tasmaniensis Sloane.

In 1896 I wrongly identified *C. dilutipes* and *C. lepida*; my *C. lepida* was *C. dilutipes* Putz., and my *C. dilutipes* of 1896 is now *C. misella* Sl. The variety *tasmaniensis* differs from the typical *C. dilutipes* of the mainland by the shape of the anterior tibiae in ♂;—the digitations are more reduced, the upper very feeble (practically obsolete), the penultimate greatly reduced; apical spur longer and more obtuse at apex; in ♀ (as in *C. dilutipes*) the digitations are more developed than in ♂, and the apical spur is pointed. The prosternum in ♂ bears on each side before the coxae a well developed ridge, ending anteriorly in a small nodule; this nodule is not found in ♀.

Hab.—Launceston, East and West Tamar, Great Lake, Swansea, Evandale (Simson, No. 2620); Latrobe (Lea).

Group *Carenides*.

Clypeus with intermediate angles obtuse; not marked, lateral seta placed inwards from intermediate angles. Anterior tibiae with penultimate external tooth placed distad from apical spur .. .. SCARAPHITES.

Clypeus with intermediate angles prominent, triangular, later seta placed outwards from intermediate angles. Anterior tibiae with penultimate external tooth placed basad from apical spur .. .. CARENUM.

Scaraphites rotundipennis Dejean.

Hab.—Kelso, Swansea, Georgetown (Simson, No. 1791); King Is., S.E. Australia, Lord Howe Is.

Carenum morosum Sloane (1907).

A species with anterior tibiae bidentate, and elytra impunctate. It suits neither the description nor the figure of *C. politulum* Westw., which was described as coming from Tasmania, it has not the posterior angles slightly emarginate. Both the description and figure of *C. politulum* suggest a species closely resembling *C. laevigatum* Macleay, but having the elytra impunctate, so that it may be an impunctate form of *C. laevigatum*; I have seen a *Carenum* from the mainland with impunctate elytra that I could not distinguish from *C. laevigatum*.

Hab.—George's Bay (Simson, No. 2313).

Note.—*C. morosum* is very close to *C. laevipenne* Macl., but has the border of the prothorax much more raised at the posterior angles.

Carenum laevigatum Macleay.

A specimen not differing from the form of *C. laevigatum* found in Victoria.

Hab.—Launceston (Simson).

CARABIDAE APERTAE.

Tribe Carabini.

CALOSOMA SCHAYERI Erichson.

(? = *C. australe* Hope; = *C. grandipenne* Castelnau.)

The description of *C. australe* Hope reads as if founded on a rather discoloured specimen of *C. schayeri*.

Hab.—Launceston, Flinders Is. (Simson); King Is. (Lea); widely distributed in Australia.

Note.—*C. oceanicum* Perroud [= *C. walkeri* Waterhouse (1898)]. I cannot differentiate *C. walkeri* (N.W. Australia) from *C. oceanicum* (New Caledonia).

CARABIDAE CONJUNCTAE.

CARABIDAE UNIPERFORATAE.

Tribe Broscini.

Table of Tasmanian genera.

1. (2) Suborbital cicatrix present (obsolete only in Tasmanian species of the *P. tasmanicus* group). Elytra with four lateral punctures, penultimate puncture giving off a short stria (sides pluripunctate only in *P. viridiaeneus*). (Mandibles with a seta in scrobe of outer side. PROMECODERUS.
2. (1) Suborbital cicatrix wanting. Elytra pluripunctate along sides.
3. (6) Head transversely impressed behind eyes and with strong divergent frontal impressions; one supra-orbital seta on each side; antennae moniliform; mandibles short. Mes-episterna narrow.
4. (5) Mandibles with a seta in scrobe of outer side .. .. EURYLYCHNUS.
5. (4) Mandibles without a seta in scrobe of outer side .. CHYLNUS (nom. nov.)
6. (3) Head very large, transverse and frontal impressions obsolete; three supra-orbital setae and one or two punctures on vertex on each side; antennae long, slender. Mes-episterna wide. ♂. Anterior femora not protuberant on lower side. .. .. PERCOSOMA.

Genus PROMECODERUS.

Table of Tasmanian species.

1 (2) Elytra pluripunctate along sides, about eight or ten punctures extending from shoulders to apex .. .. *viridiaeneus* Sl.

2 (1) Elytra quadripunctate on sides: one puncture posthumeral, the others on apical third, penultimate strioliform.

3 (11) Head with a distinct suborbital cicatrix.

4 (5) Apex of abdomen in ♂ with three setigerous pores, set in a triangle, in ♀ with two setigerous pores on each side of apex. ♂.—Anterior femora strongly and suddenly dilatate basad from middle of lower side; ventral segments 3-5 piliferous. Length, 13-15 mm. *brunnicornis* Dej.

5 (4) Apex of abdomen in ♂ with one, in ♀ with two setigerous pores on each side of apex. ♂.—Anterior femora not suddenly dilatate; ventral segments with only the two usual ambulatorial setae.

6 (13) Legs dark.

7 (12) Dorsal surface convex. ♂. Two or three basal joints of middle tarsi with vesture beneath.

8 (9) Impressions of ventral segments linear. Posterior tarsi with apical joint wide at base, subparallel on sides. ♂.—Two basal joints of middle tarsi with vesture beneath. Length, 13-16 mm. *gibbosus* Gray.

9 (8) Impressions of ventral segments foveiform. Posterior tarsi with apical joint elongate, narrow at base. ♂.—Three basal joints of middle tarsi with vesture beneath.

10 (11) Prothorax with border subsinuate before basal angles, these subrectangular, very slightly obtuse. Length, 15 mm. .. *cordicollis* Sl.

11 (10) Prothorax with border arcuate to base, basal angles open. Length, 12-13 mm. .. .. *bassi* Cast.

12 (7) Dorsal surface depressed. ♂.—Intermediate tarsi naked beneath; anterior tarsi with four joints clothed beneath. (Head strongly impressed across vertex; ♂.—Posterior tibiae curved.) Length, 12-14 mm. .. .. *curvipes* Sl.

13 (6) Legs testaceous. (Cupreous. ♂.—Middle tarsi naked beneath.) Length, 7.5—9 mm. .. .. *cuprescens* Sl.

14 (3) Head with suborbital cicatrix obsolete. ♂.—Middle tarsi naked beneath.

15 (16) ♂.—Four joints of anterior tarsi with vesture beneath. Length, 11 mm. .. .. *longus* Sl.

16 (15) ♂.—Three joints of anterior tarsi with vesture beneath.

17 (18) Prothorax with sides roundly curved to base, basal angles open Length, 10 mm. .. .. *tasmanicus* Cast.

18 (17) Prothorax with sides obliquely curved to base, basal angles obtuse but marked. Length, 8.5-10.5 mm. .. .. *plebius* Sl.

Promecoderus subdepressus Guer.

I only know *P. elegans* Cast., from the Melbourne district, as a species which suits Putzeys' description of *P. subdepressus* Guer. Putzeys' treatment of the two species *P. subdepressus* and *P. elegans* in his "Revision" of 1873 leaves the impression on my mind that only one species was before him. I have not seen any species from Tasmania that is *P. subdepressus* Guer.

Promecoderus modestus Cast.

This species is said by Castelnau to be from Tasmania. Castelnau's description might apply to *P. longus* Sl., but, in his Revision, Putzeys, with Castelnau's single specimen (♀) before him, says it has the basal angles of the prothorax rectangular. I have not seen it from Tasmania, or the mainland.

Promecoderus viridiaeneus Sloane (1915).

Hab.—Stanley, Zeehan (Simson, No. 3465); Cradle Mountain, Strahan, Waratah (Carter and Lea).

Promecoderus brunnicornis Dejean.

(= *P. degener* Guer.)

A variable species in size and appearance. I attribute to it all Tasmanian specimens with the basal angles of the prothorax very wide (open), and which have in the ♂ the following characters:—Ventral segments 3—5 plurisetose in middle, apical segment with three setigerous punctures on each side, placed triangularly (two of the punctures marginal); anterior femora suddenly dilatate on lower side (usually armed with a denticule); posterior trochanters very long and obtusely pointed; anterior tarsi with four, intermediate with two joints clothed beneath. Length, 11—14.5 mm.

Hab.—Denison Gorge, Ben Lomond (Simson No. 3052); Strahan (Carter and Lea); Marrawah, Wilmot, Sheffield, Burnie, Devonport, Ulverstone (Lea).

Var. OVICOLLIS Cast. I can only regard *P. ovicollis* Cast., as a variety of *P. brunnicornis* Dejean, from which it differs by its more convex form, reddish antennae, ♂ with anterior femora less swollen beneath, and with the denticule obsolete; posterior femora less ampliate on lower side, posterior trochanters stouter and shorter.

Hab.—Launceston, Great Lake (Simson, No. 3091); Hobart (Lea).

PROMECODERUS GIBBOSUS Gray.

(= *P. mastersi* Macleay.)

Distinguished by its convex form, sharply marked basal angles of prothorax, strongly striate elytra, fourth and fifth ventral segments with a transverse linear impression on each side. Length, 13—16 mm. I cannot now differentiate *P. mastersi* Macl., of the mainland from the Tasmanian *P. gibbosus*.

Hab.—Launceston, Brighton, Avoca, Hobart (Simson, No. 1166); Ulverstone (Lea).

PROMECODERUS CURVIPES, sp. nov.

Elongate-oval, depressed; head transversely impressed across vertex; prothorax oval, depressed, abruptly declivous to basal angles, these open; elytra oval, depressed on disc, lightly striate, interstices depressed, a little undulate; ventral segments 4—6 foveolate on each side. Bronzed—or aeneous—black; head and prothorax nitid, rather virescent; inflexed margins of elytra rather cupreous; undersurface and femora nitid, virescent; tibiae, tarsi, and antennae piceous brown.

Head large (2.75 mm. across eyes); vertex convex; eyes round, convex; postocular part of orbits well developed, about one half size of eyes. Prothorax rather oval (4 × 3.9 mm.), widest about anterior third; sides lightly rounded; apex wide, lightly emarginate; anterior angles a little prominent, not near neck; disc depressed; a wide, shallow, transverse impression before base; basal angles obtuse, placed beneath a lateral declivity; border narrow, wider anteriorly than posteriorly, obsolete on middle of base; median line lightly impressed. Elytra oval (7.5 × 4.5 mm.), depressed (but not flat) on disc, a little declivous to peduncle, wide across base, lightly rounded on sides; striae light, rather crenulate, seventh and eighth obsolete. Apical ventral segment in ♂ with one, in ♀ with two setae on each side of apex.

♂.—Anterior femora club-shaped, not suddenly inflated or dentate on lower side; posterior tibiae arcuate on lower side, wide at apex, densely fringed with setae on apical half of lower side; anterior tarsi with four joints wide and spongiose beneath; intermediate tarsi narrow, not clothed beneath. Length, 12—14, breadth, 4.2—4.5 mm.

Hab.—Tasmania (Simson, No. 3111).

Fourteen specimens have been examined. In appearance it resembles *P. brunnicornis* Dej.; but differs by basal angles of prothorax more overlapped by the sides of the segment, and less widely open; and by the following very distinct characters of the male: anterior femora not suddenly and greatly dilatate and dentate on lower side; posterior trochanters shorter; posterior tibiae bent inwards and fringed with hair on lower side; intermediate tarsi narrow, not spongiose beneath; ventral segments not pilose in middle. It is allied to *P. longus* Sl., from which it differs by size larger, curvature and hair-fringe of lower side of posterior tibiae in male.

PROMECODERUS CUPRESCENS, sp. nov.

Elongate-oval, rather depressed; prothorax oval-cordiform, lateral border narrow, obsolescent near base; elytra oval, finely crenulate-striate; anterior femora not greatly swollen on lower side; ♂, anterior tarsi with four joints dilatate and spongiose beneath, intermediate tarsi without spongiose tissue beneath. Cupreous, under surface aeneous; legs ferruginous, femora darker than tibiae; antennae fuscous, base testaceous.

Head cupreous, eyes convex, prominent, lightly inclosed behind; temporal cicatrix distinct. Prothorax broader than long (2.3 × 2.5 mm.), depressed, more or less subfoveate; base strongly bordered on each side; lateral border narrow, reduced and almost obsolete just before base; sides very declivous to basal angles, these rectangular. Elytra oval (5 × 3 mm.), lightly convex; striae distinct (less so near sides), a little crenulate; interstices depressed, more or less feebly undulate; three posterior lateral impressions foveiform, penultimate one not giving off a striole. Ventral segments 3—5 without lateral foveae or sulci; apical segment in ♂ 1-, in ♀ 2-setose on each side of apex. Length, 7 5—9, breadth, 3—3.25 mm.

Hab.—Cradle Mountain, Waratah (Carter and Lea). A good series of specimens.

A very distinct species, differing from all others by the following characters in conjunction:—small size, coppery colour, and light-coloured legs. From *P. tasmanicus* Cast. (which also has the intermediate tarsi naked beneath in ♂), it differs by colour, prothorax less transverse, less rounded on sides, basal angles much lower down on sides, and not so obtuse, elytra less convex. There are some foveae on the prothorax which vary in number and distinctness; usually four are more or less distinct: two about equidistant from median line and border at widest part of segment, and two others behind these about level with end of median line—sometimes two other foveae may be noticed, one on each side of the median line at the middle of its length.

PROMECODERUS LONGUS, sp. nov.

♂.—Depressed, elongate. Upper surface aeneous or nigro-aeneous; under surface nitid, of a greenish bronzy colour, inflexed margins of elytra aeneous; tarsi, palpi, and antennae reddish.

Head with suborbital cicatrix obsolete; eyes prominent; post-ocular part of orbits about one third length of eye, curving continuously with eye. Prothorax depressed, as long as broad (3.1 × 3.1 mm.), lightly rounded on sides, lightly and widely transversely impressed near base, declivous to basal angles, these obtuse; a light rounded impression on each side a little before middle. Elytra oval (6.5 × 4 mm.), depressed, lightly striate, discal striae crenulate, lateral striae obsolete; humeral angles marked. Ventral segments 3—5 with a lightly impressed rounded fovea on each side; apical segment with one seta on each side at apex. Anterior femora club-shaped, lower side not sharply inflated or dentate; anterior tarsi with four joints wide and spongiose beneath; intermediate tarsi narrow, not clothed beneath. Length, 11 breadth, 4 mm.

Hab.—Launceston, Zeehan (Simson).

There were two specimens in the Simson Coll. without number. It is of evidently larger size and narrower form than the species which I identify as *P. tasmanicus* Cast.; both prothorax and elytra much less strongly rounded on sides; anterior tarsi in male with four, not three, joints clothed beneath. It cannot be *P. subdepressus* Guer. by basal angles of prothorax not rectangular—as said by Putzeys.

PROMECODERUS TASMANICUS Castelnau.

I attribute the name *P. tasmanicus* to a species given to me by the late Mr. George Masters, ticketed "Tasmania"; this specimen evidently represents the form with a wide prothorax referred to by Castelnau. The following description will enable it to be recognised:—

Nigro-virescent; inflexed margins of elytra aeneous; under surface with slight viridescent reflections; anterior tarsi and palpi reddish. Elliptical-oval, rather depressed. Head with suborbital cicatrix obsolete; eyes convex, prominent; post-ocular part of orbits about one third length of eye. Prothorax broader than long (2.7 × 3 mm.), cordiform-oval, strongly rounded on sides, lightly transversely depressed across base, declivous to basal angles, these obtuse. Elytra oval, declivous to peduncle, rather strongly and roundly declivous to apex; disc lightly striate; humeral angles marked. Anterior tarsi with three joints clothed beneath; intermediate tarsi not clothed beneath. Length, 10.2, breadth, 3.7 mm.

Specimens received from Mr. Lea ticketed "Mount Wellington" only differ slightly, as under:—♂, colour black; form narrower; both prothorax and elytra less strongly rounded on sides. Length, 10.5; proth., 2.75 × 2.85; breadth, 3.6 mm. This is probably the narrow form referred to by Castelnau. *P. tasmanicus* was not represented in the Simson Coll.

PROMECODERUS PLEBIUS, sp. nov.

Elliptical-oval, lightly convex; head with suborbital cicatrix obsolete; prothorax with basal angles obtuse, but marked; elytra oval, convex, striate on disc. Black; legs piceous; tarsi and antennae piceous red.

Head ordinary (2 mm. across eyes). Prothorax lightly convex, subcordate, as long as broad (2.7 × 2.7 mm.), widest about anterior third, lightly rounded on sides; sides narrowed in a gentle curve to base; basal area with a shallow, rather rounded impression on each side; border narrow, well developed on each side of apex and base; basal angles set low down, open but marked. Elytra oval (5.5 × 3.5 mm.); striae well marked on disc, obsolete on sides. Ventral segments 4—6 with a shallow impression on each side. ♂.—Anterior tarsi with three joints clothed beneath; intermediate tarsi not clothed beneath. Length, 8.5–10, breadth, 3.3–3.8 mm.

Hab.—Ben Lomond, 5000 feet (Simson). Six specimens.

I separate *P. plebius* from *P. tasmanicus* Cast., by shape more convex, especially of prothorax, which is less strongly rounded on sides, and with basal angles set lower down, and more marked, though obtuse; even should it be regarded as a variety of *P. tasmanicus*, its separation under a varietal name seems advisable.

Genus EURYLYCHNUS.

EURYLYCHNUS FEMORALIS Sloane (1915).

A black species apparently only differing from the genus *Chylnus* (= *Lychnus* Putzeys) by the presence of a mandibular seta. Prothorax sinuate on sides before base, basal angles marked. Length, 14 mm.

Hab.—Denison Gorge (Simson No. 3113); Mount Horror (Lea).

Genus CHYLNUS, nom. nov.

Lychnus Putzeys.

The name *Lychnus* was already in use when Putzeys proposed it in 1868; I now suggest *Chylnus* (formed by a rearrangement of the letters in *Lychnus*) to replace it.

CHYLNUS ATER Putzeys.

(= *Lychnus striatulus* Bates. = *L. strangulatus* Bates.)

I have identified a specimen in my collection as *Lychnus ater* Putz., with every likelihood of the identification being correct, seeing that a comparison with specimens in the Howitt Coll. named "*Mecodema tasmanicum* Castelnau" showed it to be the same species; Putzeys in his "Revision" of 1873 notes that there were nine specimens in the Castelnau Coll. under the name *Mecodema tasmanicum* —a cabinet name. I conclude that *Chylnus ater* Putzeys = *Lychnus striatulus* Bates, and that *L. strangulatus* Bates (numbered 3051 in the Simson Coll.) is a larger and smoother form; specimens in the Simson Coll. (No. 3684), and also taken by Messrs. Carter and Lea at Wilmot and Waratah, evidently represent the convex third species alluded to by Bates (Cist. Ent., 1878, p. 318), but I am not prepared to distinguish it from *Chylnus ater*, nor can I separate *Lychnus strangulatus* Bates by any definite characters. The species seems a variable one in size and appearance, the sides of the prothorax have one or two setae just before the middle, and from two to six setae near the anterior angles. Length, 16—20, breadth, 5.5—6.6 mm. One dwarfed specimen, 15.5 × 4.7 mm.

Hab.—Launceston, Denison Gorge, Ben Lomond, 4000 feet (Simson No. 3051); Zeehan (Simson), Wilmot, Waratah (Carter and Lea) [Simson, No. 3684]; Great Lake (Simson).

Genus PERCOSOMA.

The genus *Percosoma* is a distinct one characterised by head large, mandibles long, decussate; antennae elongate, second joint longer than fourth; prothorax plurisetose along sides, lateral border not attaining base; elytra with fifth interstice punctate; mes-epimera wide; posterior tarsi a little compressed, fifth joint narrow, vertical on sides (this character occurs also to a more marked degree in some genera of Scaritini, *e.g.*, *Scaraphites*).

Elytra sub-striate, interstices flat. Length, 25—27 mm. ... . *carenoides* White.
Elytra strongly striate, interstices convex on sides. Length, 24-35 mm. *sulcipenne* Bates.

PERCOSOMA CARENOIDES White.

Hab.—Mount Wellington (Simson, No. 2727).

PERCOSOMA SULCIPENNE Bates.

Hab.—Denison Gorge, Wynyard (Simson, No. 3463); Cradle Mountain, Waratah (Carter and Lea).

Tribe **Agonicini**, trib. nov.

I place between the tribes Broscini and Harpalini a new tribe which is required for two Tasmanian species in the Simson collection; the following will be the definition of this tribe.

Head with one supra-orbital puncture on each side; mandibles long, decussate; scrobe of outer side asetose. Antennae inserted under a lateral ridge, slender;

basal joint long, scapiform; three basal joints glabrous. Labrum emarginate, 4-setose. Mentum toothed. Palpi elongate; apical joints setose, of labial securiform. Prothorax suboval; basal angles obtuse; two marginal punctures on each side, anterior at apical, posterior at basal third. Elytra convex, oval, striate; disc impunctate; scutellar striole very short, at base of first interstice; margin not interrupted posteriorly by an inner plica. Anterior coxal cavities with a single opening inwards. Mes-epimera not reaching coxal cavities; met-episterna quadrate, not divided from epimera. Legs long; anterior tibiae emarginate beneath; upper spine at inner side of emargination. ♂.—Anterior tarsi with four joints dilatate and biseriately squamose beneath; fourth joint of anterior and intermediate tarsi emarginate; posterior tarsi long, narrow, fourth joint triangular, simple.

AGONICA, gen. nov.

Head narrow; front depressed, smooth, lightly bi-impressed; one seta above middle of eye on each side; eyes prominent, hemispherical, not inclosed at base, distant from buccal fissure beneath. Labrum wide, short, emarginate, 4-setose. Clypeus not divided from front by a visible suture, bisetose. Mandibles long, acute, decussate, without a seta in scrobe of outer side. Mentum with a prominent triangular median tooth. Palpi elongate: labial with penultimate joint long, slender, bisetose; apical joint widely securiform, setulose: maxillary long, slender; two apical joints setose; terminal joint fusiform, stouter and a little longer than penultimate, compressed, blunt at apex. Antennae setaceous, rising at apex of a marginal ridge; basal condyle visible; basal joint long, nearly as long as three succeeding joints together; three basal joints glabrous; second and fourth joints much shorter than third. Prothorax oval, depressed; basal angles rounded; two marginal setae on each side, anterior at apical third, posterior at basal third. Elytra oval, convex, not bordered across base, lightly striate; striae well marked on disc, faint towards sides; margin not interrupted posteriorly by an internal plica. Body shortly pedunculate; scutellum on peduncle. Prosternum with coxal cavities closed behind; mes-epimera not reaching coxae; met-episterna quadrate, no visible suture between episternum and epimeron. Anterior coxal cavities with one opening inwards. Ventral segments without transverse sulci; apical segment in ♂ with two marginal setae on each side. Legs long; femora—anterior a little compressed, swollen; intermediate roundly swollen on lower side about anterior third; posterior lightly swollen on lower side; tibiae—anterior emarginate beneath, a sharp spur above emargination, apical spur short, stout; posterior slender, spurs short. ♂.—Anterior tarsi with four basal joints dilatate, biseriately squamulose beneath; fourth joint of four anterior tarsi short, emarginate, of posterior tarsi triangular, simple; upper surface of tarsi sparsely setose.

AGONICA SIMSONI, sp. nov.

Elliptical, convex; mandibles prominent, decussate; labrum short, emarginate, 4-setose; antennae with basal joint elongate (longer than two succeeding joints together); front strongly bi-impressed; eyes convex, distant from buccal fissure beneath. Black.

Head narrow (1.3 mm. across eyes); frontal impressions wide; lateral setae of clypeus at anterior extremity of frontal impressions; clypeal suture obsolete. Prothorax hardly broader than long (2 × 2.1 mm.), not declivous to base in middle, laevigate (some faint transverse striolae crossing median line); anterior angles wide, hardly prominent; sides arcuate; base truncate, angles rounded; border narrow; marginal channel narrow; lateral basal foveae short, shallow. Elytra oval (4 × 2.8 mm.), convex, strongly declivous to apex, striate; five inner striae well marked on disc; striae 6—8 obsolescent on sides, eighth deeply impressed posteriorly; interstices not convex, third impunctate; lateral border narrow, reaching peduncle. Length, 7.5, breadth, 2.8 mm.

Hab.—Zeehan (Simson). Unique.

AGONICA OVALIPENNIS, sp. nov.

Elliptical-oval; head bi-impressed; prothorax quadrate-oval, basal angles obtuse, posterior marginal seta at basal third; elytra oval, striate on disc, lateral striae obsolete, two inner interstices convex near base, third impunctate. Black.

Head narrow (0.8 mm. across eyes); vertex convex; front depressed, bi-impressed; impressions extending on to clypeus; clypeus declivous to anterior margin; lateral seta very near outer angle, outside (not in) anterior extremity of frontal impression. Prothorax as long as broad (1.2 × 1.2 mm.), laevigate; anterior angles wide, hardly advanced; sides evenly and lightly arcuate; base truncate, angles rounded off; border narrow, extending round basal angles; marginal channel narrow; median strongly impressed. Elytra oval (2.6 × 1.8 mm.), lightly convex; humeral angles rounded; apical curve subsinuate on each side; four inner striae well marked, fifth faint, 6—8 obsolete on sides, eighth deeply impressed posteriorly. Length, 4.5, breadth, 1.8 mm.

Hab.—Lottah (Simson No. 3120).

A single specimen was in the Simson collection; it differs from *A. simsoni* Sl., by smaller size, less convex form, lateral setae of clypeus not in frontal impressions, &c.

Tribe **Harpalini**.

Table of Tasmanian genera.

1 (8) Labial palpi with penultimate joint plurisetose. (Elytra fully striate, eyes distant from buccal fissure beneath. ♂.—If with four anterior tarsi squamose beneath, then four joints clothed with dense tissue beneath.)

2 (5) Posterior tarsi long; first joint as long as, or longer than two succeeding joints together.

3 (4) Elytra with at least third interstice pluripunctate .. GNATHAPHANUS.

4 (3) Elytra with third interstice unipunctate .. .. DIAPHOROMERUS.

5 (2) Posterior tarsi short; first joint short, not as long as two succeeding joints together.

6 (7) Sinus of mentum with a median tooth .. .. HYPHARPAX.

7 (6) Sinus of mentum without a median tooth .. .. .. CENOGMUS.

8 (1) Labial palpi with penultimate joint bisetose. (In *Amblystomus* some other feebly developed setules also.)

9 (12) Labium with paraglossae overlapping one another in front of ligula; mentum edentate.

10 (11) Elytra with first stria present, or interrupted near base, or obsolete,—if present, bent outwards near base and a scutellar striole present on first interstice,—if interrupted, scutellar striole obsolete or nearly so. ♂.—Four anterior tarsi either with or without vesture beneath. AMBLYSTOMUS.

11 (10) Elytra with first stria bent inwards near base, scutellar striole wanting. ♂.—Anterior tarsi without vesture beneath. .. .. HAPLANER.

12 (9) Labium with paraglossae free at apex; mentum dentate. (Elytra fully striate.)

13 (14) Ventral segments (including basal fovea in ♂) glabrous. Posterior tarsi long, first joint much longer than second. ♂.—Four anterior tarsi with joints 2-4 wide, clothed with dense tissue beneath ... NEMAGLOSSA.

14 (13) Ventral segments (including basal fovea in ♂) setulose. Posterior tarsi short, first joint not as long as two succeeding joints together. ♂.—Four anterior tarsi with squamae disposed biseriately at sides of joints .. .. EUTHENARUS.

Genus GNATHAPHANUS.

GNATHAPHANUS ADELAIDAE Castelnau.

Hab.—Launceston, Brighton, Great Lake, Avoca, Hobart, Flinders Is. (Simson No. 2481).

Genus DIAPHOROMERUS.

Table of Tasmanian species.

1 (8) Elytra with humeral angles marked and dentate, third interstice unipunctate.

2 (7) Legs black, or with tibiae and tarsi piceous; antennae black, or infuscate with basal joint ferruginous.

3 (4) Prothorax with sides not sinuate posteriorly, basal angles obtuse. (Colour bronze, or viridiaeneous) .. .. *edwardsi* Casteln.

4 (3) Prothorax with sides sinuate posteriorly, basal angles square.

5 (6) Colour virescent. Length, 7 mm. .. .. *rectangulus* Chaud.

6 (5) Colour black. Length, 8 mm. .. .. *quadricollis* Chaud.

7 (2) Tibiae, tarsi, and antennae ferruginous. (Scutellar striole punctiform.) Length, 6.5 mm. .. .. *viridipennis* Sl.

8 (1) Elytra with humeral angles not dentate, third interstice impunctate. (Prothorax densely punctate on each side of base, sides strongly sinuate to base, basal angles rectangular. Length, 9.7-10.5 mm. *perater* Sl.

Note.—*D. amaroides* Casteln. (= *Harpalus patrueloides* Casteln. = *H. vandiemensis* Casteln. *H. illawarrensis* Casteln., according to Chaudoir) is also reported from Tasmania; but, not having seen it from the island, I have thought it better not to include it in the table from specimens of the mainland. It is distinguished by its ferruginous tibiae and tarsi.

DIAPHOROMERUS EDWARDSI Castelnau.

Bronzed, or bronzy-green; legs black; basal joint of antennae testaceous. Length, 8.5 mm. I consider this species to be conspecific with *D. edwardsi* Casteln., a species about which little is yet known.

Hab.—Falmouth (Simson), Stonor (Lea). Also occurs in Victoria.

DIAPHOROMERUS RECTANGULUS Chaudoir.

A viridescent species with basal angles of prothorax rectangular. Length, 6.5-7 mm.

Hab.—Brighton (Simson, unique). Also found in south-eastern Australia.

Diaphoromerus quadricollis Chaudoir.

A specimen which I identify as *D. quadricollis* Chaud., from the description, has been sent to me by Mr. Lea for examination.

Deep black; prothorax with sides lightly sinuate before base, basal angles square but obtuse at summit, lateral basal impressions impunctate; elytra with puncture of third interstice more distant from apex than usual. Length, 8.5 mm.

Hab.—Zeehan (Lea).

Diaphoromerus viridipennis, sp. nov.

Oval, convex; head large, eyes prominent, lightly inclosed at base, mentum toothed; prothorax transverse, wider across base (2 mm.) than apex (1.5 mm.), basal angles obtuse; elytra ovate, convex, strongly and fully striate, second interstice with a very short striole at base, third interstice with a puncture about posterior third, humeral angles dentate; undersurface glabrous; abdomen in ♂ with a well marked, median, basal, shallow impression; point of prosternum sparsely setulose; first joint of hind tarsi long, about as long as two succeeding joints together; ♂.—Four anterior tarsi dilatate, joints 1—4 densely clothed with squamae beneath, the squamae arranged in longitudinal rows. Black, nitid; elytra bluish green; femora piceous; tibiae, tarsi, antennae, and palpi ferruginous

Head convex, not narrowed behind eyes (1.5 mm. across eyes); post-ocular part of orbits small, rising obliquely but abruptly from head. Prothorax laevigate, convex, broader than long (1.6 × 2.2 mm.), roundly and decidedly narrowed to apex, very lightly and obliquely narrowed to base; apex lightly emarginate, angles obtuse; base truncate, angles obtuse but marked; median line obsolescent; border entire. Elytra shortly truncate-oval (4 × 2.8 mm.), convex, strongly declivous to apex; apical curve short, hardly sinuate on each side; interstices subconvex, narrow and convex at apex; ninth interstice wide and with a double row of punctures towards apex. Length, 6.5, breadth, 2.8 mm.

Hab.—Hobart (Lea). The type specimen belongs to Mr. Lea, and another is in my collection, given to me by Mr. H. J. Carter, who found it at Hobart.

A small species, not like any other species of the genus *Diaphoromerus*; in general appearance it resembles a species of *Hypharpax*, but is at once distinguished from the species of that genus by the form of the posterior tarsi, which have the basal joint much longer—longer than the elongate inner apical spur of the tibiae.

Diaphoromerus perater, sp. nov.

Oval, convex, form robust; head large; prothorax transverse, strongly sinuate on sides posteriorly, basal half closely punctate on each side, basal angles rectangular; elytra strongly striate, interstices convex, third impunctate, humeral angles marked but not dentate. Black.

Head large (2.65 across eyes), convex; front obliquely depressed to anterior margin; clypeus transversely impressed behind anterior margin between lateral setae; clypeal suture distinct, linear, giving off at each end an obliquely divergent line extending across frontal depression towards eye; left mandible hooked, projecting beyond labrum, right mandible folded under labrum and left mandible. Prothorax broader than long (2.3 × 3.4 mm.); base truncate, wider (3 mm.) than apex (2.7 mm.); sides rounded anteriorly, sinuate posteriorly and meeting base at right angles; anterior angles a little prominent, obtuse; basal angles rectangular; upper surface depressed and with a light wide concavity on each side of base, closely and finely punctate towards base and along sides to marginal seta; a distinct curved anterior transverse line distant from anterior margin; median line short, not deep; marginal channel wide; border reflexed on sides, entire on base, extending almost to middle on each side of apex. Elytra ovate (6.2 × 4.5 mm.), lightly convex; base wide, truncate; apical curve lightly sinuate on each side; striae deep; striole at base of second interstice elongate; interstices convex, strongly so on apical declivity. Posterior tarsi with basal joint almost as long as two succeeding joints together. Length, 9.7—10.5, breadth, 4.2—4.5 mm.

Hab.—Tasmania (Simson Coll. No. 3686); Hobart, Huon River, Bernie (Lea); Warburton, Victoria (Sloane).

A very distinct species, which it seems only necessary to compare with *Harpalus moestus* Dej., a species which I refer to *Hypharpax* on account of its short posterior tarsi. Compared with *H. moestus*, it is larger; head more depressed anteriorly; prothorax with basal angles more sharply rectangular, anterior angles more prominent, lateral channel wider, base more depressed on each side, punctuation of basal parts finer, denser, and overspreading more of the surface; elytra less convex, basal border much less prominent at shoulders, striae deeper, scutellar striole much longer, interstices more convex, third impunctate (in *H. moestus* unipunctate above apical declivity); posterior tarsi longer; first joint of antennae black—not ferruginous.

Genus HYPHARPAX.

Table of Tasmanian species.

1 (2) Elytra with third interstice unipunctate on apical declivity. ♂.—Posterior femora strongly and sharply dilatate, dentate or subdentate on lower side. (Prothorax with basal angles very obtuse.) .. .. .. *peroni* Cast.

2 (1) Elytra with third interstice unipunctate above apical declivity. ♂.—Posterior femora not strongly dilatate on lower side.

3 (4) Prothorax with basal angles obtuse (though a little marked), not punctate on each side of base, except in bottom of basal impressions. (Tibiae dull red with apex piceous). Length, 5.7–7 mm. *australis* Dej.

4 (3) Prothorax with basal angles well marked, punctate on each side of base.

5 (6) Prothorax with sides oblique to base. Elytra lightly convex; humeral angles not dentate. Colour obscure, bronze; tibiae ferruginous, piceous at apex. Length, 6.5—7 mm. .. .. *aereus* Dej.

6 (5) Prothorax with sides sinuate before base, basal angles square. Elytra very convex; humeral angles dentate. Colour black, legs black .. *moestus* Dej.

HYPHARPAX PERONI Castelnau.

[= *H. novae-hollandiae* Cast., = *H. inornatus* Blackb. (*non* Germar), = *H. latiusculus* Chaudoir, = *H. puncticauda* Bates.]*

I identify specimens from Launceston in the Simson collection as *Hypharpax peroni* Cast., a species which Blackburn, from South Australian specimens, identi-

* I am indebted to Mr. H. E. Andrews, of London, for the information that Chaudoir's name was published before Bates's.

fied as *Harpalus inornatus* Germ., though Chaudoir had in 1878 put *H. inornatus* Germ., as a synonym of *Harpalus australis* Dej. I believe that on this question Chaudoir was right. The Simson collection contains specimens which are evidently *H. puncticauda* Bates, by their heavier form, prothorax more rounded on sides, and trochanters obtuse at apex (not almost straight on outer side nearly to apex and truncated in a curve from inner side): this is the same thing, from description, as *H. latiusculus* Chaudoir, but seems to me conspecific with a specimen from Launceston, which I cannot differentiate from *H. peroni* of the mainland; therefore, I feel unable to consider *H. puncticauda* Bates as a variety, but this is a point that can only be settled by careful collecting throughout Tasmania. The sharpness of the angulation of the lower side of the femora in ♂ varies in degree in Tasmanian specimens, as in other species of the genus; in the specimen from Launceston referred to above, it is shortly dentate. In length Tasmanian specimens vary from 6.7 to 8 mm., and vary in colour from a dull copper-colour to almost black. It was numbered 2478 and 2483 in Simson collection, but I cannot differentiate the specimens so numbered.

Hab.—Launceston, Brighton, Evandale, Longford, Interlaken (Simson); Parattah, Stonor, Hobart (Lea). Widely spread in Australia.

HYPHARPAX AUSTRALIS Dejean.

Hab.—Launceston, Evandale, Great Lake (Simson, No. 2484); Stonor, Mount Wellington (Lea); Lord Howe Island (Lea). Widely spread in S.E. Australia.

HYPHARPAX AEREUS Dejean.

Hab.—Hobart (Lea). Southern coastal districts of Australia.

HYPHARPAX MOESTUS Dejean.

Hab.—Brighton (Simson, No. 2881); Hobart (Lea). Also reported from Melbourne.

Genus CENOGMUS.

CENOGMUS ROTUNDICOLLIS Castelnau.

Hab.—Tasmania (Lea). Very widely distributed over Australia.

Genus AMBLYSTOMUS.

Erichson, Kaf. Mark. Brandb., i., p. 59, 1837; *Hispalis* Rambur, Faun. Andal., p. 135, 1842; *Megaristerus* Nietner, Ann. Mag. N.H., 1858, p. 427; *Notophilus* Blackburn, Trans. Roy. Soc. S. Aust., 1887, p. 185; Proc. Linn. Soc. N.S. Wales, 1889, p. 1250; *Thenarotidius* Sloane, *op. cit.* 1898, p. 461; *Psilonothus* Sloane, *op. cit.*, 1899, p. 557.

All authors have not been in agreement as to the position of the genus *Amblystomus;* for Erichson, Lacordaire, Bates, Ganglbauer, and Tschitscherine its place was in the tribe Harpalini; for Schaum, in the Lebiini; for Bedel and Apfelbeck in the Licinini; in the European Catalogue of 1906 it is placed in a special tribe; I believe it to represent a group in the tribe Harpalini. The genus is here used in a wide sense, the genera *Notophilus*, *Thenarotidius* and *Psilonothus* being included in it. Of these, *Thenarotidius* is unquestionably a synonym, and I do not know definite reasons for maintaining *Notophilus* and *Psilonothus* as distinct. *Notophilus* has the clypeus and labrum symmetrical, but the want of symmetry in

Amblystomus varies so considerably that I do not think this a character on which the genus should be founded. The clypeus and labrum cannot be said to be asymmetrical in *Psilonothus*, and *Ps. ovalis* Sl., has naked tarsi in ♂, but a species described below, *A. convexus*, is evidently congeneric with *Ps. ovalis*, yet has the four anterior tarsi in ♂, lightly dilatate and squamulose beneath.

Table of Tasmanian species.

1 (4) Met-episterna elongate; elytra striate near suture, puncture of third interstice before apical declivity; eyes near buccal fissure beneath. Winged.

2 (3) Prothorax arcuate to base, basal angles rounded, not marked. Length, 3.3-3.5 mm. .. .. *niger* Blackb.

3 (2) Prothorax decidedly and obliquely narrowed to base; basal angles obtuse, but marked. Length, 2.3-2.5 mm. .. .. *parvus* Blackb.

4 (1) Met-episterna (excluding epimera) quadrate; elytra without striae on disc, puncture of third interstice on apical declivity, eyes distant from buccal fissure beneath. Apterous.

5 (6) ♂ with four anterior tarsi squamulose beneath. Length, 4-4.5 mm. *convexus* Sl.

6 (5) ♂ with anterior tarsi naked beneath. Length, 2.5-3mm. *ovalis* Sl.

AMBLYSTOMUS (NOTOPHILUS) NIGER Blackburn.

Hab.—Evandale (Simson No. 3122); Latrobe, Jordan River, Strahan, Mount Wellington (Lea). Common in South-eastern Australia.

AMBLYSTOMUS (NOTOPHILUS) PARVUS Blackburn.

Hab.—Launceston, Evandale, Zeehan (Simson, No. 2877); Jordan River (Lea). South Australia.

AMBLYSTOMUS CONVEXUS, sp. nov.

Apterous, oval, convex; prothorax with lateral margin narrow; elytra smooth, a fine puncture at position of third interstice near apical fifth; met-episterna wide, short, quadrate—including epimera longer than broad; posterior tarsi with first joint as long as three succeeding joints together. ♂.—Abdomen at apex bisetose on each side; four anterior tarsi with joints 1—4 lightly dilatate and squamulose beneath. Olivaceous-black; basal joint of antennae and tibiae testaceous-brown.

Head smooth; labrum, clypeus and front shagreened, and showing some minute punctures under a lens; eyes round, convex, distant from buccal fissure beneath; mentum edentate. Prothorax smooth, convex, transverse cordate (1.4 × 1.4 mm.); base wide; basal angles obtuse; lateral border narrow, more strongly reflexed at basal angles, entire on base. Elytra smooth, convex, oval (2.6 × 2 mm.); eighth stria obsolete; submarginal punctures wanting on middle of sides. Length, 4.1—4.1, breadth, 1.75—2 mm.

Hab.—Brighton (Simson, No. 2858). Also found by Mr. Lea at Lucindale and Port Lincoln, S. Australia.

A distinct species much larger than *A. (Psilonothus) ovalis* Sl. Compared with *Amblygnathus minutus*, a species I also refer to *Amblystomus*, and to which it is allied, the prothorax narrowly bordered at once distinguishes it

AMBLYSTOMUS (PSILONOTHUS) OVALIS Sloane.

Hab.—Strahan (Carter and Lea). This species, which extends from N.S. Wales to Western Australia, was represented in the Simson collection by one specimen, without exact locality.

Genus HAPLANER.

HAPLANER VELOX Castelnau.

Hab.—Wedge Bay (Hardy). *H. velox* was sent to me by Mr. H. J. Carter, as having been found at Wedge Bay by Mr. Hardy. It is found in the southern coastal districts of Australia from Perth to Melbourne.

Genus NEMAGLOSSA.

Solier, Gay's Hist. Chili: Zool., iv., p. 215, 1848: *Lecanomerus* Chaudoir, Bull. Soc. Imp. Nat. Mosc., 1850, p. 446: *Thenarotes* Bates, Cist. Ent., 1878, p. 320.

I have examined a specimen of *Nemaglossa brevis* Solier (= *Lecanomerus marginatus* Reed) from Chili: and do not know how to distinguish the genus *Lecanomerus* from *Nemaglossa*, nor do I think that *Thenarotes* is (even on Bates's own showing) separable from *Lecanomerus*, except by trivial characters that are not of generic value; therefore these three genera are considered as one here.

Table of Tasmanian species.

1 (4) Form stout; upper surface black, rarely with a virescent tinge on elytra.
2 (3) Size major, 6.5-7 mm. Elytra nitid in ♂, opaque in ♀ ... *verticalis* Erichs.
3 (2) Size minor, 4.5 mm. Form oval, convex; elytra nitid in both sexes ... *mastersi* Macl.
4 (1) Form narrow; prothorax at least reddish.
5 (8) Head black; antennae infuscate after second joint.
6 (7) Elytra red at base; each elytron with a piceous plaga extending over interstices 2-8. Length, 5 mm. .. .. *bicolor* Sl.
7 (6) Elytra piceous; first interstice, apex, and lateral margin reddish. Length, 3.8-4.1 mm. .. .. *obtusa* Sl.
8 (5) Colour (including head and antennae) reddish; each elytron with a piceous plaga extending over interstices 2-5. Length, 5 mm ... *tasmanica* Bates.

NEMAGLOSSA (HARPALUS) VERTICALIS Erichson.

Hab.—Launceston (Simson, No. 2480), West Tamar (Simson, No. 3105); Devonport, Zeehan, Hobart (Lea). Common in the coastal districts of N.S. Wales and Victoria

NEMAGLOSSA MASTERSI Macleay.

(=*Acupalpus mastersi* Macl., = *Lecanomerus nitidus* Blackb.)

Hab.—Stanley, Stonor, King Is. (Lea). Also found over a large area of S.E. Australia.

NEMAGLOSSA (THENAROTES) BICOLOR Sloane.

Hab.—Launceston, Beaconsfield (Simson, No. 2492). Also found in Victoria and S. Australia.

NEMAGLOSSA OBTUSA, sp. nov.

Elongate-oval; head bifoveate; prothorax laevigate, punctate on each side of basal foveae; elytra truncate-oval (2.5 × 1.8 mm.), convex, fully striate, second interstice without striole at base, third interstice unipunctate a little before apical third. Head black; prothorax ferruginous, middle of anterior margin and disc vaguely infuscate; elytra piceous-black, first interstice, lateral margins and apex reddish; legs testaceous; antennae infuscate, two basal joints testaceous; mandibles and labrum reddish.

Head laevigate; each frontal fovea giving off an oblique line running towards middle of eyes; vertex convex; eyes prominent, lightly inclosed behind. Prothorax broader than long (0.9 × 1.2 mm.), widest before middle; sides lightly rounded, roundly and strongly narrowed to apex, decidedly narrowed to base; apex truncate; angles rounded, not marked; base truncate in a curve, angles obtuse, not marked; lateral basal foveae wide, shallow, punctate; median line distinct. Length, 3.8–4.1 mm., breadth, 1.8 mm.

Hab.—Evandale (Simson, No. 2494); Launceston, Latrobe, Strahan (Lea).

This is the species which is entered as *Thenarotes discoidalis* Blackb. in Lea's "List" of 1902, but I believe it to be a distinct species. Compared with *N. atriceps* (= *Trechus id* Macleay), it differs by prothorax more strongly narrowed to base, basal angles more rounded off. I am not sure that I know *N. minor* Blackb., which may not be different from *N. atriceps* Macl.; the same differences should separate *N. obtusa* from *N. minor* as from *N. atriceps*. It seems to me better to consider the Tasmanian species as distinct, rather than attach it to any of the described species of the mainland as a variety. All the allied forms known to me from the mainland differ from *N. obtusa* by having the prothorax less strongly narrowed to base, and with the basal angles more marked.

Two small specimens belonging to Mr. Lea, ticketed "Launceston" are smaller than the typical form (3.5 mm.) and have the elytra almost wholly black, only the first interstice towards apex, lateral margins posteriorly, and apex narrowly reddish; it may be a variety.

NEMAGLOSSA (THENAROTES) TASMANICA Bates.

Hab. Launceston (Simson, No. 2491). Also common in S.E. Australia.

Genus EUTHENARUS.

Prothorax with basal angles rectangular; legs yellowish .. *promptus* Erichs.
Prothorax with basal angles obtuse; legs black. .. .. *nigellus* Sl.

EUTHENARUS (HARPALUS) PROMPTUS Erichson.

Hab. Launceston, Beaconsfield, Kelso, Zeehan (Simson, No. 2859); Latrobe, Strahan, King Is. (Lea). Common in S.E. Australia.

EUTHENARUS NIGELLUS, sp. nov.

Elongate-oval; prothorax laevigate, sparsely punctate in basal impressions; elytra convex, fully striate, second interstice without striole at base, third interstice unipunctate near posterior third. Black; antennae piceous with basal joint reddish; legs black; tarsi ferruginous-brown, posterior darker than anterior.

Head laevigate; frontal impressions well marked, oblique, anterior extremities connected by clypeal suture; eyes not prominent. Prothorax broader than long (1 × 1.3 mm); sides rounded, angustate to base; base arcuate-truncate, angles obtuse; border thick, extending round basal angles on each side; lateral basal fovea wide, shallow, punctulate. Elytra wider than prothorax (2.65 × 1.75 mm.), strongly declivous to apex; inner humeral angles widely obtuse; apical curve short, without lateral sinuosities; striae entire, fine but well defined, second rising from a rather large puncture; interstices depressed. Length, 4.2, breadth, 1.75 mm.

Hab. Strahan (Lea). Unique.

Allied to *E. comes* Sl., from which it presents the following differences:—legs black; eyes less convex; prothorax more strongly narrowed to base, less densely punctate along base, particularly near angles.

Tribe **Merizodini**, trib. nov.

Antennae with second and third joints setulose; mandibles with a seta in groove of outer side; maxillary palpi with penultimate joint setiferous, apical joint glabrous. Elytra with margin interrupted posteriorly by an inner plica, eighth interstice carinate towards apex.

I have formulated this tribe for the Australasian species hitherto put in the genus *Oopterus*. Dr. R. Jeannel, of Toulouse, has examined the genotype, *Oopterus clivinoides* Guerin, and has kindly communicated to me the fact that not only is it not congeneric with the New Zealand species hitherto referred to as *Oopterus*, but actually belongs to another tribe of the Carabidae; this leaves the South American *Merizodus* as the first described genus of this tribe, and therefore the one from which the tribal name must be taken. The characters given above differentiate this tribe from the Trechini. The only extra-Australasian genus of the tribe known to me is *Merizodus*, the genotype of which, *M. angusticollis* Solier from Chili, I have examined.

Table of genera.

1 (8) Eyes large, prominent.
2 (7) Head with two supra-orbital setae on each side.
3 (6) Elytra bordered on base; prothorax without a submarginal carina.
4 (5) Facies *Oodes*-like. Prothorax with posterior marginal seta present. BRACHYDEMA.
5 (4) Facies *Harpalus*-like. Prothorax without posterior marginal seta PERCODERMUS.
6 (3) Elytra not bordered on base; prothorax with a submarginal carina near basal angles, posterior marginal seta present .. .. MERIZODUS.
7 (2) Head with one supra-orbital seta on each side. [Prothorax with a submarginal carina and a marginal seta near basal angles; elytra with border obsolete except beside humeral angle.] ..PTEROCYRTUS.
8 (1) Eyes small, depressed. [Prothorax narrow, near basal angles concave and without submarginal carina; legs unusually long] IDACARABUS.

Genus BRACHYDEMA.

BRACHYDEMA TASMANIAE Sl. (= *B. victoriae* Sl.)

I now believe I was wrong in trying to differentiate the Tasmanian and Victorian forms from one another.

Hab.—Denison Gorge (Simson No. 3126), Hobart (Lea); Warburton, Victoria (Sloane).

Percodermus, gen. nov.

Head small; frontal impressions obsolete; two supra-orbital setae on each side; eyes hemispherical, hardly inclosed at base, distant from buccal fissure beneath. Labrum truncate, 6-setose. Clypeus with a seta on each side. Mandibles with a seta in scrobe of outer side. Palpi stout: maxillary with penultimate joint obconic, setose; apical joint stout, short, obtusely pointed, glabrous; labial short; penultimate joint bisetose; apical joint short, stout, obtusely pointed. Antennae long, slender; second and third joints setulose. Prothorax depressed, subquadrate, wider across base than apex, lightly and roundly ampliate at widest part, bi-impressed on each side of base; basal angles rectangular, obtuse at summit; border narrow, passing round basal angles; submarginal basal carina not developed; posterior marginal seta wanting. Elytra rather depressed; base bordered; humeral angles marked, not dentate; striae lightly marked on disc, obsolete on sides; first interstice with a very short striole at base, third 4-punctate beside third stria, eighth carinate at apex, obsolete in middle. ♂.—Anterior tarsi with two basal joints lightly dilatate and squamose beneath.

The position of this genus is near *Pterocyrtus*, but it differs by form more depressed; head with frontal impressions obsolete, two supra-orbital setae on each side; prothorax without a submarginal basal carina, seta at basal angles wanting. The genotype is a small, jet-black, rather nitid beetle.

Percodermus niger, sp. nov.

Elliptical-oval, subdepressed. Black, nitid; legs and antennae piceous or piceous red, femora darker than tibiae, base of antennae reddish. Head short (1.3 mm. across eyes); front wide; eyes large, round, prominent. Prothorax subquadrate (1.5 × 2 mm.), widest just before middle, depressed; apex narrow (1.2 mm.), angles not prominent, rounded; sides arcuate anteriorly, subsinuate to base; base wide (1.7 mm.), truncate, angles rectangular, summit obtuse; border narrow, passing round both anterior and basal angles, very narrow in middle of apex, obsolete in middle of base; basal impressions shallow, inner one well marked, outer one short, distinct; space between these impressions wide, depressed. Elytra with disc lightly striate; sides smooth; third interstice 4-punctate, eighth carinate at apex, obsolete in middle; a short striole at base of first interstice. Tarsi setose on upper surface; basal joint of posterior tarsi as long as three succeeding joints together. Length, 6, breadth, 2.3 mm.

Hab. Great Lake (Simson). Three specimens.

Pterocyrtus, gen. nov.

Head bi-impressed; impressions not divergent posteriorly; one supra-orbital seta on each side; eyes distant from buccal fissure beneath. Labrum truncate, 6-setose. Mandibles with a seta in scrobe of outer side. Mentum with sinus moderately deep, oblique on sides; a wide prominent median tooth. Ligula corneous, narrow, rounded at apex, bisetose in middle of apex; paraglossae narrow, free, hardly extending beyond ligula. Palpi stout; labial short; penultimate joint 2-setose in front, apical joint compressed, rather wide behind middle; maxillary with two apical joints short, wide at point of union; penultimate joint obconic, narrow at base, setose; apical joint angustate, obtuse at apex. Maxillae hooked, sparsely setose on inner side, outer lobe biarticulate. Antennae slender, not long; joints short, second and third about equal (third hardly longer than second): joints 4—10 oval, moniliform, equal; basal joint only glabrous. Prothorax broader than long; two short impressions on each side of base; border narrow, terminating at basal angles; two marginal setae on each side, posterior seta at basal angle. Elytra convex; base not bordered; humeral angles marked; lateral channel terminating at humeral angle; margin interrupted posteriorly and with an internal plica; eighth interstice carinate at apex, an apical striole along inner side of carina. Metepisterna short; metepimera narrow, not distinct. Ventral segments corneous, first narrowly dividing posterior coxae; segments 3—6 with an ambulatorial seta on each side near middle; apical segment in ♂ unisetose, in ♀ bisetose on each side. Tarsi with a few setae on upper surface; ♂.—Anterior short; two basal joints triangular, a little dilatate, triangularly produced at inner apical angle, squamose on lower side. Genotype, *P. globosus* Sloane.

I am not sure whether the New Zealand species which are now referred to *Oopterus* are actually congeneric with *Pterocyrtus*, but they are certainly very closely allied.

Table of Species.

1 (6) Eyes convex, prominent; elytra strongly convex on disc.
2 (5) Prothorax widest before middle; sides lightly sinuate near base; a prominent, narrow, submarginal ridge at base.
3 (4) Size major. Elytra decidedly striate on disc. Length, 5-5.5 mm. *striatulus* Sl.
4 (3) Size minor. Elytra smooth. Length, 3.2-4 mm. .. *tasmanicus* Cast.
5 (2) Prothorax widest at middle; sides obliquely narrowed to base (base wide); submarginal basal ridge short, wide, lightly raised. Length, 4.3-5 mm. .. .. *globosus* Sl.
6 (1) Eyes small, round, not prominent; elytra not strongly convex on disc. (Colour reddish, elytra strongly striate on disc). Length, 4 mm. *rubescens* Sl.

PTEROCYRTUS STRIATULUS, sp. nov.

Apterous, oval, robust, convex; head wide, front with two elongate, rather irregular, parallel depressions; prothorax subquadrate, wider across base (1.4 mm.) than apex (1.1 mm.), a submarginal carina on each side of base; elytra oval, convex, punctate-striate on disc, striae 5—7 faint. Black, with a narrow reddish margin at apex; legs and antennae piceous red.

Head large (1.15 mm. across eyes); frontal impressions parallel, not outturned posteriorly; one supra-orbital seta on each side behind the convex lateral space; eyes convex, rather prominent. Prothorax broader than long (1.3 × 1.7 mm.), widest before middle, strongly angustate to apex, obliquely narrowed to base; sides subsinuate just before base; basal angles rectangular; basal foveae deep, bi-impressed; base truncate, sloping slightly forward on each side; submarginal carina narrow, well developed; lateral channel narrow and deep towards base; a seta in channel at basal angle; border narrow, reflexed. Elytra much wider than prothorax (3.5 × 2.7 mm.), strongly rounded on sides; humeral angles prominent, shortly subdentiform; basal border obsolete, but closing lateral channel at humeral angles; scutellar striole wanting; four inner striae well marked on disc, weaker on apical declivity, eighth strongly impressed; interstices a little convex on disc, third finely 3-punctate beside third stria, eighth carinate towards apex, ninth narrow, depressed. Length, 5—5.5, breadth, 2.4—2.7 mm.

Hab.—Cradle Mountain (Carter and Lea). Several specimens.

Note.—A specimen in the Simson collection from the Blue Tier is 4.8 mm. in length, and has a similar prothorax, but the elytra less strongly striate.

PTEROCYRTUS (DRIMOSTOMA) TASMANICUS Castelnau.

Brown; head, prothorax and margin of elytra reddish. Length, 3.2, breadth, 1.5 mm.

Hab.—Blue Tier (Simson, No. 3121). Two specimens.

This is likely *Drimostoma tasmanica* Cast., but seems smaller than the type form. Bates referred it to *Oopterus*.

Three specimens were in the Simson Coll. under No. 3121, which are a little larger and black in colour. Length, 3.6—4 mm. I believe they must go under *P. tasmanica*.

PTEROCYRTUS GLOBOSUS, sp. nov.

Apterous, subglobose; head large, lightly bi-impressed; prothorax transverse, wider across base (1.5 mm.) than apex (1.1 mm.); elytra subglobose, substriate on disc, smooth towards sides. Black; elytra with narrow lateral and wide apical testaceous margin; legs and antennae reddish.

Head wide, convex (1.2 mm. across eyes); frontal impressions parallel, short; eyes convex, prominent. Prothorax convex, broader than long (1.3 × 1.7 mm.), broadest just before middle, strongly angustate to apex, gently obliquely narrowed to base; basal angles rectangular; base truncate; two short basal impressions on each side (inner foveiform, outer narrow); a short rather wide submarginal carina near each basal angle; posterior marginal seta in lateral channel at basal angle. Elytra subrotundate (3 × 2.6 mm.); three inner striae marked towards base, first entire, eighth strongly impressed; third interstice finely 3-punctate along third stria, eighth shortly carinate at apex, ninth narrow, placed at bottom of the lateral channel. Length, 4.3—5, breadth 2.3—2.6 mm.

Hab.—Cradle Mountain, Waratah (Carter and Lea). A good series of specimens.

Differs from the black species in the Simson Coll., which I have referred above to *P. tasmanicus* Cast., by form shorter; prothorax shorter, more transverse, more ampliate at widest part, wider across base, lateral basal impressions not so deep and more distinctly divided into two foveae, lateral basal carina shorter, more distant from, and less parallel to the margin; elytra more ampliate, inner striae more distinct, sides and apex with a much more distinct ferruginous margin. From *P. striatulus* Sl., it differs almost by the same characters as from *P. tasmanicus*, and has the elytra much less strongly striate.

PTEROCYRTUS RUBESCENS, sp. nov.

Oval, convex; head with frontal channels not divergent posteriorly; prothorax subquadrate, basal angles rectangular; elytra oval, convex, crenulate-striate on disc, humeral angles marked, scutellar striole wanting, basal border obsolete inwards from fifth interstice. Reddish, sometimes becoming brownish on disc of elytra.

Head convex (0.7 mm. across eyes); frontal channels wide, parallel, extending backward to level with base of eyes, not out-turned at posterior extremity; eyes not prominent, small, round, lightly convex; a narrow lateral sulcus passing above eye and extending behind eyes on each side of head. Prothorax broader than long (1 × 1.2 mm), broadest before middle, wider across base than apex; sides obliquely narrowed to base; apex truncate; base bisinuate (lightly rounded in middle, straight on each side); basal angles marked, rectangular, with summit blunted; border narrow; lateral basal impressions well marked; a short carina near each basal angle on inner side of marginal channel. Elytra oval (2.5 × 1.75 mm.), convex; five inner striae well marked on disc, becoming faint (except first) on apical declivity, lateral striae more feeble, eighth near margin; eighth interstice strongly carinate at apex, wide and declivous beneath this carina. ♂.—Tarsi with two basal joints dilatate, triangular at inner apical angle. Length, 4, breadth, 1.75 mm.

Hab.—Waratah (Carter and Lea).

Distinguished from other known Tasmanian species by eyes smaller, more depressed; form less robust; elytra much less convex and ampliate; colour reddish brown, &c.

Tribe **Trechini**.

Genus Trechus.

(*Sporades* Fauvel = *Trechodes* Blackburn.)

Table of Australian and Tasmanian species.

1 (32) Prothorax with base truncate.

2 (3) Head narrow, hardly constricted behind eyes; eyes small, depressed. Black. Length, 5 mm. .. .. *leai* Sl.

3 (2) Head decidedly constricted behind eyes; eyes convex, more or less prominent.

4 (19) Elytra with third puncture of third interstice on apical declivity.

5 (14) Form depressed, or subdepressed. Colour black, or with indeterminate pattern.

6 (9) Elytra with punctures of third interstice not interrupting the interstice. (Apical striole continuous with fifth stria. Black.)

7 (8) Elytra with border extending inwards on base to first interstice. Length, 5.7 mm. .. .. *pacificus* Sl.

8 (7) Elytra with border not extending inwards on base past third interstice. Length, 6.5-7 mm. .. .. *robustus* Sl.

9 (6) Elytra with anterior puncture of third interstice interrupting the interstice, or beside fourth stria.

10 (11) Elytra with interstices depressed. Piceous. Length, 5-5.5 mm. *diemenensis* Bates.

11 (10) Elytra with interstices convex. Bicolorous species.

12 (13) Prothorax with basal angles acute, preceded by a short sinuosity; elytra with basal border reaching first interstice. Length, 5.5 mm. *victoriae* Blackb.

13 (12) Prothorax with basal angles subrectangular, obtuse, not preceded by a sinuosity; elytra with basal border not reaching inward beyond fourth interstice. Length, 3.8 mm. .. .. .. *castelnaui* Sl.

14 (5) Form convex, elytra oviform. Black, elytra with a transverse fascia of testaceous maculae on posterior half, sometimes also a testaceous post-humeral lunule.

15 (16) Elytra without post-humeral maculae. Length, 4.3 mm *subornatellus* Blackb.

16 (15) Elytra with post-humeral maculae.

17 (18) Elytra strongly striate on disc, striae 2-4 strongly impressed on apical declivity; anterior discal puncture near third stria. Length, 3.3 mm. .. .. *carteri* Sl.

18 (17) Elytra substriate, striae 2–4 obsolete on apical declivity; anterior discal puncture near fourth stria. Length, 4.2 mm. .. .. *coxi* Sl.

19 (4) Elytra with third puncture of third interstice distant from apex, not on apical declivity.

20 (23) Elytra with striae 1–7 deeply impressed; interstices convex.

21 (22) Colour black, legs piceous. Length, 4 mm. .. .. *austrinus* Sl.

22 (21) Colour piceous-testaceous, femora testaceous, tibiae light brown. Length, 3.8 mm. .. .. *simsoni* Blackb.

23 (20) Elytra striate on disc, striae becoming obsolete towards sides; interstices depressed.

24 (27) Elytra piceous-black, with a testaceous, post-humeral macula on each elytron.

25 (26) Prothorax with basal angles acute, preceded by a sinuosity. Length, 3.4 mm. .. .. *longinotatus* Sl.

26 (25) Prothorax with basal angles obtuse, not preceded by a sinuosity. Length 3.7 mm. .. .. *brevinotatus* Sl.

27 (24) Elytra black, without post-humeral maculae.

28 (31) Prothorax with sides obliquely narrowed to base; basal angles marked and with border prominent.

29 (30) Elytra subdepressed, sides lightly rounded. Length, 3 mm. *nitens* Putzeys.

30 (29) Elytra convex, sides strongly rounded. Length, 3.8 mm *blackburni* Sl.

31 (28) Prothorax with sides evenly rounded to base; basal angles obtuse, not marked nor with border prominent. Length, 3 mm. *tasmaniae* Blackb.

32 (1) Prothorax with base lobate.

33 (34) Prothorax with basal angles prominent, triangular, base truncate behind them on each side of lobe; each elytron with six punctate striae. Length, 4 mm. .. .. *baldiensis* Blackb.

34 (33) Prothorax with basal angles not prominent and triangular, base sloping behind them on each side of lobe; elytra with not more than three simple striae on each side of suture.

35 (36) Elytra with three inner striae marked. Length, 4 mm. *macleayi* Sl.

36 (35) Elytra unistriate on each side of suture.

37 (38) Head wide; prothorax transverse, depressed, lateral margin and channel wide, elytra depressed. Length, 3.5–4 mm. *bipartitum* Macleay.

38 (37) Head narrow; prothorax globose, lateral margin and channel narrow; elytra convex, a deep transverse-oblique foveiform impression at position of anterior discal puncture. Black, nitid. Length, 2.8 mm. .. .. *gibbipennis* Blackb.

I sent specimens of *Bembidium bipartitum* Macl., to Dr. R. Jeannel, of Toulouse, the present authority on the tribe Trechini, and have been informed by him that it belongs to *Sporades* of Fauvel (genotype, *S. serpunctatus* Fauv., New Caledonia), a genus which Dr. Jeannel informed me has also been found in the Oriental Region, and in East Africa. The genus *Trechodes*, founded by Blackburn on his *Bembidium secaloides*, must become a synonym of *Sporades*, for the only difference I can note between *Bembidium bipartitum* Macl., and *B. secaloides* Blackb., is one of colour (*B. bipartitum*, elytra piceous, head and prothorax red; *B. secaloides*, upper surface wholly piceous). The genus *Trechus* as used in this paper will include *Sporades* as a subgenus.

Blackburn has tabulated the Australian and Tasmanian species of *Trechus* known to him (Trans. Roy. Soc. S. Aust., 1901, p. 117). My idea of the genus is wider than his, as including his *Trechodes*, and the table given above is on quite different lines from his.

Macleay has described as belonging to the genus *Trechus*, four species which must be excluded from it. These are *T. ater*, *T. atriceps*, and *T. concolor*, which are Harpalids, and *T. rufilabris* which is a species of *Perigona*.

To render my work more complete I have included in the table the species of the mainland, and have described a new species (*T. castelnaui*) from Victoria.

TRECHUS LEAI, sp. nov.

Elongate-oval, convex; head narrow, eyes small, depressed; prothorax broader than long, base truncate, basal angles obtuse; elytra oval, fully striate, eighth interstice narrow and raised at apex. Black; legs, antennae, and mouth-parts reddish.

Head convex, elongate (0.9 mm. across eyes), hardly narrowed behind eyes; frontal impressions long, parallel, deep; eyes small, round, depressed; post-ocular parts of orbits very little swollen, longer than eyes. Prothorax convex, subquadrate (1.3 × 1.5 mm.), broadest before middle, wider across base than apex; sides lightly rounded, obliquely narrowed to base, border wide, reflexed, prominent at basal angles; lateral basal impressions short, rather narrow, separated from marginal channel by a raised space. Elytra strongly convex, oval (3.2 × 2.2 mm.); interstices convex on disc, third with a foveiform puncture about anterior third, and another puncture beside second stria on posterior declivity. Length, 5, breadth, 2.2 mm.

Hab.—Cradle Mountain (Carter and Lea). Unique.

This species is very distinct from all other described Tasmanian species. By the form of its head, prothorax, and elytra it is allied to *T. subornatellus* Blackb., but can be distinguished easily from that species by larger size; head narrower with less prominent eyes; elytra without a pattern, etc.

TRECHUS PACIFICUS, sp. nov.

Elongate-oval, subconvex; head ordinary, eyes prominent; prothorax short, wide truncate at base, basal angles obtuse but marked; elytra oval, fully striate, apical striole continuous with fifth stria, basal border extending inwards to scutellum. Deep black, nitid; femora piceous; tibiae and tarsi reddish.

Head wide (1.2 mm. across eyes), front strongly bi-impressed; lateral and median spaces convex; eyes prominent; post-ocular parts of orbits about half the length of eyes; labrum emarginate. Prothorax transverse (1.2 × 1.8 mm.), widest at middle, a little wider across base (1.45 mm.) than apex (1.3 mm.); apex lightly emarginate; anterior angles rounded; sides evenly rounded; border reflexed, prominent at basal angles; lateral basal impressions shallow, wide. Elytra oval (3.5 × 2.3 mm.), strongly striate; striae simple, eighth distinct; interstices depressed third 3-punctate (two anterior punctures foveiform, beside third stria, third on apical declivity beside second stria); interstices 6–8 united at apex to form a narrow pointed ridge. Length, 5.7, breadth, 2.3 mm.

Hab.—Strahan (Carter and Lea). Unique.

Allied to *T. robustus* Sl., but smaller; colour deeper black; femora piceous; eyes more prominent; post-ocular part of orbits smaller; prothorax proportionately wider, evenly rounded on sides, widest at middle, less emarginate on base, basal foveae shallower; elytra less convex, more decidedly bordered on base, border extending inwards past fourth interstice—(it is the only Tasmanian species showing this character).

Trechus robustus, sp. nov.

Elongate-oval, subconvex; head large, eyes prominent; prothorax short, wide, truncate-emarginate at base, basal angles obtuse; elytra oval, fully striate, apical striole continuous with fifth stria. Piceous, elytra rather iridescent: reflexed and inflexed margins of elytra, legs, antennae, and mouth-parts reddish.

Head wide (1.5 mm. across eyes); vertex convex; front bi-impressed; lateral and median spaces convex; eyes roundly prominent; post-ocular part of orbits large, two-thirds length of eyes; labrum emarginate. Prothorax transverse (1.5 × 2 mm.), broadest before middle, a little wider across base (1.6 mm.) than apex (1.5 mm.); apex emarginate; anterior angles obtuse; sides lightly rounded; border wide, reflexed; lateral basal foveae wide, short, strongly impressed, bordered along posterior margin. Elytra oval (4 × 2.5 mm), rather convex; striae simple, third 3-punctate (two anterior punctures beside third stria, third beside second stria just below beginning of apical declivity); interstices 6—8 united at apex to form a narrow ridge; border not extending on base inwards past fourth interstice. Length, 6.5—7, breadth, 2.5—2.7 mm.

Hab.—Zeehan (Coll. Simson, type); Waratah (Carter).

Two specimens have been examined; it is the largest Australian species of the genus, and is allied to *T. pacificus* Sl.; under the description of *T. pacificus* will be found a note of the most obvious differences between these two species.

Trechus diemenensis Bates.

[= *T. solidior* Blackburn (1901).]

Hab.—Launceston, St Mary's (Simson, No. 3045); Waratah (Carter and Lea). "In moss and lichens," Lea.

I obtained specimens of a species of *Trechus* in a damp decaying log at Marysville, Victoria, in January; it agreed with the description of *T. solidior* Blackb.; but to me, it seems conspecific with *T. diemenensis;* specimens from Dorrigo, N.S.W., are larger, more shining, and smoother towards sides of elytra, but do not seem specifically distinct.

Trechus castelnaui, sp. nov.

Broad, oval, subdepressed; head strongly bisulcate; prothorax transverse, wide across base; elytra fully striate, striae deep, disc bifoveolate on course of fourth stria, a hooked striole on each side of apex, marginal furrow and border not extending inwards along base beyond fourth interstice. Piceous; prothorax brown with disc piceous; elytra piceous, a lateral space and apex brownish testaceous (the lateral testaceous marking is a stripe occupying that part of seventh interstice opposite the interval between the discal foveae, and sending off a narrow transverse branch across sixth and fifth interstices just behind the level of the posterior fovea); femora brownish testaceous; tibiae, tarsi, and antennae brown; palpi testaceous.

Head large (0.8 across eyes); frontal furrows deep, curving outwards anteriorly and posteriorly; median space convex; eyes round, convex, coarsely faceted, orbits small behind eyes. Prothorax transverse (0.8 × 1.2 mm), subdepressed, wider across base than apex; sides lightly rounded, slightly obliquely narrowed to base; basal angles obtuse, subrectangular; base slightly obliquely truncate on each side, a little produced backward in middle; marginal channel wide; margin wide explanate and reflexed at basal angles; basal foveae deep, divided from margin by a narrow ridge; median line deeply impressed. Elytra widely oval (2.2 × 1.8 mm.), depressed on disc, decidedly declivous on sides, rounded at shoulders; striae deep, simple, first entire, curving round apex and extending forward opposite posterior extremity of sixth stria in a short deeply marked course hooked at extremity (about apical fifth); interstices rather irregular, convex towards sides, second wide towards apex, third ended considerably before apex by the union of third and fourth striae, interrupted by posterior discal fovea, fourth interrupted about basal fifth by anterior fovea. Length, 3.8, breadth, 1.8 mm.

Hab.—Victoria: Marysville and Warburton (Sloane).

One specimen obtained by me at Warburton, and another at Marysville in January, in damp, heavily wooded gullies.

Allied to *T. victoriae* Blackb., but differing by smaller size; darker colour; head less swollen at eyes; prothorax less rounded on sides, not sinuate before basal angles, these not acute; elytra similar, but with sculpture of the apical declivity different (*T. victoriae* without a hooked sublateral striole), marginal border not extending along base to peduncle as in *T. victoriae*. It is altogether different from *T. simsoni* Blackb., by facies; prothorax more transverse (not cordate), more widely margined; elytra more depressed, humeral angles more marked (in *T. simsoni* quite rounded off), anterior discal puncture interrupting fourth interstice, etc.

TRECHUS CARTERI, sp. nov.

Oval, convex; head large, eyes convex, orbits small behind eyes; prothorax subquadrate, base truncate, basal angles rectangular (a little blunted at summit); elytra oval, disc strongly striate, striae fainter towards sides.

Black; legs (tibiae darker than femora), base of antennae, and mouth-parts testaceous; prothorax piceous, reddish towards basal angles; elytra with yellowish markings as under:—(1) on apical margin and first interstice on apical declivity, (2) a post humeral oblique macula extending from fourth stria behind anterior discal puncture to margin, and reaching base at shoulder, (3) a small discal spot on third interstice at second puncture, (4) an irregular arcuate fascia from fourth stria to margin above apical declivity.

Prothorax broader than long (0.7 × 0.85 mm.), widest before middle, hardly wider across base than apex; sides lightly rounded, obliquely narrowed to base; lateral border not wide anteriorly, strongly reflexed towards base. Elytra widely oval (2 × 1.5 mm.), convex, four inner striae strongly impressed, eighth obsolete on sides, third interstice 3-punctate (two anterior punctures beside third stria, third on apical declivity beside second stria); eighth interstice carinate at apex, defined on inner side by the well marked apical striole. Length, 3.3, breadth, 1.5 mm.

Hab.—Cradle Mountain (Carter and Lea). Many specimens. "In moss and lichens," Lea.

Allied to *T. subornatellus* Blackb., from which it can be readily differentiated by size smaller; prothorax more strongly narrowed to base, border narrower; elytra with post-humeral maculae. From *T. coxi* Sl., which it resembles in pattern of elytra, it can be distinguished by smaller size; eyes smaller and less convex; prothorax much less transverse, more narrowed to base; elytra with striae strongly impressed on disc.

TRECHUS AUSTRINUS, sp. nov.

Elongate-oval, convex. Head rather wide, strongly arcuately bisulcate; prothorax subcordate, apex and base of about equal width, basal angles almost rectangular; elytra oval, strongly striate, seventh and eighth striae weak, interstices 1–5 convex, third interstice 3-punctate beside third stria, apical striole in line with fifth stria. Black, legs and antennae reddish.

Head large (0.8 mm. across eyes), obliquely narrowed behind eyes (continuously with slope of eyes); vertex convex; frontal sulci curved, decidedly divergent and defining orbits posteriorly; eyes prominent; mandibles prominent; labrum emarginate. Prothorax broader than long (0.85 × 1.15 mm.); apex lightly emarginate; anterior angles obtuse, a little prominent; sides lightly rounded; base truncate, sloping lightly forward at each side; basal angles, sub-rectangular, summit obtuse; border strongly reflexed, not wide, hardly wider towards base; lateral channel curving round at basal angles and uniting with bottom of basal impressions, these deep; median line strongly impressed. Elytra oval (2.5 × 1.6 mm.), convex; humeral angles rounded off, not marked; interstices 6–8 uniting to form a narrow carina at apex, this carina defined on inner side by a strongly impressed apical striole; posterior puncture of third interstice level with anterior end of apical striole. Length, 4, breadth, 1.6 mm.

Hab.—Great Lake. Unique in the Simson Coll.

A very distinct species, not nearly allied to any other yet found in Tasmania. If the sides of the prothorax are viewed from straight above they appear to be lightly sinuate before the basal angles; but, if looked at from the opposite side across the segment, this sinuosity (which is caused by a slight horizontal curve of the border) disappears.

TRECHUS SIMSONI Blackburn (1894).

Hab.—Thomas Plains (Simson, No. 3506).

TRECHUS LONGINOTATUS, sp. nov.

Oval, robust; head large, arcuately bisulcate; prothorax cordate, narrower across base than apex, sides sinuate posteriorly, basal angles acute; elytra widely oval, weakly striate, third interstice 3-punctate, posterior puncture above apical declivity. Black; elytra with a humeral lunule, inflexed margin, apex, a small ante-apical spot, and apical part of first interstice lurid-testaceous; antennae infuscate, base reddish; legs testaceous, tibiae and tarsi brown.

Head finely shagreened, large (0.7 mm. across eyes), strongly narrowed behind eyes); vertex convex; frontal sulci curved, strongly divergent posteriorly; eyes convex, rather small, a little prominent; post-ocular part of orbits about as long as eyes, curving continuously with eyes to head. Prothorax broader than long (0.7 × 1 mm.); apex lightly emarginate; anterior angles obtuse, bordered, a little prominent; sides lightly rounded anteriorly, shortly sinuate before base; basal angles acute; base truncate; border narrow, reflexed, very little wider at basal angles; lateral channel curving round at basal angles to form bottom of basal impressions, these well marked; median line well marked on disc. Elytra oval (2 × 1.1 mm.) subconvex; base wide; basal curve short; discal striae lightly impressed, first only entire; striae 6–8 obsolescent; recurved apical striole narrow. Length, 3.4, breadth, 1.4 mm.

Hab.—Ben Lomond, 5000 feet (Simson). Unique.

With *T. brevinotatus* Sl., this species forms a distinct group. Comparing these two species with *T. monolobus* Putz., and *T. scapularis* Putz., from Chili, species which also have post-humeral maculae, it is at once seen that there is little affinity towards the Chilian species. The Tasmanian species have the head narrower, more deeply bisulcate, eyes smaller and less prominent; elytra more striate, third puncture of the third interstice above the apical declivity. In *T. longinotatus* the elytra have, on each, a lurid testaceous humeral lunule extending from the sixth interstice at the humeral angle and curving inwards behind the anterior puncture of third interstice on to the fourth interstice, and there is an indistinct macula of a duller colour on the apical declivity beside the recurved striole.

Trechus brevinotatus, sp. nov.

Oval; head large, arcuately bisulcate; prothorax cordate, hardly narrower at base than apex, sides roundly narrowed to base, basal angles obtuse; elytra oval, lightly striate, interstices depressed, third 3-punctate beside third stria, posterior puncture above apical declivity. Piceous-black; vertex, sides and base of prothorax (narrowly), border, inflexed margin, and first interstice (especially behind middle) reddish; apex (rather widely), and a rotundate humeral spot outside fifth interstice lurid-testaceous; antennae infuscate, base reddish; legs testaceous; tibiae and tarsi brownish.

Head large (0.7 across eyes); vertex convex; frontal sulci deep, lightly divergent posteriorly; post-ocular part of orbits small (not half size of eye), strongly raised from head; eyes large, convex. Prothorax broader than long (0.7 × 1 mm.); apex truncate; angles obtuse, not prominent; sides lightly rounded; base truncate; angles obtuse; lateral border narrow anteriorly, a little wider near base; lateral channel wide; lateral basal impressions well marked; median line distinct. Elytra oval (2.2 × 1.5 mm.), convex (a little depressed near suture); base wide; striae 1—5 lightly impressed, 6—8 obsolescent. Length, 3.7, breadth, 1.5 mm.

Hab.—Great Lake (Simson). Unique.

Allied to *T. longinotatus* Sl., from which it differs decidedly by eyes larger and more convex, orbits less developed behind eyes, frontal sulci less divergent posteriorly; prothorax with anterior angles less prominent, sides not sinuate before basal angles, these obtuse; elytra with shoulders more rounded off, post-humeral maculae shorter, not reaching backwards as far as anterior puncture of third interstice. The apical declivity is of a rather lurid-testaceous colour, but the dark ground colour extends well down the declivity.

Trechus nitens Putzeys.

I have identified *T. nitens* Putz., from the description. Length, 3 mm.

Hab.—Mount Wellington (Lea); "in roots of grass at summit." Mr. Lea sent it to me, ticketed *T. tasmaniae* Blackb., which I believe to be an allied, but distinct, species.

Trechus blackburni, sp. nov.

Oval; head large; prothorax cordate; elytra rotundate-oval, convex. Black; inflexed margins of elytra, legs, mouth-parts, and antennae reddish.

Head ordinary (0.8 mm. across eyes). Prothorax cordate (0.8 × 1 mm.), widest before middle; base and apex of about equal width; sides rounded, obliquely narrowed to base; basal angles marked, obtuse; border strongly reflexed at basal angles; lateral basal impressions foveiform. Elytra widely oval (2.3 × 1.7 mm.), convex; base rotundate; disc striate; striae faint towards sides; apical striole in line with fifth stria (but not quite uniting with it); third interstice 3-punctate beside third stria, posterior puncture above apical declivity; interstices 6—8 uniting to form a ridge at apex. Length, 3.8, breadth, 1.7 mm.

Hab.—Cradle Mountain (Carter and Lea).

Allied to *T. nitens* Putz., which it closely resembles, but larger; prothorax more cordate; elytra more convex, wider, more strongly rounded on sides, more ampliate on each side of peduncle in a more evenly rounded curve. The wider, more convex, and more rotundate elytra are the most conspicuous differences. It differs from *T. tasmaniae* Blackb. by size larger; prothorax less rounded on sides, border prominent at basal angles, etc.

TRECHUS TASMANIAE Blackburn.

This species (as included in the table of species given above) has been identified from the description.

Hab.—Cradle Mountain (Carter and Lea).

TRECHUS BALDIENSIS Blackburn.

Hab.—Cleveland, Great Lake (Simson, No. 3312).

TRECHUS MACLEAYI, sp. nov.

Subdepressed; head wide, arcuately bisulcate, eyes prominent; prothorax subquadrate, base shortly lobate, posterior angles obtuse; elytra with three inner striae marked, others (including eighth) obsolete, recurved apical striole distinct, third interstice 3-punctate (two anterior punctures beside third stria, third puncture on apical declivity beside second stria), an elongate striole at base of first interstice, basal border reaching scutellum. Piceous; elytra with lateral channel, inflexed margin, and apex ferruginous; femora lurid-testaceous; tibiae and tarsi brown; antennae infuscate, basal joint reddish.

Head large (0.8 across eyes); frontal sulci deep, curved, strongly divergent posteriorly; median frontal space convex, not as wide as lateral spaces, these convex; supra-orbital punctures near eye, anterior set in a foveiform puncture; eyes hemispherical, large, prominent; postocular part of orbits laminate, strongly and abruptly raised from head. Prothorax broader than long (0.8 × 1 mm.), a little wider across basal angles than apex; anterior angles wide, rounded; apex truncate; sides lightly rounded; basal curve between posterior angles wide, bisinuate, curving forward from sinuosity to posterior angle on each side; basal lobe short, wide, rounded; lateral border narrow, rather widely reflexed beside basal angles; anterior transverse impression faint; base declivous on each side towards margin; posterior marginal seta on edge of border at posterior angle. Elytra subdepressed (2.5 × 1.7 mm.), laevigate outside discal foveae, wide at base; humeral angles rounded; sides subparallel (hardly rounded); two inner striae well marked, second not reaching apex, third faint. Length, 4, breadth, 1.7 mm.

Hab. Cleveland (Simson, No. 3504). Unique. Grampian Mountains, Victoria (Mr. Ejnar Fischer).

A very distinct species allied to *T. bipartitum* Macl., from which it differs by larger size; darker colour; prothorax with posterior angles far less marked; elytra with more than one stria on each side of suture.

TRECHUS GIBBIPENNIS Blackburn (*Trechodes id.* Blackb.)

Hab.—Lake District (Blackburn). Grampian Mountains, Victoria. Mr. Ejnar Fischer has given me a specimen which I consider to be *T. gibbipennis* Blackb. It is altogether different from any other species known to me.

Tribe **Bembidiini.**

Table of Tasmanian genera.

1 (4) Elytra with a scutellar striole at base of first interstice; anterior tibiae not oblique at apex.
2 (3) Clypeus decidedly obliquely narrowed to apex .. .. .. BEMBIDIUM.
3 (2) Clypeus short, wide, hardly narrowed to apex .. .. .. CILLENUM.
4 (1) Elytra without a scutellar striole; anterior tibiae oblique above apex externally .. .. TACHYS.

Genus BEMBIDIUM.

BEMBIDIUM DUBIUM Blackburn.

Hab.—Cleveland (Simson, No. 3505).

Genus CILLENUM.

CILLENUM MASTERSI Sloane.

I cannot differentiate specimens in the Simson collection from specimens from Sydney. Ilfracombe ("on beach," Simson).

Genus TACHYS.

Table of Tasmanian species.

1 (4) Elytra with a submarginal stria on middle of sides (indicated by some punctures in Tasmanian species).
2 (3) Elytra 6-striate; prothorax strongly rounded on sides. Length, 2—2.2 mm. .. .. *semistriatus* Blackb.
3 (2) Elytra 5-striate; prothorax lightly rounded on sides. Length, 2 2 mm. *flindersi* Blackb.
4 (1) Elytra with submarginal stria obsolete on sides.
5 (6) Form short, oval, very convex; prothorax not perceptibly narrowed to base; elytra laevigate, unistriate on each side of suture, unipunctate on disc, apical striole well developed. Length, 2.2 mm. *bifoveatus* Macl.
6 (5) Depressed; prothorax evidently narrowed to base; elytra bipunctate on disc, apical striole obsolete. Length, 1.5-1.7 mm. *captus* Blackb.

All these species also occur on the mainland.

TACHYS SEMISTRIATUS Blackburn.

Hab.—Strahan (Simson), Latrobe, Jordan River, Hobart, King Is. (Lea).

TACHYS FLINDERSI Blackburn.

Hab.—Jordan River (Lea).

TACHYS BIFOVEATUS Macleay.

Hab.—West Tamar (Simson).

TACHYS CAPTUS Blackburn.

Allied to *T.* (*Polyderis*) *brevicornis* Chaud., of the northern hemisphere. I have not seen it from Tasmania, but Mr. Lea has recorded it in his "List" of 1902.

Tribe **Pterostichini.**

Table of Tasmanian genera.

1 (8) Mandibles with a seta in scrobe of outer side. (Nomiini, Sloane, olim.)
2 (3) Elytra with eighth interstice not carinate at apex. .. MECYCLOTHORAX.
3 (2) Elytra with eighth interstice carinate near apex.
4 (5) Intercoxal part of mesosternum narrow and excised at apex, met-episterna elongate .. .. AMBLYTELUS.
5 (4) Intercoxal part of mesosternum wide and emarginate at apex, met-episterna short, quadrate.
6 (7) Antennae with third joint bearing a few fine setules besides usual apical setae .. .. PTEROGMUS.
7 (6) Antennae with third joint glabrous (except usual apical setae) .. .. PHERSITA.
8 (1) Mandibles without a seta in scrobe of outer side. (Pterostichini, *sensu stricto*.)
9 (24) Antennae with three basal joints glabrous.
10 (13) Ventral segments 4–6 transversely sulcate. (Scutellar striole of elytra, if present, at base of second interstice. Apterous.)
11 (12) Head with frontal sulci obsolete. (Elytra with three punctures on third interstice—all beside third stria.) .. .. SIMODONTUS.
12 (11) Head with strongly impressed divergent frontal sulci .. PROSOPOGMUS.
13 (10) Ventral segments without transverse sulci.
14 (21) Elytra with scutellar striole at base of first interstice.
15 (18) Apterous. (Elytra with third interstice punctate; met-episterna in Tasmanian species short.)
16 (17) Prothorax depressed across base, basal impressions wide, extending to lateral border .. .. RHABDOTUS.
17 (16) Prothorax with basal impressions narrow, distant from lateral border. NOTONOMUS.
18 (15) Winged. (Met-episterna elongate.)
19 (20) Elytra with third interstice 3-punctate (Two anterior punctures beside second stria, posterior puncture beside third stria) .. PSEUDOCENEUS.
20 (19) Elytra with third interstice impunctate .. .. CHLAENIOIDIUS.
21 (14) Elytra without scutellar striole. Winged.
22 (23) Elytra with third interstice unipunctate near middle, pro-episterna laevigate .. .. LOXANDRUS.
23 (22) Elytra with third interstice impunctate, pro-episterna striolate RHYTISTERNUS.
24 (9) Antennae with four basal joints glabrous. (Length exceeding 26 mm.) CATADROMUS.

I am now unable to support the separation of the genera with a seta in the outer scrobe of the mandibles from the great tribe Pterostichini: in the tribe Migadopini there is the genus *Rhytidognathus* with a mandibular seta, though usually it is wanting in the tribe, and many Broscides of Australia, Tasmania, and New Zealand are without the ordinary mandibular seta of the tribe Broscini.

Loxandrus gagatinus Castelnau was described from Tasmania, but I have not seen it.

Genus MECYCLOTHORAX.

MECYCLOTHORAX AMBIGUUS Erichson.

Hab.—Launceston, West Tamar, Evandale, Great Lake (Simson, Nos. 2493, 2612, 3473); King Is. (Lea); Cradle Mountain, Waratah (Carter and Lea). Occurs also in Australia (widely spread), and New Zealand.

Genus AMBLYTELUS.

Table of Tasmanian species.

1 (8) Upper surface unicolorous.
2 (7) Prothorax with basal angles obtuse, anterior marginal seta present.
3 (6) Prothorax with margin widely reflexed and bearing a seta at basal angles.
4 (5) Elytra with third, fifth, and seventh interstices seriate-punctate; striae strongly crenulate. Length, 7.5 mm. .. .. *striatus* Sl.
5 (4) Elytra with third and fifth interstices punctate, seventh impunctate; striae finely crenulate. Length, 8 mm. .. .. *simsoni* Sl.
6 (3) Prothorax with margin narrow and without a seta at basal angles. (Elytra with striae faint, or obsolete, third interstice only punctate). Length 7-8 mm. .. .. *niger* Sl.
7 (2) Prothorax with basal angles marked, anterior marginal seta wanting. (Third interstice of elytra impunctate.) Length, 4.5—5.5 mm. *placidus* Lea.
8 (1) Elytra black with two discoidal vittae and lateral margins testaceous. (Third, fifth and seventh interstices punctate, sutural black area reaching base.) Length, 8—11 mm .. .. *curtus* Fabr.

My conception of the genus *Amblytelus* includes *Dystrichothorax* of Blackburn, which I believe to have been differentiated generically from *Amblytelus* on insufficient grounds. I do not know *Dyscolus australis* Erichs., and *D. dilatatus* Erichs., in nature.

AMBLYTELUS STRIATUS, sp. nov.

Oval; prothorax a little wider at base (1.5 mm.) than apex (1.35 mm.), rounded on sides, basal angles obtuse, two marginal setae on each side; elytra oval, wide, strongly punctate-striate, interstices 3, 5, and 7 bearing a series of setiferous punctures. Black; femora reddish piceous; tibiae, tarsi, antennae, and palpi ferruginous.

Head large (1.5 mm. across eyes), obliquely narrowed behind eyes, convex posteriorly; occiput a little swollen behind eyes (beside posterior supra-orbital seta); front depressed; eyes large, protuberant. Prothorax broader than long (1.5 × 2.1 mm.), widest before middle, strongly roundly narrowed to apex, narrowed to base in a light curve; apex very lightly emarginate, bordered; anterior angles widely obtuse, not near neck; base arcuate, lightly sinuate on each side, bordered; lateral border wide, bearing a few fine setules near anterior angles besides two usual marginal setae. Elytra oval (5 × 3.5 mm.), convex; apical curve wide, sinuate at extremity of ninth interstice; border wide, reflexed; striae strongly crenulate. Tarsi with fourth joint of anterior wide, deeply excised; of intermediate deeply excised, lobes short, outer more prominent than inner; of posterior small, emarginate (not bilobed), outer side a little more prominent than inner. Length, 7.5, breadth, 3—3.5 mm.

Hab.—Great Lake (Simson). Three specimens.

In size and shape resembling *A. simsoni* Sl., but distinct by colour black; head larger; elytra more strongly striate, the striae more coarsely crenulate, seventh interstice well defined and seriate-punctate. It may be allied to *Dyscolus australis* Erichs., but does not agree with the description of that species by colour; form of prothorax (also basal angles and lateral basal impressions); elytra evidently far more strongly striate, etc.; in all the characters just mentioned it differs even more from the description of *D. dilatatus* Erichs.

Amblytelus simsoni, sp. nov.

Oval; prothorax cordate, rounded on sides; basal angles obtuse, two marginal setae on each side; elytra oval, wide, lightly punctate-striate (sixth and seventh striae faint or obsolete), third interstice with three punctures, fifth interstice with one or two fine punctures on disc, seventh interstice impunctate. Brown (head and prothorax piceous brown, elytra reddish brown); legs, antennae, palpi, and abdomen ferruginous (tibiae darker than femora); prosternum and mesosternum reddish piceous.

Head large (1.7 mm. across eyes), lightly angustate behind eyes; vertex convex; front depressed; eyes prominent. Prothorax broader than long (1.7 × 2.1 mm.); apex (1.5 mm.) a very little narrower than base; base arcuate, very lightly sinuate on each side; lateral border wide, cut obliquely behind basal angles; lateral basal impressions well developed, short, wide; median line lightly impressed. Elytra oval (5.4 × 3.5 mm.), convex; five inner striae well marked, fine, crenulate; interstices depressed. Met-episterna (without epimera) about as broad as long. Tarsi with fourth joint of anterior wide, deeply excised; of intermediate bilobed (outer lobe a little longer than inner); of posterior wide, emarginate, outer side produced into a short lobe. Length, 8, breadth, 3.5—3.8 mm.

Hab.—Tasmania (Simson, No. 3314). Three specimens. A fourth specimen is darker in colour, proportionately a little wider, and more decidedly striate, but seems conspecific. Ben Lomond, 4000 feet (Simson).

In the Simson collection this species was named *Dyscolus dilatatus* Erichson, but it does not at all suit the description of that species; attention may be drawn to the following differences from Erichson's description of D. *dilatatus*:—Colour not "*subaeneomicans*"; antennae and prosternum not testaceous; basal angles of prothorax not "*denticuli instar subprominulis*"; elytra not "*subtillissime obsoleteque striatis*." Erichson makes no mention of punctures on the third and fifth interstices in the description of *D. dilatatus*, and in all his descriptions of other Tasmanian Carabs these punctures are carefully recorded, when present. It may be near *D. australis* Erichs., but I cannot think it agrees with that species in colour—"*metallico-nitidus*"; it has not the basal angles of prothorax "*prominulis subrectis*"; and the elytra are too decidedly striate to be described as "*subtiliter obsoleteque punctato-striatis*."

Amblytelus niger, sp. nov.

Apterous, oval; prothorax of about equal width at base and apex, rounded on sides, basal angles not marked, anterior marginal seta present, basal seta wanting; elytra oval, wide, feebly striate, striae obsolete towards sides, eighth entire. Black; tibiae reddish piceous; tarsi and antennae reddish.

Head convex (1.5 across eyes), depressed between eyes, lightly and obliquely narrowed behind eyes; frontal impressions feeble; eyes protuberant. Prothorax broader than long (1.5 × 2 mm.), widest before middle, subdepressed; apex lightly emarginate, finely bordered; anterior angles obtuse, not near neck; lateral border narrow; lateral basal impressions wide, shallow. Elytra oval (4.4 × 3.5 mm.), convex; apical curve wide, a little sinuate at extremity of ninth interstice; sides a little narrowed to base; border rather wide, reflexed; interstices depressed, third with two or three fine punctures on disc. Met-episterna (without epimera) about as long as broad. Length, 7—8, breadth, 2.9—3.5 mm.

Hab.—Mount Wellington ("Summit," Lea). Ten specimens have been examined. Mr. Lea informed me it was found on trunks of trees.

A distinct species differing from all others described by the following characters in conjunction: colour black; prothorax rounded on sides, narrowly bordered; posterior marginal seta wanting; in no other species of *Amblytelus* known to me does this occur. Compared with *A. curtus* Fabr., the fourth joint of the tarsi is less strongly bilobed.

Amblytelus (Dystrichothorax) placidus Lea (1908).

It is a distinguishing character of this species to have the legs testaceous with the middle part of the femora black; the lobes of the fourth joint of the tarsi are equal. Length, 4.5—5.5 mm.

Hab.—Cradle Mountain, Waratah (Carter and Lea); King Is. (Lea). A large series of specimens was obtained by Messrs. Carter and Lea, some of which Mr. Lea recorded as found "on King William Pine."

Amblytelus curtus Fabricius.

A specimen (♀) from Launceston, 9.5 mm. in length, with the sutural black stripe of the elytra reaching the base, I cannot differentiate from the typical form of the mainland. Six other specimens (♂) are in the Simson collection, which, though smaller (6.7—8.5 mm.), must be taken to be conspecific with the larger specimen, from which they only differ by their smaller size; it would seem that Tasmanian specimens of *A. curtus* are of smaller average size than those of the mainland.

Hab.—Launceston, Brighton (Simson, No. 1368); Exeter (Carter).

Var. vittata Motschulsky.—A numerous series of specimens (16, ♂, ♀.) in the Simson collection seem to represent *A. vittatus* Motsch.; these specimens only differ from *A. curtus* Fabr., by having the eighth interstice black, as well as the sixth and seventh, leaving only a narrow testaceous margin the ninth interstice. It is doubtful whether this slight colour variety is deserving of a varietal name. Length, 8.5—11 mm.

Hab.—Launceston, Brighton, St. Patrick's River, Turner's Marsh, Avoca, Interlaken (Simson No. 1368).

Pterogmus, gen. nov.

Head convex, laevigate; frontal impressions strongly impressed, short, obliquely divergent backwards; two supraorbital setae on each side; a longitudinal border above base of antennae; eyes convex, strongly inclosed at base, distant from buccal fissure beneath. Labrum truncate, 6-setose. Clypeus with a setigerous foveiform puncture on each side. Mandibles stout, hooked, a seta in outer scrobe. Maxillae short; inner lobe hooked, not densely spinulose on inner side; outer lobe with two joints, apical joint stout. Maxillary palpi rather long; penultimate joint short, obconic, very sparsely setulose; apical joint stout, fusiform, sparsely setulose. Mentum with a short triangular median tooth. Ligula small, corneous, bisetose.

Labial palpi short; penultimate joint bisetose; apical joint short, subfusiform, rather ampliate at basal third, obtuse at apex, sparsely setulose. Antennae slender, compressed, not long; two basal joints glabrous; third joint one-half longer than second, longer than fourth, sparsely setulose. Prothorax lightly transverse, rounded on sides, subsinuate just before base; basal angles rectangular; posterior marginal seta wanting; a few fine punctures on each side of base. Elytra convex, fully striate; third interstice 3-punctate beside third stria; eighth interstice subcarinate towards apex; base bordered; margin interrupted by an internal plica towards apex. Met-episterna short, quadrate (including epimera hardly longer than broad). Ventral segments without a transverse sulcus; apical segment bisetose on each side in both sexes (in ♀ also with two other anteapical setae). Anterior tarsi in ♂ with three basal joints lightly dilatate and biseriately squamulose beneath.

Though the third joint of the antennae is sparsely setulose, and the penultimate joint of the maxillary palpi has some minute setules, this genus cannot be placed in the tribe Merizodini on account of the anterior tarsi in ♂ having three joints dilatate and biseriately squamulose beneath. I believe its position is beside *Phersita*.

PTEROGMUS RUFIPES, sp. nov.

Oval, convex; head strongly bi-impressed; prothorax subquadrate, punctulate and without a submarginal carina near basal angles, posterior marginal seta wanting; elytra strongly striate, bordered on base, third interstice 3-punctate beside third stria. Black; margin of elytra, legs, and antennae reddish.

Head wide (1.2 mm.) across eyes; vertex laevigate; frontal impressions deep, strongly divergent, attaining margin at middle of eyes, connected in front by a strong transverse line; spaces between border and frontal sulci convex; anterior supra-orbital seta situated at posterior extremity of frontal sulci. Prothorax laevigate, broader than long (1.4 × 2 mm.), widest just before middle, a little wider across base (1.5 mm) than apex (1.3 mm.); sides rounded, shortly sinuate before base; border narrow, continued strongly along base on each side; basal angles a little prominent, summit obtuse, inner angle well marked; median line distinct; lateral basal impressions narrow, well marked. Elytra oval (3.6 × 2.6 mm.), convex; humeral angles obtuse but marked (basal border a little raised above lateral border at junction); interstices a little convex, more strongly so on apical declivity; eighth interstice wide, strongly raised above ninth and with a narrow edge near apex, ninth narrow, seriate-punctate. Length, 5.5–6.5, breadth, 2.5–2.6 mm.

Hab.—Ben Lomond, 4000 feet (Simson No. 3124); Waratah (Carter and Lea). A good series of specimens was in the Simson Coll.

Resembles a species of *Abacetus*, or a rather convex species of *Simodontus* in general appearance. No marginal seta is present near the basal angles in any of the eight specimens before me.

Genus PHERSITA.

Believing that the validity of Castelnau's genus *Teraphis* cannot be maintained under the laws of nomenclature, owing to the previous use of *Therapis* (1816), and *Teraphus* (1864), I adhere to the change of name I proposed in 1903. I now prefer to consider *Drimostoma montanum* Cast., as the type of a section in the genus *Phersita* rather than to formulate a new genus for its reception: it does not belong to the genus *Drimostoma*. *Drimostoma helmsi* Sl., also represents a section of the genus *Phersita;* but if we examine many other genera we will find variations among the species as great as those between *Teraphis melbournensis* Cast., *Drimostoma montanum* Cast., and *D. helmsi* Sl.

Table of Australian and Tasmanian species.

1 (6) Antennae increasing in thickness to apex, joints 5—11 moniliform, compressed; elytra with humeral angles dentate; met-episterna (with epimera) longer than broad (epimera long).

2 (5) Prothorax with outer basal impression strongly impressed, third interstice of elytra bipunctate beside third stria.

3 (4) Prothorax with sides obliquely subsinuate to base, basal angles rectangular, not denticulate .. .. *melbournensis* Cast.

4 (3) Prothorax with sides arcuate posteriorly, very shortly sinuate just before base, basal angles denticulate .. .. *tasmanica* Sl.

5 (2) Prothorax with outer basal impressions obsolescent, elytra with third interstice impunctate .. .. *helmsi* Sl.

6 (1) Antennae setaceous, slender, joints 5—11 oblong, elytra with humeral angles marked but not dentate, met-episterna (with epimera) quadrate (epimera very short). (Form very convex, elytra with third interstice impunctate.)

7 (10) Prothorax with outer basal impression shallow and separated from inner impression.

8 (9) Form larger, less convex, elytra less ampliate on sides...Length, 7.5—8.5 mm. .. .. *montana* Cast.

9 (8) Form smaller, more convex, elytra more ampliate on sides. Length, 5.6—6.3 mm. .. .. *australis* Cast.

10 (7) Prothorax with outer basal impression deep, not separated from inner impression. Length, 6.7 mm. .. .. *convexa* Sl.

Note.—*Teraphis melbournensis* Cast. (= *T. argutoroides* Cast., from specimens in Howitt Coll.). *Drimostoma montanum* Cast. (= *D. alpestris* Cast.) I feel sure the synonymy given here is correct.

PHERSITA TASMANICA, sp. nov.

Oblong-oval; prothorax wide, wider at base (1.7 mm.) than apex (1.5 mm.); elytra ovate, strongly crenulate-striate, eighth interstice carinate towards apex, first interstice with a well marked short striole at base, third interstice bipunctate beside third stria, basal border acutely denticulate at shoulders. Ferruginous-brown.

Front strongly bi-impressed, impressions divergent backwards; eyes (with orbits) reniform; postocular part of orbits rather more than half the length of eyes, sloping obliquely to neck. Prothorax large (1.6 × 2.2 mm.), rather depressed; sides rounded, very shortly sinuate beside basal angles; anterior angles obtuse, bordered; base truncate, angles acute, subdentate; lateral margin rather wide, especially posteriorly; lateral basal impressions wide, sparsely punctulate. Elytra truncate-oval (4 × 2.6 mm.), lightly convex; interstices a little convex, seventh stria present as a row of closely placed punctures. Length, 7, breadth, 2.6 mm.

Hab.—Tasmania (Simson No. 3119). Several specimens.

Allied to *Ph. melbournensis* Cast., but eyes less globose and prominent, post ocular part of orbits longer, less abruptly raised from head; prothorax more rounded on sides, more depressed posteriorly, sinuosity of sides much shorter, denticle at basal angles more sharply marked; elytra with humeral tooth more prominent.

PHERSITA AUSTRALIS Cast.

Hab.—Tasmania (Simson, No. 3690). Unique.

PHERSITA CONVEXA, sp. nov.

Oval, convex; prothorax broader than long, roundly ampliate at middle, sides sinuate before basal angles, base deeply concave, punctate; elytra very convex, strongly crenulate-striate; scutellar striole wanting, interstices convex, third impunctate, eighth strongly raised above seventh stria and subcarinate at apex, ninth narrow, seriate punctate. Black; legs, antennae, and palpi red.

Head convex (1.5 mm. across eyes); frontal impressions parallel, wide, shallow; eyes prominent, distant from buccal fissure beneath, lightly inclosed at base. Prothorax broader than long (1.8 × 2.3 mm.), convex, declivous to base; sides rounded, shortly (but evidently) sinuate to base; basal angles rectangular, subdentate; base truncate above peduncle, sloping slightly forward on each side; basal area depressed, punctate; two impressions on each side, outer impression shorter than inner, space between these impressions depressed; median line distinct. Elytra oval (4 × 3.2 mm.), declivous to base, strongly declivous to apex; base wide, emarginate, bordered; humeral angles marked, not dentate; sides rounded. Length, 6.7, breadth, 3.2 mm.

Hab.—Zeehan (Simson, No. 2123); Strahan and Waratah (Carter and Lea). Eleven specimens have been examined.

Very closely allied to *Ph. australis* Cast., from which it differs by larger size, more convex form; the concavity formed by the bases of prothorax and elytra deeper and (on prothorax) more punctate; prothorax more ampliate on sides, basal impressions deeper, margin more strongly raised above the outer impression.

Genus SIMODONTUS.

Note.—I have identified with confidence *S. orthomoides* Chaudoir, as synonymous with *S.* (*Argutor*) *holomelanus* Germ. (*Hab.*—Mount Lofty Ranges, S. Aust.). *S. elongatus* Chaudoir, I believe to be a species found about Sydney, and in the Blue Mountains (*cf.* Sloane, Proc. Linn. Soc. N.S.W., 1899, p. 573); I have not seen it from Tasmania.

Table of Tasmanian species.

1 (4) Met-episterna elongate.
2 (3) Prothorax hardly narrowed to base; interstices of elytra depressed *australis* Dej.
3 (2) Prothorax evidently narrowed to base, elytra lightly striate *transfuga* Chaud.
4 (1) Met-episterna short .. .. *aeneipennis* Chaud.

SIMODONTUS AUSTRALIS Dejean.

7.5 × 3.1 mm. This species was not in the Simson Coll., but specimens ticketed "Tas." were sent to me from the South Australian Museum.

Note. Two specimens (♂) from Mr. Lea's collection ticketed "Hobart" are more elongate than *S. australis*, and have the elytra more strongly striate; more specimens would be needed to enable it to be properly studied.

Two specimens (♂) from Green Island are in the Simson Coll. numbered 2482; these have altogether the facies of *S. convexus* Chaud., but have the basal angles of the prothorax more marked. It seems conspecific with *S. convexus*, but I am not prepared to determine it.

SIMODONTUS TRANSFUGA Chaudoir.

I identify as *S. transfuga*, specimens in the Simson Coll. ("No. 3479"); it differs from *S. australis* Dej. by shape more elongate, more parallel; prothorax less transverse, more narrowed to base, more shortly narrowed to apex (in *S. australis* the prothorax is widest about middle, in *S. transfuga* a little before middle): elytra with humeral denticule more prominent, more opaque in ♀. *S. murrayanus* Blackb., very closely resembles *S. transfuga*, but has the humeral denticule of the elytra less developed.

Hab.—Brighton, Flinders Is. (No. 3479).

SIMODONTUS AENEIPENNIS Chaudoir.

Hab.—Brighton, Devonport (Simson): Stanley, King Is. (Lea). Also found in Victoria (Portland).

Genus PROSOPOGMUS.

My idea of the genus *Prosopogmus* includes Chaudoir's subgenera *Ceneus*, *Hormochilus*, and *Ophryosternus*.

Table of Tasmanian and Australian species.

1 (22) Elytra with eighth interstice free at apex, fifth and seventh inclosing sixth.
2 (19) Elytra with third interstice 3-punctate (anterior puncture beside third, two posterior punctures beside second stria).
3 (14) Legs red, femora sometimes piceous.
4 (9) Size large, 10.5—13.5 mm.
5 (8) Prothorax with basal angles well marked; elytra depressed on disc.
6 (7) Black. Length, 12—13.5 mm. .. .. *boisduvali* Cast.
7 (6) Head and prothorax bright green, elytra with eighth and ninth interstices green. Length, 10.5 mm. .. .. *harpaloides* Chaud.
8 (5) Prothorax with basal angles obtuse; elytra lightly convex on disc. Length, 11.5 mm. .. .. *leai* Sl.
9 (4) Size smaller, not exceeding 8.5 mm.
10 (13) Prothorax with basal angles rectangular; elytra with seventh and eighth interstices narrow, convex, subequal in width with ninth.
11 (12) Elytra with punctures of third interstice punctiform. Length, 7.5 mm. .. .. *austrinus* Sl.
12 (11) Elytra with punctures of third interstice foveiform. Length, 6.5 mm. *rubicornis* Sl.
13 (10) Prothorax with basal angles obtuse; elytra with eighth interstice much wider than ninth. Length, 7—8 mm. .. .. *tasmanicus* Sl.
14 (3) Legs testaceous.
15 (16) Elytra with interstices (including lateral ones) depressed. (Olivaceous, shagreened; prothorax not punctate near base; dorsal punctures of elytra interrupting the narrow third interstice.) Length, 7 mm. *yarrensis* Sl.
16 (15) Elytra with lateral interstices convex.
17 (18) Prothorax strongly punctate on each side of base. Piceous, elytra reddish near sides and on apical declivity. Length, 6.5 mm *punctiferus* Sl.

18 (17) Prothorax minutely punctate in lateral basal impressions. Piceous, elytra with sides (widely) and apex brownish yellow. Length, 7—8 mm. .. .. *forcipennis* Macl.

19 (2) Elytra with one or two punctures beside second interstice, (anterior puncture wanting).

20 (21) Prothorax hardly narrowed to base, sides not subsinuate posteriorly, basal impressions wide and shallow; elytra with only one puncture on third interstice (the posterior one). Length, 10.5 mm. *suspecta* Chaud.

21 (20) Prothorax decidedly narrowed to base, sides subsinuate posteriorly, two deep basal impressions on each side; elytra with two punctures on third interstice beside third stria. Length, 8.5—10 mm. *monochrous* Chaud.

22 (1) Elytra with seventh interstice inclosed at apex by sixth and eighth. (Met-episterna elongate.)

23 (26) Elytra with interstices nitid and strongly convex in both sexes.

24 (25) Prothorax with basal impressions impunctate. Length, 10—11.5 mm. *coracinus* Erichs.

25 (24) Prothorax with basal impressions punctate. Length, 7—8 mm. *occidentalis* Macl.

26 (23) Elytra with interstices opaque in ♀.

27 (28) Prothorax evidently narrowed to base; striole at base of second elytral interstice short. Colour atrous. Length, 9 mm. *namoyensis* Sl.

28 (27) Prothorax not evidently narrowed to base, striole at base of second interstice elongate. Colour of a somewhat bronzy or greenish tint.

29 (30) Antennae and tarsi ferruginous. Colour atrous, with slight metallic bronzed tint on elytra. Length, 7.5—9 mm. *oodiformis* Macl.

30 (29) Antennae and tarsi infuscate. Upper surface bluish green. Length, 7—8.5 mm. .. .. *delicatulus* Tschitsch.

Note.— *P.* (*Argutor*) *nitidipennis* Macl., is a species of *Prosopogmus*, but no specimen is available to me at present. *P.* (*Abax*) *reichei* Cast. is likely conspecific with *P. boisduvali* Cast. *P.* (*Harpalus*) *quadraticollis* Cast., I have not identified. *P. insperatus* Sloane is not now available for reference; the type is missing. All the species known to me as occurring in Tasmania are noted hereunder.

PROSOPOGMUS LEAI, sp. nov.

♀. Elliptical, lightly convex; prothorax subquadrate, base (3.2 mm.) much wider than apex (2.5 mm.), basal angles obtuse; elytra strongly striate, interstices not convex except towards apex, third interstice 3-punctate, shoulders dentate; met-episterna (with epimera) longer than anterior breadth; prosternum bordered at point. Black nitid.

Head convex (2.2 mm.) across eyes; frontal impressions not deep, divergent backwards; eyes inclosed behind, reniform (with orbits). Prothorax transverse (2.75 × 3.5 mm.), widest before middle, strongly narrowed to apex, lightly obliquely narrowed to base, impunctate near base; anterior margin bordered, hardly emarginate; base lightly emarginate in middle, truncate on each side; lateral border narrow; median line lightly impressed; inner basal impression shallow, sulciform, outer impression obsolete; posterior marginal puncture foveiform, a little distance from base. Elytra oval (6.7 × 4 mm.); third interstice with anterior puncture beside third stria, two posterior punctures beside second stria; eighth interstice free at apex, fifth and seventh inclosing sixth, ninth seriate-punctate, the punctures not interrupted in middle; striole at base of second interstice linear. Length, 11.5, breadth, 4 mm.

Hab.—Tasmania (Lea). Unique.

In size and general appearance more resembling *P. coracinus* Erichs. than any other species; but differing decidedly by frontal impressions weaker, eyes less convex, more strongly inclosed at base by orbits; prothorax with basal angles obtuse, outer basal impression obsolete; elytra with striae shallower, interstices much less convex, fifth and seventh inclosing sixth at apex, eighth free at apex, punctures of ninth not interrupted in middle.

Prosopogmus tasmanicus, sp. nov.

♂.—Parallel-elliptical; prothorax subquadrate, wider at base (2.1 mm.) than apex (1.7 mm.), bi-impressed on each side of base, basal angles obtuse, but marked; elytra striate, interstices depressed, third interstice 3-punctate, eighth free at apex; met-episterna (with epimera) longer than broad. Black; tibiae piceous red; tarsi and antennae red.

Head ordinary (1.6 across eyes), lightly bi-impressed. Prothorax broader than long (2 × 2.5 mm.); sides arcuate to apex, oblique to base; inner basal impression sulciform, outer foveiform; pore of posterior marginal seta distinct, between outer basal impression and basal angle. Elytra truncate-oval (4.5 × 3 mm.); humeral angle strongly marked, shortly dentate; interstices a little convex towards apex, third with anterior puncture beside third stria, two posterior punctures beside second stria, fifth and seventh inclosing sixth at apex; striole at base of second interstice short. Prosternum bordered at point, ventral segments smooth; ♂ with two, ♀ with four setigerous submarginal punctures at apex. Length, 7—7.7, breadth, 2.15—3 mm.

♀.—A little wider than ♂; prothorax with basal angles a little more obtuse; elytra slightly duller.

Hab.—Denison Gorge, Lottah, Zeehan, Mount Wellington (Simson, No. 3118); Devonport, Sheffield, Hobart (Lea).

The type is from Denison Gorge; two specimens (♀) in the Simson Coll. from Mount Wellington, have the prothorax with basal angles more obtuse than in the specimen (♀) from Lottah, and a specimen (♀) from Zeehan has the second, fourth, and sixth interstices of the elytra evidently wider than the third, fifth, and seventh; two specimens in Mr. Lea's collection from Devonport and Sheffield have the elytra more strongly striated than in the type. I believe all these specimens are referable to one species, but a good knowledge of numerous specimens from many localities in Tasmania is necessary before the question of its variations can be dealt with.

Prosopogmus punctiferus, sp. nov.

♂.—Elliptical-oval, subdepressed; prothorax subquadrate, wider at base (1.7 mm.) than apex (1.5 mm.), bi-impressed and punctate on each side of base, basal angles almost rectangular; elytra strongly striate, interstices convex on lateral and apical declivities, third 3-punctate, eighth free at apex; met-episterna (with epimera) longer than broad, without epimera hardly as long on inner side as at anterior margin. Head and prothorax shining bronzed-black; elytra piceous with faint bronzy tints on disc; lateral margin from seventh interstice and some obscure maculae on apical declivity brownish; undersurface black (including posterior coxae and base of posterior trochanters); antennae and palpi ferruginous; mandibles piceous red; four anterior coxae, femora, and apex of posterior trochanters testaceous; tibiae, tarsi, and four anterior trochanters ferruginous; extreme apex of femora and tibiae infuscate.

Head ordinary (1.3 mm. across eyes), lightly bi-impressed. Prothorax transverse (1.5 × 2 mm.), widest before middle; sides lightly curved to apex, oblique to base; apex lightly emarginate; base lightly emarginate in middle; basal angles marked, almost rectangular, obtuse at summit; base depressed, bi-impressed and covered with a decided puncturation on each side; a posterior marginal seta present just within basal angle. Elytra truncate-oval (3.6 × 2.3 mm.), lightly convex; second and fourth interstices wider than third; seventh and eighth interstices equal, convex, narrower than ninth; striole at base of second interstice elongate; punctures of third interstice interrupting its course. Length, 6.5, breadth, 2.3 mm.

Hab.—Waratah (Lea). Unique.

A distinct species differing from all others, except *P. yarrensis* Sl., and *P. foveipennis* Macl., by its testaceous legs; from *P. yarrensis* it differs greatly by colour; prothorax strongly punctate; elytra with interstices more convex, especially the narrower eighth. The specimen before me has a foveiform depression on the fifth interstice, half-way between the two posterior punctures of the third interstice.

PROSOPOGMUS MONOCHROUS Chaudoir.

(= *Hormochilus id.*, = *Eccoptogenius feronoides* Castelnau.)

Hab.—Launceston (Simson No. 2477); Hobart (Lea). Also found in the coastal districts of Victoria and N.S. Wales.

PROSOPOGMUS CORACINUS Erichson.

(= *Pterostichus id.*, = *Ceneus chalybeipennis* Chaudoir, = *Feronia vilis*.) Castelnau).

PROSOPOGMUS DELICATULUS Tschitscherine (1898). (*Feronia* (*Ophryosternus*) *ca.*)

Its most apparent differences from *P. oodiformis* Macl., a common species on the mainland, are its bluish-green colour, and infuscate tarsi and antennae.

Hab.—Launceston, East Tamar (Simson).

Genus RHABDOTUS.

RHABDOTUS REFLEXUS Chaudoir.

Pterostichus diemenensis Cast., is synonymous with *R. reflexus* Chaud., and I would reduce *R. floridus* Bates to a variety. Chaudoir described *R. reflexus* as black sides of prothorax subsinuate, basal angle rectangular; *R. floridus* Bates has similar angles, but is, as Bates says, "distinguished from *R. reflexus* by the rich, uniform, purple colour of the elytra." A specimen from Zeehan has head black, prothorax nigro-virescent, elytra purple; prothorax wider than usual at base, basal angles rather obtuse, sides curving very lightly to base. With the large series of specimens I have before me I cannot draw any definite line dividing *R. floridus* from *R. reflexus*; there seems every degree of variation of colour from the black specimens to the most highly coloured.

Hab.—*R. reflexus*, typical form: Mount Wellington, Ben Lomond, 4000 feet, Forester River (Simson). Var. *florida*: Zeehan, Strahan (Simson, Nos. 3040 3317, 3464); Cradle Mountain, Waratah, Magnet, Devonport (Lea).

Genus NOTONOMUS.

Table of Tasmanian species.

1 (4) Elytra deeply and fully striate, interstices convex, particularly at apex.

2 (3) Elytra with apical sinuosities obsolescent. Length, 15—20 mm. *politulus* Chaud.

3 (2) Elytra with apical sinuosities well marked, (third interstice inflated near apex, in ♀ protuberant; a triangular projection on lateral border on each side of apex in ♀). Length, 16.5—18 mm. *tubericaudus* Bates.

4 (1) Elytral striae (excepting eighth) faint or obsolete, interstices depressed.

5 (6) Elytra with lateral border narrow near base, basal border forming a blunt protuberance at humeral angles. Length, 13—16 mm. *chalybeus* Dej.

6 (5) Elytra with lateral border strongly reflexed near base, basal border uniting with lateral border at humeral angles without a marked prominence. Length, 16.5—18 mm. .. .. .. *philippi* Newm.

NOTONOMUS POLITULUS Chaudoir.

This species is widely distributed in Tasmania; specimens are in the Simson Coll. from Launceston, Denison Gorge, Ben Lomond (4000 feet), Forester River, Wynyard, Strahan, Zeehan, Mount Wellington (Nos. 3056, 3090), Flinders Is. (No. 2728). It occurs at Cradle Mountain, Waratah, Strahan (Carter and Lea). In the long series of specimens brought from Waratah by Mr. Lea in January, 1918, the number of punctures on the third interstice of the elytra varies from two to four; some specimens had the prothorax a little more narrowed to the base, and the elytra more rounded on the sides than usual, but all were evidently of one species.

NOTONOMUS TUBERICAUDUS Bates.

It is easy to distinguish the ♀ of this species from the ♀ of *N. politulus* Chaud., by the ante-apical protuberance of the third interstice of the elytra, and the triangular projection on the border near the apex; but to separate the ♂ is not so easy: the third interstice is a little swollen at apex, and the fourth interstice curves round the extremity of the third in a way it does not do in *N. politulus*: the lateral apical sinuosities also are more decided.

Hab.—Denison Gorge, Ben Lomond, 4000 feet (Simson, No. 3112).

NOTONOMUS CHALYBEUS Dejean.

Hab.—Stanley (Simson No. 3466); Strahan (Carter and Lea); King Is. (Lea).

NOTONOMUS PHILIPPI Newman.

Hab.—Flinders Is. (Simson 3478). Also common about Port Phillip.

Genus PSEUDOCENEUS.

PSEUDOCENEUS SOLICITUS Erichson.

(? = *Poecilus iridipennis* Cast., ? = *P. iridescens* Cast.)

Hab.—Launceston, Kelso, Evandale, Avoca, Great Lake (Simson No. 2896). Small specimens (length 8.5 mm.) from the Great Lake were numbered "3693," as distinct from *P. solicitus*; this form is more convex; prothorax shorter, more rounded on sides; elytra more strongly striate, interstices convex; there are, however, in the Simson Coll. specimens which link this slightly differentiated race with the typical form of the species; one would need to be more confident of the value of these apparent differences than I am to give a distinctive name to No. 3693 of the Simson Coll.

Genus CHLAENIOIDUS.

CHLAENIOIDUS PROLIXUS Erichson.

Hab.—Flinders Is. (Simson No. 2487).

Genus RHYTISTERNUS.

Table of Tasmanian species.

1 (4) Prothorax sinuate, or subsinuate before basal angles, these marked.
2 (3) Elytra with all striae distinctly marked, interstices convex at apex (seventh stria faint or obsolete for two thirds of its length). Length, 10—12 mm. .. .. *miser* Chaud.
3 (2) Elytra with five inner striae well marked, sixth and seventh faint or obsolete, except near apex. Length, 15—17 mm. *liopleurus* Chaud.
4 (1) Prothorax with sides arcuate to base, basal angles not marked. (Four inner striae well marked, striae 5—7 faint or obsolete, except towards apex.) Length, 14—17 mm. .. .. *cyathoderus* Chaud.

All these species are common and widely spread on the Australian mainland; only *R. cyathoderus* (No. 2176) was in the Simson Coll. The others are included here on the authority of Mr. Lea's "List" of 1902.

Genus CATADROMUS.

CATADROMUS LACORDAIREI Castelnau.

Hab.—Macquarie River, Tasmania (Simson). Generally distributed in Australia.

Tribe **Anchomenini.**

Table of Tasmanian genera.

1 (4) Mentum dentate; prothorax with a marginal seta at basal angles; outer lobe of maxillae biarticulate.
2 (3) Elytra with third interstice punctate, tarsi glabrous above, ungues simple .. .. ANCHOMENUS.
3 (2) Elytra with third interstice impunctate, tarsi setose above, ungues serrulate .. .. LAEMOSTENUS.
4 (1) Mentum edentate; prothorax without a marginal seta at basal angles; outer lobe of maxillae uniarticulate .. .. HOMOTHES.

ANCHOMENUS MARGINELLUS Erichson.

Hab. Evandale, East Tamar, Great Lake (Simson, No. 2876); Strahan, Waratah (Carter and Lea).

LAEMOSTENUS COMPLANATUS Dejean.

Hab. Launceston (Simson). Introduced.

Genus HOMOTHES.

I now consider this genus to belong to the tribe Anchomenini, which is the position assigned to it by Erichson. It is certainly not a Lebiid, the anterior coxal cavities having a single opening inwards; the tarsal vesture of the ♂ is as in the Anchomenini, not as in the Odacanthini.

Note.—I would delete from the genus, and from the Australian fauna, *Homothes emarginatus* Chaudoir, which I have recognised from the description as a species of Celebes and Borneo; it requires a new genus.

Table of Tasmanian species.

1 (4) Prothorax arcuate-angustate to base, and with an evident juxta-basal sinuosity.
2 (3) Elytra sericeous-black, inflexed margins piceous; antennae with seventh and eighth joints albescent .. .. *elegans* Newm.
3 (2) Elytra sericeous-brown, lighter-coloured near margin, inflexed margins testaceous; antennae brownish . (Punctures of third and ninth interstices set in testaceous spots.) .. .. *guttifer* Germ.
4 (1) Prothorax obliquely angustate to base without evident juxta-basal sinuosity. (Punctures of third interstice not testaceous.)
5 (6) Elytra with interstices flat, striae shallow; elytra sericeous-black; femora testaceous with apex infuscate .. .. .. *sericeus* Erichs.
6 (5) Elytra with interstices rather convex, striae deep; elytra black, opaque; femora piceous .. .. *niger* Sl.

HOMOTHES ELEGANS Newman.

(? = *H. micans* Germ.).)

Hab.—Brighton, Roseberry, Strahan (Simson, No. 2613); Waratah, Bruni Is. (Lea). Common in S.E. Australia.

HOMOTHES GUTTIFER Germar.

Hab.—Launceston, Brighton (Simson, No. 2964). Very widely distributed on the mainland.

HOMOTHES SERICEUS Erichson.

(= *H. porricollis* Blackburn, = *H. vicinus* Sloane). I feel confident about this synonymy.

Hab.—Strahan (Simson). Ranges from Sydney to Perth on the mainland.

HOMOTHES NIGER, sp. nov.

Black, opaque; tibiae lurid.

Depressed. Head convex (1.5 mm. across eyes), lightly obliquely narrowed behind eyes. Prothorax shagreened, wider than head, cordate (1.4 × 1.7 mm.), widest and angulate at marginal seta, obliquely narrowed to base; sides not sinuate before base. Elytra oval (5 × 3.3 mm.), subsinuate-truncate at apex, deeply crenulate-striate; interstices opaque, shagreened, subconvex, a little transversely wrinkled, especially towards sides; third interstice 5-punctate. Length, 8.2, breadth, 3.3 mm.

Hab.—Cradle Mountain (Carter). Unique.

A very distinct species differentiated from all others by colour coal-black; femora black; elytra more strongly striate, etc. Its prothorax resembles that of *H. sericeus* Erichs., but is wider, and the sides are obliquely angustate to the base with a faint outward curve, not an inward curve as in *H. sericeus*.

Tribe **Ctenodactylini.**

This tribe has not hitherto been recognised as entering the Australian fauna, but *Plagiotelum opalescens* Olliff, is certainly a member of it, as is also *Plagiotelum irinum* Solier; these two species are, from comparison, truly congeneric

PLAGIOTELUM OPALESCENS Olliff.

Prothorax with a fine marginal seta just before middle, no seta near basal angles; elytra with two shallow discal impressions along course of third interstice (anterior impression considerably before, posterior just behind middle); anterior coxal cavity with a single opening inwards; mesosternum unusually narrow between middle coxae; apex of abdomen in ♂ 6-setose, in ♀ plurisetose; tarsi more or less setulose beneath in both sexes, particularly the bilobed fourth joint; ♂, anterior tarsi clothed beneath with long, not dense, griseous hairs, this setosity on second and third joints most developed towards sides, in middle of these joints two narrow rows of pulvilli; ungues pectinate.

Hab.- Waratah (Carter and Lea). Not uncommon on flowers of *Leptospermum*.

CARABIDAE BIPERFORATAE.

Tribe **Licinini.**

Table of Tasmanian genera.

1 (4) Mentum joining gula without support at base. Penultimate joint of labial palpi bisetose.
2 (3) Antennae with two basal joints glabrous .. .. LESTIGNATHUS.
3 (2) Antennae with three basal joints glabrous .. .. LACORDAIRIA.
4 (1) Mentum supported at base by a submentum. Penultimate joint of labial palpi plurisetose .. .. DICROCHILE

Genus LESTIGNATHUS.

Table of species.

1 (4) Elytra with two fine punctures on third interstice.
2 (3) Size major; elytra with apical curve even. Length, 13.5-15.5 mm. *cursor* Erichs.
3 (2) Size minor; elytra with apical curve strongly sinuate on each side. Length, 9.5 mm. .. .. *simsoni* Bates.
4 (1) Elytra with three or four foveiform punctures on third interstice. Length, 7.5 mm. .. .. *foveatus* Sl.

LESTIGNATHUS CURSOR Erichson.

This species is widely spread, and varies a good deal in size and appearance, some specimens being proportionately broader than others; the length varies from 13.5 to 15.5, and the breadth from 5 to 6.2 mm.; the prothorax varies from 3 × 3.1 to 3.3 × 3.5 mm. (in these measurements the length of the prothorax has been measured between anterior and basal angles, *i.e.*, at place of greatest length). The greater breadth of the prothorax and elytra in some specimens as compared with others is evidently not altogether a sexual difference, though generally narrow specimens are females. The specimens from the West Coast seem usually smaller than those from Denison Gorge and Ben Lomond.

Hab.- Denison Gorge, Ben Lomond, Zeehan, Strahan (Simson, No. 3114); Waratah, Mount Magnet (Lea).

LESTIGNATHUS SIMSONI Bates.

(Simson No. 3115.)

LESTIGNATHUS FOVEATUS, sp. nov.

Oval; prothorax bisetose on each side, posterior seta on edge of border a little before basal angle; elytra lightly striate, interstices flat, third with three or four foveae; antennae with two basal joints glabrous, third setulose; met-episterna short, transverse. Piceous black; lateral channel and inflexed margin of elytra testaceous; legs piceous; four anterior coxae, posterior trochanters, apex and base of femora, and tarsi lurid-testaceous; antennae infuscate.

Head small (1 2 mm. across eyes); labrum emarginate, with four submarginal setae. Prothorax broader than long (1.6 × 2 mm.), widest at anterior third, depressed, flat on each side of base; lateral basal impressions narrow, distant from lateral margin; sides rounded, strongly roundly narrowed to apex, narrowed in a gentle curve to base; apex feebly emarginate in middle; angles rounded off; border narrow, hardly more strongly reflexed at basal angles than on middle of sides, entire along anterior margin, obsolete only on middle of base. Elytra ovate (4.6 × 3.1 mm.); apical curve short, oblique, not perceptibly bisinuate; inner striae more or less interrupted near base; disc with a row of four equally spaced foveiform punctures on third interstice. Penultimate joint of maxillary palpi proportionately shorter, and terminal joints of both maxillary and labial palpi stouter than in *L. cursor* Erichs. Length, 7.5, breadth, 3.1 mm.

Hab.—Zeehan (Simson, type), Waratah, Strahan (Carter and Lea).

A distinct species, which differs decidedly from the other two species of the genus by the four large discal punctures of the third interstice of the elytra. As in *L. simsoni* Bates, the posterior marginal seta of the prothorax rises from a pore on the edge of the border a little before the basal angle; in *L. cursor* the post-marginal seta and its pore are obsolete. The prothorax is flatter and shorter than in *L. cursor*, therefore more resembling that of *L. simsoni*.

Genus Lacordairia.

Lacordairia calathoides Castelnau.

Oval, depressed Head small (1 mm. across eyes); antennae with three basal joints glabrous; labrum deeply triangularly excised, 4-setose; clypeus emarginate. Prothorax depressed, transverse (1.5 × 2.2 mm.), evidently wider across base than apex; derm finely shagreened; sides lightly rounded; apex lightly emarginate; angles obtuse; base truncate, curving lightly forward on each side, angles obtuse; basal area flat on each side; lateral basal impressions short, distinct; border entire, narrow on sides, bearing at basal angle a setigerous pore. Elytra ovate (4.2 × 2.9 mm.), depressed on disc, lightly declivous to basal border on each side of base, rather strongly declivous to apex, finely striate; interstices flat, third impunctate, eighth very wide; apical curve short, even. Black, nitid; antennae, tibiae, and tarsi ferruginous. Length, 7, breadth, 2.9.

Hab.—St. Marys (Simson, No. 3643). Unique.

I feel confident in identifying this species as *L. calathoides* Cast., and offer the above description to record some characters of importance not noticed by Castelnau. It differs from the Victorian species *L. argutoroides* Cast. (which also has the third interstice of the elytra impunctate) by femora piceous; form wider; prothorax broader with sides more evenly rounded; elytra much wider, more finely striate, eighth interstice wider, etc.

Genus Dicrochile.

Table of Tasmanian species.

1 (2) Prothorax with a deep concavity on each side, base bordered externally by the strongly upturned margin, basal angles marked; third interstice of elytra 3-punctate. Length, 15.5 mm. .. *quadricollis* Cast.

2 (1) Prothorax flat on each side of base, the depressed area bordered externally by the lateral border, basal angles rounded; third interstice of elytra 2-punctate.
3 (6) Prothorax very broad; elytra with interstices convex, nitid in both sexes.
4 (5) Elytra with striae crenulate. Length, 14—15 mm. *goryi* Guer.
5 (4) Elytra with striae simple. Length, 12 mm. .. .. *brevicollis* Chaud.
6 (3) Prothorax lightly transverse; elytra with interstices depressed, opaque in ♀. Length, 12 mm. .. .. *minuta* Cast.

Note.—Bates reported *D. punctipennis* Cast., as a Tasmanian species received from Mr. Simson; perhaps this may be the same species which I have identified as *D. quadricollis* Cast.

DICROCHILE QUADRICOLLIS Cast.

♂. Black. Head large. Prothorax subquadrate (2.5 × 3.6 mm.), widest before middle; base and apex of equal width (3 mm.); sides subsinuate posteriorly; basal angles marked; a concavity on each side of base extending to the strongly upturned margins. Elytra wide, strongly striate; striae simple; interstices hardly convex, third 3-punctate. Ventral segments 3—5 setigero-punctate. Length, 15, breadth, 6 mm.

Hab.—Flinders Is. (Simson, No. 2375). Also found in Victoria.

I unhesitatingly identify this species as *D. quadricollis* Cast.; it is conspecific with specimens in my collection from Mooroolbark (eastward of Melbourne). In the ♀, the ventral segments are without setigerous punctures.

DICROCHILE GORYI Guerin.

Hab.—Falmouth (Simson). Very widely spread in Australia.

DICROCHILE BREVICOLLIS Chandoir.

Hab.—Great Lake (Simson). Widely spread in Australia.

DICROCHILE MINUTA Castelnau.

Hab.—Hobart (Lea); Epping (Griffith). In a note, Mr. Lea says, "Found by Mr. Griffith flying plentifully in Epping Forest at dusk." Common and widely spread on the mainland. It may be noted that in all the specimens I have examined, only two punctures have been present on the third interstice of the elytra, though Castelnau gives the number as three.

Tribe **Oodini.**

Genus OODES.

OODES MODESTUS Castelnau.

Hab.—Evandale (Simson, No. 3502).

Genus COPTOCARPUS.

COPTOCARPUS AUSTRALIS Dejean.

Hab.—Launceston, East Tamar, Evandale (Simson).

Tribe **Tetragonoderini.**

Genus SAROTHROCREPIS.

Lebiomorpha (gen. incd.) Chandoir. *Ectroma (nom praeoc.)* Blackburn.

I have found the characters on which Blackburn sought to establish his genus

Ectroma elusive; and, though the species on which Blackburn founded this genus (genotype, *Lebia civica* Newm.), might be put in Chaudoir's suggested genus *Lebiomorpha* (genotype, *L. civica* Newm.), as has been done by me in the past, it now seems better to follow Macleay and refer them to *Sarothrocrepis*, *sensu lato*.

Table of Tasmanian species.

1 (10) Fourth joint of all tarsi bilobed.
2 (7) Size large. Length, 7.5 mm., or over.
3 (6) Prothorax testaceous.
4 (5) Elytra with interstices 6—8 infuscate to base, base also infuscate. Length, 9—10 mm. .. .. *calida* Newm.
5 (4) Elytra testaceous on basal third, and with a large, ante-apical, black area. Length, 7.5—8 mm. .. .. *posticalis* Guer.
6 (3) Prothorax and elytra piceous (or black) with wide, testaceous, lateral margins. Length, 7—8 mm. .. .. *luctuosa* Newm
7 (2) Size small, less than 6 mm. in length.
8 (9) Head testaceous, elytra black with post-basal plagae, lateral margins, and apex testaceous .. .. *benefica* Newm.
9 (8) Head and prothorax black, elytra black with testaceous post-basal plagae .. .. *civica* Newm.
10 (1) Tarsi with fourth joint bilobed on four anterior tarsi, simple on posterior tarsi.
11 (12) Elytra testaceous, four basal black spots and a wide, post-median, black area extending across elytra—only lateral border and inflexed margins excepted .. .. *gravis* Blackb.
12 (11) Elytra testaceous, two basal black spots on fourth and fifth interstices, and a narrow irregular black fascia above apical declivity (its anterior margin deeply emarginate). (Sometimes the fascia continuous across six inner interstices, sometimes it is obsolete on fifth interstice and its usual apex appears as a small black spot just before the middle of the length of the sixth interstice—typical form.) *inquinata* Erichs.

Sarothrocrepis calida Newman.

(= *S. infuscata* Sloane, Proc. Linn. Soc. N.S. Wales, 1916, p. 206.)

Mr. H. E. Andrewes, to whom I sent specimens, has compared *S. infuscata* with the type of *Lebia calida*, in the British Museum, and has informed me that it is the same species. I believe it is distinct from *S. corticalis* Fabr.

Hab.—Launceston, Brighton, St. Patrick's River, Mole Creek (Simson, No. 2486); Burnie, Sheffield (Carter and Lea). Also found in the mountains of S.E. Australia.

Sarothrocrepis posticalis Guerin.

[= *S. suavis* Sloane (*non* Blackburn), Proc. Linn. Soc. N.S. Wales, 1917, p. 423.]

I formerly took this species for *S. suavis* Blackb., from which it differs by the sharply marked basal angles of the prothorax. Testaceous, with a large black patch on the apical half of the elytra. Length, 7.5—8 mm.

Hab.—Launceston, Brighton, Beaconsfield, West Tamar (Simson No. 2675). Also found in the mountains of S.E. Australia.

Sarothrocrepis luctuosa Newman.

Hab.—Brighton (Simson, No. 2676). Widely spread in the mountains of South-eastern Australia.

SAROTHROCREPIS BENEFICA Newman.

Hab.—Launceston, St. Patrick's River, Epping (Simson, No. 2490). Widely spread in Australia.

SAROTHROCREPIS CIVICA Newman.

Hab.—Launceston, West Tamar, Karoola (Simson, No. 3311). Widely spread in Australia.

SAROTHROCREPIS GRAVIS Blackburn.

Hab.—Denison Gorge (Simson). Mountains of Victoria and N.S. Wales.

SAROTHROCREPIS INQUINATA Erichson.

Hab.—Kelso "beach" (Simson).

Tribe **Lebiini.**

Table of Tasmanian genera.

1 (4) Tarsi with fourth joint bilobed.
2 (3) Labial palpi with apical joint stout, but not triangularly securiform XANTHOPHAEA.
3 (2) Labial palpi with apical joint securiform. (Tarsi glabrous.) TRIGONOTHOPS.
4 (1) Tarsi with fourth joint simple.
5 (10) Mesosternum narrow between intermediate coxae.
6 (9) Tarsi setulose on upper surface. Interstices of elytra setulose-punctate, third bearing at least three setiferous punctures.
7 (8) Palpi with penultimate joint long; intermediate tarsi in ♂ with two or three joints squamose beneath .. .. PHILOPHLOEUS.
8 (7) Palpi with penultimate joint short, intermediate tarsi in ♂ without squamae beneath .. .. AGONOCHILA.
9 (6) Tarsi glabrous on upper surface. Interstices of elytra laevigate, third bipunctate (anterior puncture on basal third beside third stria, posterior puncture about apical third beside second stria) DIABATICUS.
10 (5) Mesosternum wide between intermediate coxae.
11 (12) Eyes not enclosed at base in swollen orbits .. .. .. MICROLESTES.
12 (11) Eyes enclosed at base in swollen orbits .. .. ANOMOTARUS.

Genus XANTHOPHAEA.

Table of Tasmanian species.

1 (4) Tarsi with upper surface setose; antennae with basal joints setulose
2 (3) Form narrow, elongate (elytra, 5 × 3 mm.); elytra testaceous with a piceous vitta along sixth and seventh interstices. *infuscata* Chaud.
3 (2) Form oval (elytra, 4 × 3.2 mm.); upper surface piceous .. ..*setosa* Sl
4 (1) Tarsi with upper surface glabrous; antennae with three basal joints glabrous. Testaceous .. .. *brachinoderus* Chaud.

XANTHOPHAEA INFUSCATA Chaudoir.

Hab.—Launceston, Brighton, Beaconsfield, George Town (Simson, No. 2488).

XANTHOPHAEA SETOSA, sp. nov.

Oval; head obliquely and strongly narrowed behind eyes, antennae with three basal joints sparsely setulose; prothorax transverse, lateral margins explanate, reflexed, basal angles acute, surface sparsely setose, several long setae on anterior part of sides; elytra wide, ovate, interstices sparsely setigero-punctate; tarsi setose on upper surface, fourth joint deeply emarginate, ungues pectinate. Piceous; antennae and palpi ferruginous; legs ferruginous-yellow.

Head wide across eyes (1.5 mm.); vertex convex, setose; front wide, subdepressed; labrum rounded at angles, apex emarginate in middle, 6-setose, the setae submarginal; palpi stout, labial with apical joint stout, obliquely truncate from inner side, strongly rounded on external side; mentum with a strong median tooth. Prothorax broader than long (1.3 × 1.8 mm.), widest at anterior third, wider at base (1.4 mm.) than apex (1.2 mm.); apex lightly emarginate; anterior angles rounded; sides rounded on anterior two-thirds, subsinuate posteriorly and meeting base at right angles; basal angles acute, denticulate; base truncate on each side behind margins, a little produced backwards and truncate in middle; median line strongly impressed, the setae of the surface rising from punctures. Elytra ovate (4 × 3.2 mm.), lightly convex, widest a little behind middle, more narrowed to base than to apex, rounded on sides; apex emarginate at suture; outer angles widely rounded; setae of interstices sparsely and rather irregularly placed, rising from conspicuous punctures; striole at base of first interstice short. Abdomen setigero-punctate, in ♂ with one, in ♀ with two setae on each side of apex. Length, 7—8, breadth, 3.2—3.4 mm.

Hab.—Mount Wellington (Lea). Five specimens have been examined.

Thoroughly distinguished from all other species except *X. pilosula* Chaud., by its setose upper surface. *X. pilosula* is unknown to me in nature, but *X. setosa* differs greatly from the description of that species which is described as having the elytra narrower and more elongate than *X. vittata* Dej.; in *X. setosa* the elytra are much wider and more oval than in *X. vittata*.

XANTHOPHAEA BRACHINODERUS Chaud.

Hab.—Launceston (Littler). Also from Western Australia, South Australia, Victoria, and New South Wales.

Genus TRIGONOTHOPS.

TRIGONOTHOPS PACIFICA Erichson.

I have seen only this one species from Tasmania; it is a species which varies considerably in size and appearance; always in *T. pacifica* the base of the elytra is black.

Hab.—Launceston, Brighton, St. Patrick's River, Mole Creek (Simson, No. 2489).

Genus PHILOPHLOEUS.

Idius Chaudoir.

Table of Tasmanian species.

1 (6) Prothorax with more than one marginal seta anteriorly. Apex of abdomen plurisetose.

2 (3) Prothorax narrow, usually with three setae on each side (very rarely with two or four setae). Intermediate tarsi in ♂ with three joints squamose beneath .. .. *distinguendus* Chaud.

3 (2) Prothorax wide. Intermediate tarsi in ♂ with two joints squamose beneath.

4 (5) Size major (12 mm.). Prothorax lightly emarginate, three to five setae anteriorly on each side .. .. *eucalypti* Germ.

5 (4) Size minor (8.5—9 mm.). Prothorax deeply emarginate, two strong setae on each side distant from apex, several fine setules at apical angles. (Apex of abdomen in ♂ 4-setose on each side.) *myrmecophilus* Lea

6 (1) Prothorax with one marginal seta anteriorly.

7 (8) Black. (Apex of abdomen plurisetose.) .. .. .. *moestus* Chaud.

8 (7) Piceous, head prothorax (sometimes disc infuscate), margins of elytra, a discoidal plaga on each elytron, antennae, and legs testaceous.

9 (12) Prothorax deeply emarginate.

10 (11) Prothorax with basal angles rounded off, elytra 3-maculate. Apex of abdomen in both sexes 4-setose on each side .. .. .. *simsoni* Sl.

11 (10) Prothorax with basal angles marked, though obtuse; elytra bivittate, vittae uniting at apex, narrow or interrupted at apical third. Apex of abdomen in ♀ 2-setose on each side .. .. .. *obtusus* Chaud.?

12 (9) Prothorax lightly emarginate. (Elytra with two narrow pointed discoidal vittae. Apex of abdomen in ♀ 2-setose on each side.) *bivittatus* Sl.

Note.—I take the present opportunity of recording that on examining the type specimen of *P. ornatus* Blackb., it was evident that *P. truncatus* Sl. was the same species.

PHILOPHLOEUS DISTINGUENDUS Chaudoir.

This species is distinguished by having the elytral vittae usually short and pointed, rarely extending to the second puncture of third interstice; the typical form has generally three anterior marginal setae on the prothorax, rarely four, and in one Tasmanian specimen only two setae on each side.

Hab.—Turner's Marsh, St. Patrick's Plains, Mole Creek (Simson).

PHILOPHLOEUS EUCALYPTI Germar.

It can hardly be distinguished from *P. australis* Dej., except by the intermediate tarsi of ♂ having two, not three joints squamose beneath; this character I have found constant in *P. eucalypti* and *P. distinguendus* Chaud. I do not see any reasons for distinguishing the Tasmanian form by the varietal name "*tasmanica*," as suggested by Blackburn.

Hab.—Launceston, Brighton (Simson, No. 2485).

PHILOPHLOEUS MYRMECOPHILUS Lea.

Hab.—Mole Creek, Karoola (Simson).

PHILOPHLOEUS MOESTUS Chaudoir

(= *Idius id.* Chaud.)

Hab.—Great Lake (Simson).

PHILOPHLOEUS SIMSONI, sp. nov.

Oval, depressed; head depressed; prothorax deeply emarginate, posterior angles rounded off, two marginal setae on each side; elytra biplagiate on basal half; apical ventral segment in ♂ 3- or 4-setose, in ♀ 4- or 5-setose on each side; intermediate tarsi in ♂ with two basal joints squamose beneath. Head, disc of prothorax, tibiae, tarsi, palpi, antennae, and undersurface more or less ferruginous; femora and margins of prothorax testaceous; elytra piceous, a large elongate plaga extending from base to about half the length on interstices 3—5 of each elytron, a rather large common apical mark on interstices 1—4 (emarginate on anterior margin), and a narrow lateral margin testaceous.

Head wide (1.8 mm. across eyes), strongly obliquely narrowed behind eyes, finely shagreened and punctulate; eyes very prominent. Prothorax transverse (1.5 × 2.7 mm.); surface covered with fine setulose punctures; lateral margins wide, depressed; sides strongly rounded; base shortly lobate. Elytra quadrate-oval (4.6 × 3.8 mm.); striae obsolescent; base arcuate on each side, emarginate in middle. Length 8.5, breadth, 3.8 mm.

Hab.—Launceston, Kelso, Mole Creek (Simson, No. 2847).

I know of no described species attributed to *Philophloeus* which has the pattern of the elytra similar to that of *P. simsoni.* It is allied to *P. sydneyensis* Blackb., with which it agrees in apical emargination of the prothorax, and the two marginal setae; apex of abdomen 4-setose on each side in ♂; intermediate tarsi with two joints squamose beneath; but the pattern of the elytra is different; in *P. sydneyensis* the pale vittae reach the apex, where they unite. Compared with *P. myrmecophilus* Lea, the prothorax has the anterior angles less rotundate, not plurisetulose, the sides not with two or three setae anteriorly; elytra with shorter plagae, and apex testaceous in middle.

Philophloeus obtusus Chaudoir?

Two specimens (♀, No. 2674) are in the Simson collection without exact locality, which I identify as *P. obtusus* Chaud. Prothorax with two setae on each side; apex of abdomen in ♀ bisetose on each side; it resembles *P. simsoni* in pattern, but the testaceous plagae are more elongate, in one specimen attaining the apical macula, the prothorax is differently shaped, being less oblique and arcuate on each side of base, basal angles marked, but obtuse at summit and preceded by a light sinuosity. Length, 7—8, breadth, 3.5—3.7 mm.

Philophloeus bivittatus, sp. nov.

Oval, depressed; prothorax transverse, two lateral marginal setae on each side, basal angles obtuse; elytra bivittate, the vittae long, pointed, apex and ninth interstice piceous; apex of abdomen (♂) 2-setose on each side. Piceous; margins of prothorax (widely), vittae, lateral channel, border and inflexed margins of elytra, femora, middle of prosternum, and metasternum testaceous; head, antennae; mouth-parts, tibiae, and tarsi ferruginous; abdomen infuscate.

Head wide (1.65 mm. across eyes), shagreened, sparsely punctulate. Prothorax transverse (1.3 × 2.5 mm.); apex lightly emarginate; sides rounded, widely and obtusely subangulate at anterior marginal seta, oblique to base; basal angles obtuse; basal lobe short; base obliquely truncate on each side. Elytra oval-quadrate (4.3 × 3.4 mm.), finely and closely setulose-punctate, faintly striate; inner apical angles obtuse; base not roundly prominent on each side. Length, 7.5, breadth, 3.4 mm.

Hab.—Launceston (Simson). Two specimens.

Nearly allied to *P. confertus* Blackburn. From the Western Australian species which I identify as *P. confertus* it differs by ♂ with tarsal vesture on under side of three basal joints of intermediate tarsi; colour darker, especially prothorax not wholly testaceous; prothorax less transverse, less roundly narrowed anteriorly, anterior angles a little indicated, not so roundly obtuse. *P. confertus* has the apex of abdomen in both sexes bisetose on each side.

Genus AGONOCHILA.

Table of Tasmanian species.

1 (10) Prothorax transverse, strongly ampliate behind anterior angles. (Head short, eyes hemispherical.)
2 (5) Elytra with discal spots transverse, greatly reduced in length beyond fifth interstice.
3 (4) Prothorax with sides oblique to base, basal angles obtuse. Length, 5.5—6.5 mm. .. .. *curtula* Erichs.
4 (3) Prothorax with sides sinuate to base, basal angles rectangular. Length, 5 mm. .. .. *bimaculata* Sl.
5 (2) Elytra with discal spots variable, but not greatly reduced in length beyond fifth interstice.
6 (9) Prothorax ampliate and strongly rounded at widest part, evidently narrowed to base; sides subsinuate before base.
7 (8) Size major (7—7.5 mm.). Prothorax with one or two marginal setae before middle .. .. *plagiata* Sl.
8 (7) Size minor (4.5—5 mm.). Prothorax with one seta before middle *sinuosa* Chaud.
9 (6) Prothorax lightly rounded at widest part, obliquely narrowed to base. (Base wide; basal angles obtuse.) Length, 5—6 mm. *binotata* White.
10 (1) Prothorax lightly ampliate behind anterior angles. (Form rather elongate; elytra with narrow discal spots.)
11 (12) Size minor (4.5—5 mm.). Head short, eyes hemispherical *fenestrata* Blackb.
12 (11) Size major (5.5—6 mm.). Head longer, eyes prominent, but less than hemispherical.
13 (14) Prothorax with basal angles obtuse; anterior marginal seta at anterior third. Length, 5.5—6 mm. .. .. *biguttata* Chaud.
14 (13) Prothorax with basal angles sharply marked, anterior marginal seta behind anterior third. Length, 5.5 mm. .. .. .. *flindersi* Sl.

AGONOCHILA CURTULA Erichson.

(= *A. corticalis* Chaudoir.)

Hab. Launceston, Kelso, Beaconsfield, Avoca, Turner's Marsh, Epping, Interlaken (Simson, No. 2487); Wilmot, Waratah (Carter and Lea). Common in S.E. Australia.

AGONOCHILA BIMACULATA, sp. nov.

Depressed; prothorax transverse, lightly emarginate at apex, sides strongly ampliate at widest part, sinuate posteriorly, basal angles rectangular, lateral margins explanate, wide anteriorly; elytra widest behind middle, decidedly narrowed to base, puncturation rather coarse. Piceous; elytra 3-maculate, maculae testaceous, discal pair irregularly oval, extending across interstices 3—6, apical spot common to both elytra, wide, extending forward on third and fourth interstices.

Head punctulate, depressed (1.25 mm. across eyes); eyes hemispherical. Prothorax widely transverse (1 × 1.65 mm.); sides strongly rounded, subangulate beside anterior marginal seta; sides strongly sinuate posteriorly, meeting base at right angles; apex lightly and widely emarginate; base shortly lobate, cut sharply on each side; basal angles sharp, almost rectangular; disc a little convex, covered with small setulose punctures; margins wide, rugulose-punctate. Length, 5, breadth, 2.3 mm.

Hab.—Launceston (Simson).

Only the specimen on which the description is founded suits it in regard to the sharply rectangular basal angles of the prothorax; a second specimen (gummed on the same card with the type) has the prothorax similar, except that the ante-basal sinuosity of the sides is less developed, and the summit of the angles is a little obtuse; a third specimen (♂) resembling the second was numbered 3688; the pattern of the elytra in these three specimens is the same.

AGONOCHILA PLAGIATA Sloane.

Hab.—Sheffield. (Carter). I originally found this species on the trunks of *Eucalyptus coriacea* in N.S. Wales

AGONOCHILA SINUOSA Chaudoir.

Depressed; prothorax transverse, lightly emarginate at apex, base and apex of about equal width (1.1 mm.), basal angles obtuse, lateral margins explanate posteriorly, narrow anteriorly; elytra widest behind middle, a little narrowed to base, puncturation fine. Head rather dark red; prothorax ferruginous, sometimes slightly infuscate on disc; elytra piceous with testaceous markings, sometimes bimaculate on anterior half, and with an apical mark common to both elytra (trimaculate form), sometimes the two discal marks reach the apical one along the fourth, or fourth and fifth interstices (bivittate form); tibiae and antennae ferruginous, femora and basal joint of antennae testaceous. Length, 4.5—5 mm. The measurements of a specimen are:—Length, 5, proth., 1 × 1.5, el., 2.8 × 2.2 mm.

Hab.—Launceston (Carter); Hobart (Lea).

I have identified *A. sinuosa* Chaud., from the description of that author, which is insufficient. In pattern of elytra it is variable, so much so that it seems to me very probable that *A. vittula* Chaud., will prove to be the same. It was numbered 3315 in the Simson Coll., and under that number there was also a second specimen having the elytral pattern of the trimaculate form, but with the three spots much larger, prothorax with margins wide anteriorly; I believe this represents an undescribed species, but it could not be satisfactorily dealt with on a single specimen.

AGONOCHILA BINOTATA White.

After comparison of Tasmanian specimens with one from New Zealand, I consider the species the same; it has not yet been found on the mainland of Australia.

Hab.—Mole Creek (Simson. No. 2610).

AGONOCHILA FENESTRATA Blackburn.

Hab.—Tasmania (Simson. No. 2898). Widely spread on the mainland.

AGONOCHILA BIGUTTATA Chaudoir.

Hab.—Launceston (Simson, No. 2735). Widely spread on the mainland.

AGONOCHILA FLINDERSI, sp. nov.

Elongate. Prothorax subquadrate (1 × 1.4 mm.); sides lightly sinuate posteriorly; basal angles subrectangular, obtuse at summit. Elytra much wider than prothorax (3 × 2.3 mm.), resembling those of *A. biguttata*, but a little wider, very finely setulose-punctate. Head, prothorax, tibiae, tarsi, and antennae ferruginous; elytra piceous-brown, a nebulous elongate spot on disc of each elytron between anterior and second setiferous puncture of third interstice. Length, 5.5, breadth, 2.3.

Hab.—Flinders Is. (Simson, No. 3491). Two specimens.

Allied to *A. biguttata* Chaud., but differing by head and prothorax reddish; prothorax wider, anterior marginal seta further from apex, basal angles more decidedly marked; elytra proportionately wider, discal spots less clearly defined, the apical, light-coloured spot is wanting, but this often occurs in *A. biguttata*.

Genus DIABATICUS.

DIABATICUS AUSTRALIS Erichson.

Hab. Launceston, St. Marys, Flinders Is. (Simson, No. 2609).

Genus MICROLESTES ?.

Table of Tasmanian Species.

Elytra piceous, shoulders and usually an apical spot testaceous	*humeralis* Macl.
Upper surface black, elytra shining	*yarrae* Blackb.

MICROLESTES (?) HUMERALIS Macleay.

Hab.- Hobart (Lea).

MICROLESTES (?) YARRAE Blackburn.

Hab.—New Norfolk (Lea).

Genus ANOMOTARUS.

ANOMOTARUS AENEUS Macleay.

Hab.—Brighton, East Tamar (Simson, No. 2968).

Tribe **Pentagonicini**

Neck condyliform; eyes of ordinary size	PENTAGONICA.
Neck wide; eyes unusually large and prominent	SCOPODES.

Genus SCOPODES.

Table of Tasmanian species.

1 (10) Prothorax with two marginal setae on each side.

2 (3) Prothorax with posterior marginal seta at posterior angles, these not dentiform. Length, 6.5 mm. .. .. *tasmanicus* Bates

3 (2) Prothorax with posterior marginal seta on an ante-basal, triangular, dentiform prominence.

4 (9) Head with frontal declivity depressed, strongly shagreened; clypeus strongly shagreened, not divided from front by a deep transverse impression.

5 (6) Black (including legs and upper side of basal joint of antennae). Length, 5 mm. .. .. *boops* Erichs.

6 (5) Rather metallic, legs lurid or flavous.

7 (8) Legs lurid, antennae infuscate after third joint. Length, 4—4.5 mm. *sigillatus* Germ.

8 (7) Legs and antennae testaceous; (tarsi and sometimes antennae towards apex rather infuscate). Length, 5—5.5 mm. *flavipes* Black.

9 (4) Head with frontal declivity convex, not shagreened, clypeus with basal part raised into a convex transverse ridge, divided from front by a deep transverse impression. (Black, each elytron deeply 3-foveate.) Length, 3.6—5.5 mm. .. .. *aterrimus* Chaud.

10 (1) Prothorax strongly angustate to base without ante-basal prominence or posterior marginal seta. Length, 6 mm. .. .. *griffithi* Sl.

SCOPODES TASMANICUS Bates.

Hab.—Launceston, Denison Gorge, George's Bay, Deloraine, Strahan (Simson, No. 3116); Wilmot (Carter and Lea). Also found in Gippsland.

SCOPODES BOOPS Erichson.

Hab.—Launceston, West Tamar, Ben Lomond (5000 feet), Strahan (Simson, Nos. 3117, 3691); Cradle Mountain (Carter and Lea). Widely spread in Australia.

SCOPODES SIGILLATUS Germar.

(= *S. intermedius* Blackburn.)

Hab.—Evandale, Epping, Flinders Is. (Simson, No. 2971). Widely spread in Australia.

I think there is no doubt but that No. 2971 of the Simson Coll. is *S. intermedius* Blackb., but I cannot differentiate it from *S. sigillatus* Germ.

SCOPODES FLAVIPES Blackburn.

(= *S. lineatus* Lea.)

Hab.—Launceston, Golconda (Simson, No. 3507); Waratah (Carter and Lea); King Is. (Lea).

I have in my collection a specimen of *S. flavipes* Blackb., sent to me under that name by Mr. Blackburn, and a cotype of *S. lineatus* Lea, received from Mr. Lea, also several specimens from near Melbourne. With these materials before me I cannot differentiate *S. flavipes* and *S. lineatus*, therefore have felt compelled to unite them.

SCOPODES ATERRIMUS Chaudoir.

(= *S. sydneyensis* Sloane.)

Specimens which I obtained at Albany are the same as my *S. sydneyensis*; other specimens which I took in South-western Australia are the form with the head more rugulose, which I considered *S. aterrimus* in 1903; one of these specimens measures 5.5 mm. in length. With the data now available I consider one name sufficient for the species.

Hab.—Great Lake (No. I 1940, South Australian Museum); Launceston (Littler).

SCOPODES GRIFFITHI Sloane.

Hab.—Mount Wellington (Lea and Griffith).

Tribe **Pseudomorphini.**

Antennae short .. .. ADELOTOPUS.
Antennae long, slender .. .. SILPHOMORPHA.

Genus ADELOTOPUS.

Table of Tasmanian species.

1 (4) Prosternum not carinate.
2 (3) Prothorax with anterior angles prominent, triangular; upper surface impunctate. Elytra without post-basal pores. Length 7.5—8.5 mm. .. .. *haemorrhoidalis* Erichs.
3 (2) Prothorax with anterior angles not prominent, widely obtuse; upper surface minutely punctate. Elytra with two post-basal pores near scutellum. Length, 5.5—6.5 mm. .. .. *scolytides* Newm.
4 (1) Prosternum carinate. Length, 5.6 mm. (After Blackburn.) *tasmani* Blackb.

ADELOTOPUS HAEMORRHOIDALIS Erichson.

(= *A. inquinatus* Newman.)

Hab.—Kelso (Simson, No. 2611). Widely spread in Australia.

ADELOTOPUS SCOLYTIDES Newman.

What I consider the typical form has the elytra with a very narrow reddish apical edge (Strahan, Zeehan, Simson); other specimens are coloured like *A. haemorrhoidalis* Erichs. [Brighton (Simson); Parattah, Hobart (Lea).] Also found on the mainland.

Genus SILPHOMORPHA.

Tasmanian species.

Black, prothorax and elytra with a narrow reddish margin. Length, 8—9 mm. *decipiens* Westw.

Black. Length, 12—15 mm. .. .. *tasmanica* Cast.

Only *S. decipiens* Westw., was in the Simson Coll., numbered 2812, but without exact locality. *S. dubia* Cast., is conspecific with *S. tasmanica*, as I have ascertained from named specimens in the Howitt Coll. *S. decipiens* and *S. tasmanica* have a wide range on the mainland.

APPENDIX.

List of species now attributed to Tasmania, but of which I have not seen specimens from that island, or which have not been dealt with in this paper.

Species marked with an asterisk are only known to me by description.

Species marked with a note of interrogation are those which I believe to be doubtfully Tasmanian, and which might be deleted from the list of Tasmanian species till they are definitely reported from there.

?*Clivina lepida* Putz.
**Carenum politulum* Westw.
**Promecoderus modestus* Cast.
**P. subdepressus* Guer.
Diaphoromerus amaroides Cast.
?*D. australasiae* Dej.
?*Thenarotes discoidalis* Blackb.
**Harpalus vestigialis* Erichs.
**Bembidium hobarti* Blackb.
**Dyscolus (?) australis* Erichs.
**Dyscolus (?) dilatatus* Erichs.
**Idacarabus flavipes* Lea.
I. troglodytes Lea.
?*Simodontus elongatus* Chaud.
?*Simodontus orthomoides* Chaud.
**Loxandrus gagatinus* Cast.
?*Leptopodus subgagatinus* Cast.
**Homothes rotundatus* Blackb.
**Lacordairei anchomenoides* Cast.
**L. erichsoni* Cast.
**Dicrochile punctipennis* Cast.
**Xanthophaea angustula* Chaud.
**Trigonothops lineata* Dej
T. longiplaga Chaud.
**Diabaticus pauper* Blackb.
Cymindis illawarrae Macl
Pentagonica vittipennis Chaud.
**Adelotopus tasmani* Blackb.

Three other species recorded from King Island by Mr. Lea are not dealt with in this paper, viz., *Amblytelus brevis* Blackb., *Chlaenius australis* Dej., and *Trigonothops vittipennis* Sl.

ORDINARY MONTHLY MEETING.

28TH APRIL, 1920.

Mr. J. J. Fletcher, M.A., B.Sc. President, in the Chair.

Messrs. WILLIAM FARIS BLAKELY, Botanic Gardens, Sydney; ARTHUR NEVILLE ST. GEORGE HANDCOCK BURKITT, B.Sc., M.B., Lecturer in Anatomy, The University of Sydney; HARRY FLOCKTON CLARKE, The Hillside, View St., Chatswood; Rt. Rev. JOSEPH WILFRID DWYER, R.C. Bishop of Wagga; ALBERT H. ELSTON, 50 Lefevre Terrace, North Adelaide; ANTHONY MUSGRAVE, Wycombe Road, Neutral Bay; TORRINGTON HAWKE PINCOMBE, B.A., Public School, Mayfield, Waratah; and AUGUSTUS SELWYN TAYLOR, Geological Survey of N.S.W., Sydney, were elected Ordinary Members of the Society.

The President announced that the Council had elected Messrs. C. HEDLEY, F.L.S., W. W. FROGGATT, F.L.S., A. G. HAMILTON, and Professor H. G. CHAPMAN, M.D., B.S., to be Vice-Presidents; and Mr. J. H. CAMPBELL (Royal Mint, Sydney) to be Hon. Treasurer for the current Session, 1920-21.

The President announced that a Special General Meeting of the Society will be held on Monday, 14th June, for the purpose of celebrating the centenary of the birth of Sir William Macleay.

The President reminded members of the Council's invitation to subscribe towards the cost of the Honour Roll.

The President also reminded members of the Council's request that notices of exhibits should be curtailed and confined to the scientific significance of the objects exhibited.

The Donations and Exchanges received since the previous Monthly Meeting (31st March, 1920), amounting to 9 Vols., 49 Parts or Nos., 7 Bulletins, 4 Reports, and 8 Pamphlets, etc., received from 46 Societies and Institutions, and one private donor, were laid upon the table.

NOTES AND EXHIBITS.

Mr. Fred Turner exhibited a specimen of, and offered observations on, *Amarantus macrocarpus* Benth., which, after the January and February rains of this year, covered, with *Boerhaavia diffusa* Linn., thousands of acres of Wootton Station, Upper Hunter, to the exclusion of all other herbage, including many noxious exotic weeds which previously had been abundant. The first-named plant, locally known as "Boggabri," has been used for salad, for which it is considered superior to "water cress."

Several years ago the late Honble. G. H. Cox, M.L.C., brought to the exhibitor for identification from his station on the Liverpool Plains a specimen of *Stipa aristiglumis* F. v. M., that was nine feet six inches tall. That growth had resulted from heavy summer rains, and had completely suppressed thistles which had previously occupied thousands of acres on his property.

In the Brewarrina district some years ago, after summer rains, twenty-five thousand acres of land became densely covered with *Anisacantha muricata* Moq., where only a few plants of this species had previously been seen. During Mr. Turner's extensive travels over the country he had made a number of similar observations on the indigenous and acclimatised flora, and he purposed publishing these when time permitted.

Mr. J. L. Froggatt exhibited a specimen of *Martynia lutea* which has become a noxious weed in some country districts owing to the seeds becoming caught in the wool, or getting round the hocks of sheep or horses or cattle. Men employed in cutting the plants become extremely dizzy in the head after working on it for any length of time It is known locally as the "Ram's Horn" or "Devil's Grip." The specimen came from five miles south of Dalby, Queensland.

Mr. Walter W Froggatt exhibited, and read a note on, the identification of the Thrips damaging the tobacco in the Tamworth District as *Thrips striatus*, the "Grass Thrips" of the United States, not previously recorded from Australia; also other small Hemiptera infesting the leaves.

Mr. E. Cheel exhibited a leaf and fruits of *Pisonia Brunoniana*, together with an abstract from a letter received by Mr. Hugh Dixson, of "Abergeldie," Summer Hill, from Mr. R. E. Shaw, of Austinmer, as follows:—"A young lady was in the scrub yesterday, and noticed a little bird fluttering and being held captive, she thinking a large spider had caught it, but found it hopelessly stuck fast to the leaves of a tree by the gum exuded from the flower seed bud. She did her best to free the little creature, but some of the tail feathers held fast, and it got away, somewhat the worse for the encounter."

For previous records of this species trapping birds, etc., by the exudation of a viscid substance on the ribs of the fruits, see these Proceedings, 1915, p. 629.

A NEW GENUS OF AUSTRALIAN *DELPHACIDAE* (HOMOPTERA).

By F. Muir, F.E.S.

(*Communicated by E. W. Ferguson, M.B., Ch.M.*)

(With one text-figure.)

Very little is known of the Australian *Delphacidae*, and most, if not all, of the species recorded are from the Eastern States. The finding of an undescribed species from King George's Sound, South-west Australia, in the Macleay Collection at the Sydney University is therefore of interest.

I have proposed a new genus for this species for reasons stated below, and consider that it is entogenic. Of the fourteen genera, containing about fifty species, recorded as Australian, I consider only one, with one species (*Proterosydne arborea* Kirk.) can be regarded as entogenic, all the others being genera whose centres of density are situated outside of Australia, or they are so nearly allied to such genera as to demonstrate their origin clearly.

The character of the tibial spur places this genus in the Tropidocephalini. From *Tropidocephalus* it differs in having the head much more elongate and flattened laterally instead of horizontally. The Hawaiian genus *Dictyophorodelphax* Swezey is superficially like it, but belongs to the Alohini; the head is not flattened laterally and the tegmina are truncate at apex. The South African genus *Embolophora* Stal, I only know by the description. Stal sank it into *Liburnia* Stal, so for the present we must consider that it belongs to the Delphacini. The head is not so long as in *Pseudembolophora.*

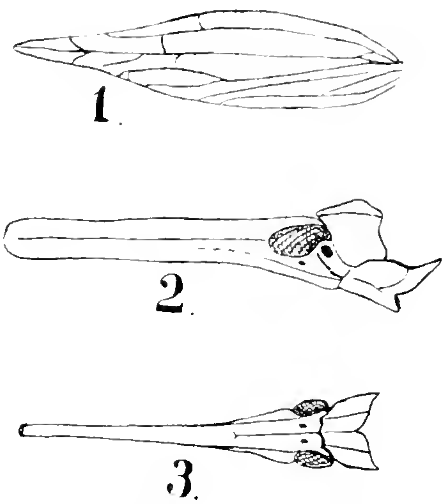
Pseudembolophora, n.g.

Type, *Pseudembolophora macleayi.*

Head very long and flattened laterally, three times as long as the pro- and meso-nota together; vertex narrower at apex than at base, a median carina on basal third after which it fades out; median frontal carina entire from base to apex, lateral carinae from base to eye, and another from near the eye to apex, a transverse carina on gena; eye oblong with a slight antennal emargination; clypeus in profile produced into a strong point in middle, tricarinate; antennae terate reaching slightly beyond apex of face, first joint about as long as wide, second joint twice the length of first, slightly enlarged to apex, arista apical. Pronotum tricarinate, lateral carinae very slightly diverging posteriorly, reaching the hind margin; mesonotum tricarinate. Hind femora short, reaching one-fourth from apex of abdomen in male and about one-half in female; tibiae longer than femora; tarsi shorter than tibiae, first tarsal joint subequal to the other two together; spur slightly shorter than first tarsus, cultrate, thick, slightly concave on inner surface, a strong tooth at apex but none on hind margin. Tegmina long and narrow, the apex produced to an acute point.

PSEUDEMBOLOPHORA MACLEAYI, n.sp.

Male.—Brachypterous; ochraceous or light brown, carinae of head and thorax lighter; dorsum of abdomen dark brown. Tegmina hyaline, veins and apex of tegmina brown the brown veins broken by small white dots. The pygofer cannot be made out very well as the specimen is carded and too old to relax and remount. The ventral edge of opening straight, the sides angular and curved in-



Pseudembolophora macleayi, n.sp.

1. Left tegmen.
2. Head and pronotum, lateral view.
3. The same, dorsal view.

ward; anal segment large with large anal style; genital styles small, slightly curved and gradually narrowed to a point. Length, 5.5 mm.; tegmen, 3 mm.

Female. Macropterous and brachypterous; similar in colour to the male. Pygofer large, ovipositor small, reaching about half way along pygofer; anal segment large, wider than deep, anal style large, narrowly oblong. Length, 6 mm.; tegmen, 4 mm.

Hab.—King George's Sound, South-west Australia.

The material consists of one carded male in good condition with tegmina but no wings, as is generally the condition of brachypterous Homoptera; two females, one on a pin in fairly good condition with tegmina and no wings, and one female on card with no tegmina but with wings present, but in a bad condition. This indicates that there are both macropterous and brachypterous forms, at least in the female sex. Whether the macropterous forms have a different shaped tegmen I am unable to say. There is also one nearly full grown nymph carded; the head is not so long proportionately and the tegmina pads are pointed at apex. All the material is in the Macleay Collection.

AN UNDESCRIBED SPECIES OF *CLYTOCOSMUS* SKUSE.

(Tipulidae, Diptera.)

By Charles P. Alexander, Ph.D., Urbana, Illinois, U S.A.

(*Communicated by R. J. Tillyard, M.A., D.Sc., F.L.S., F.E.S.*)

The genus *Clytocosmus* was erected by Skuse* to receive the remarkably beautiful new species of crane-fly, *Clytocosmus helmsi*, from Mt. Kosciusko, New South Wales. The genus has remained monotypic until the present day. Through the kindness of Dr R. J. Tillyard, I am now able to describe a second species, a superb fly from the Dorrigo Tableland, about three hundred miles north of Sydney. Some time ago Dr. Tillyard wrote me that he had once found a magnificent crane-fly in the Northern scrubs with much the general appearance of a great robber-fly. The only specimen then in his possession was an injured female in rather poor condition to be made a type. An effort was made to secure additional specimens during March and April, 1919, when the insect was due to appear on the wing, but a prolonged drought, followed by floods, badly damaged the habitat frequented by this fly, and it was impossible to secure more material at this time. Dr. Tillyard has kindly sent me the unique specimen above discussed, and it is made the type of the new species described herewith. It is with great pleasure that this exquisite creation is dedicated to Dr. Tillyard, through whose kindly interest the species was first made known to science. The type has been returned to Dr. Tillyard, and will ultimately be placed in the Australian Museum with the Skuse types.

The two known species of *Clytocosmus* may be separated by means of the following key:—

Prothorax black; mesonotal praescutum orange with a black spot anteriorly; pseudosutural foveae black; scutellum and postnotum velvety black; thoracic pleura velvety black with brown and white spots; abdomen velvety black with white spots, only the genital segment reddish fulvous . . . . *helmsi* Skuse.

Prothorax orange; mesonotal praescutum orange without black markings; pseudosutural foveae orange; concolorous with the remainder of the praescutum; scutellum and postnotum orange; thoracic pleura orange with white spots; abdomen orange with tergites one, the caudal part of three, and segments four to seven black with white spots . . . . *tillyardi* n.sp.

Clytocosmus tillyardi, n.sp.

General colouration fiery orange, the thoracic pleura spotted with white; legs black; wings yellow the posterior and anal cells with paler centres; abdomen with the basal tergite black with lateral white spots; intermediate tergites (three to six, and the caudal part of two) similar to the basal tergite; remainder of the abdomen orange.

♀.—Length, 33.5 mm.; wing, 22 mm.; head alone, 5 mm.; thorax alone, 7.5 mm.; abdomen alone, 21 mm.; hind leg, femur, 13 mm.; fore leg, femur, 9 mm.; tibia, 9.2 mm.

Frontal prolongation of the head bright orange, long and slender (2.3 mm.), with no indication of a nasus; dorsal surface with small, scattered, erect or

*Proc. Linn. Soc. N. S. Wales, 2nd. Ser., V., 1890, pp. 74-76.

slightly proclinate hairs, the lateral and ventral surfaces glabrous; palpi and mouth-parts dark brown. Antennae with the first segment orange, stout, narrow at base, with two or three pale, transverse rings beyond midlength; second segment dark brown, the base obscure yellow; flagellum broken. Summit of the vertex immediately behind the antennal bases. Head fiery orange with numerous short black setae that become very long and dense on the curiously buccate post-genae. Eyes relatively small with fine ommatidia.

Pronotum narrow, flattened, dull orange. Mesonotal praescutum fiery orange, the margin with a moderately broad white line; interspaces pale with numerous, short, erect setae; the broad median stripe is split by a capillary white line; scutum orange, the lobes fiery orange, margined proximally and caudally and less distinctly laterally with white; scutellum moderately projecting, orange, with a large whitish spot on either side; postnotum orange. Pleura orange, spotted with white; a spot on the mesepisternum, immediately behind the anterior spiracle; another on the mesepimeron immediately beneath the wing-base; three others surrounding the posterior spiracle; a large blotch on the sides of the mesosternum between the fore and middle coxae. Halteres with the base of the stem orange, the remainder of the halteres broken. Legs with the coxae orange, more or less whitish on the outer face, least distinct on the posterior coxae; coxae clothed with delicate hairs, shortest on the posterior coxae; trochanters blackish, indistinctly margined distally with red; femora and tibiae black; tarsi broken; fore legs much shorter than the hind legs. Wings with a strong yellowish tinge, darkening into fulvous brown in the apical and caudal portions; veins conspicuously yellow; centres of cells *M*, *1st* M_2, *2nd* M_2, M_4, Cu_1, *1st A* and *2nd A* paler. Venation: Sc_1 lacking, Sc_2 ending in R_1 just before *r*; cell R_2 narrowed at its inner end; cell *1st* M_2 large, pentagonal; petiole of cell M_1 short, about one-half of *m*. Macrotrichiae on the veins lacking or very sparse.

Abdomen with the first tergite narrowly margined with orange, the disk deep black with a large rounded white spot near each cephalic—lateral angle; suture between tergites one and two ill-defined; tergite two with the basal half orange with a small, median, basal, black mark, the caudal half black with a rounded, lateral, white spot and much fainter submedian spots; tergites three to six black, each with the conspicuous, rounded, lateral, white spot, the third and fifth also with fairly distinct, submedian, white markings; each of these black tergites, proximad and caudad of the lateral white spots, have about six or seven small, lens-shaped silvery dots arranged in a roughly oblique group; on each of the second and third tergites, cephalad of the lateral white spots is a small, transverse, impressed area as in many other Tipuline crane-flies; seventh to ninth tergites orange. Sternites uniformly orange. On the ventral surface of the abdomen, nine distinct and approximately subequal sternites are visible; on the dorsal surface, however, there are ten tergites visible unless we consider the first tergite as fused with the very long second tergite as above described; in this latter case, the basal tergite is as long as the basal three sternites; tergites three to seven are approximately equal in length, but the last two are greatly narrowed. Ovipositor horn-coloured, the tergal valves long, straight and very slender; sternal valves much shorter, compressed, the tips obliquely truncated.

Hab. New South Wales.

Holotype, ♀, Ulong, on the spurs of the Dorrigo Tableland, altitude about 2000 feet, April, 1917 (W. Heron).

Type returned to Dr. Tillyard.

Leaves of Reversion-Foliage of *Acacia suaveolens*. (Nat. size).

Euphyllode and Seedling of *A. implexa* (?). (Nat. Size).

1. *Caesalpinia Gilliesii*. 2. *A. discolor*. 3-6. Leaves of Reversion-Shoots of *A. implexa* (?) (Nat. size).

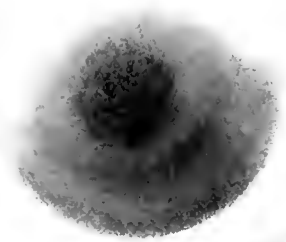
1. Leaf of *A. Baileyana*. 2-5. Leaves of Reversion-Shoots of *A. implexa* (?). (Nat. size).

Leaves of Reversion-Shoots of *A. implexa* (?). (Nat. size).

Leaves of Reversion-Shoots of *A. implexa* (?); late stages. (Nat. size.

Leaves of Reversion-Shoots of *A. implexa* (?); last stages. (Nat. size).

1-7. *A. podalyriaefolia.* 8. *A. myrtifolia.* 9. *A. discolor.* 10. *Jacaranda.* 11. *A. decurrens.* (Nat. size).



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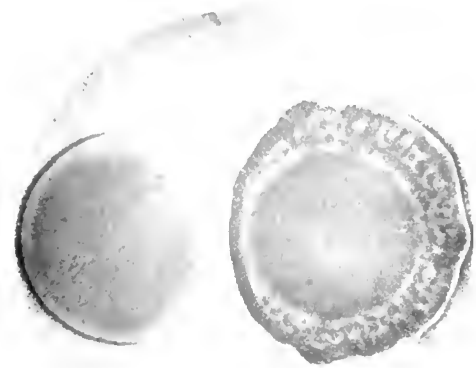

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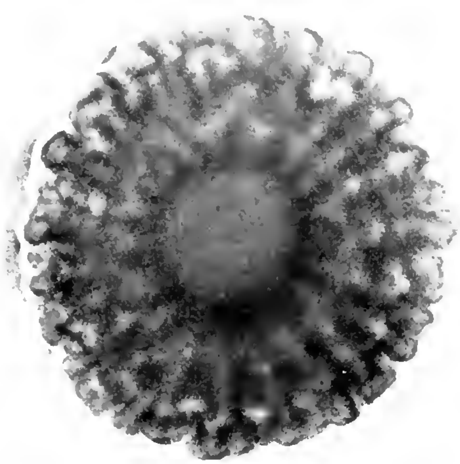

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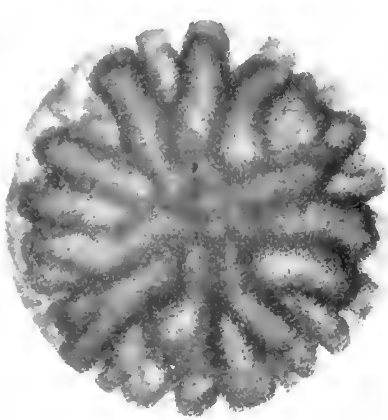

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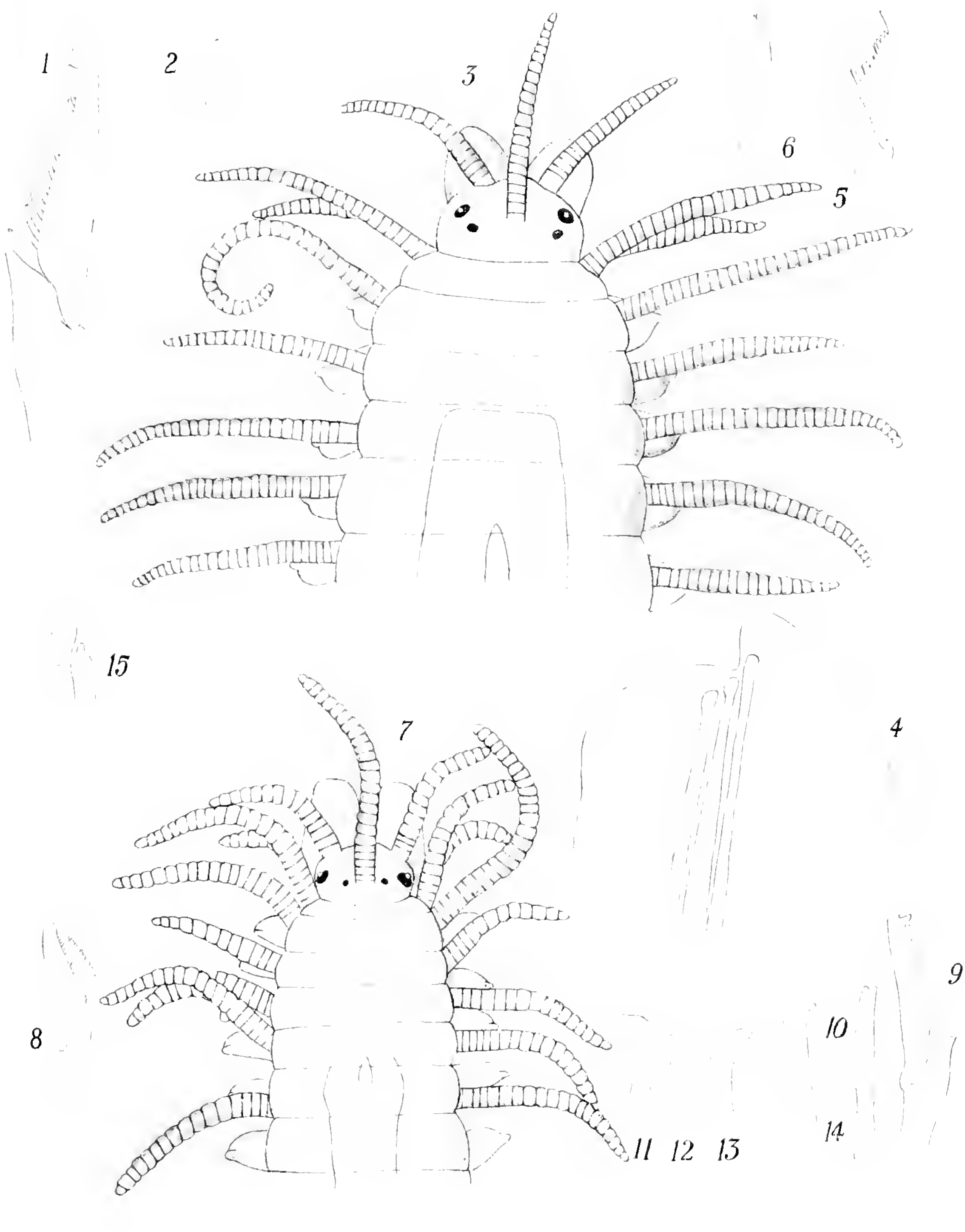
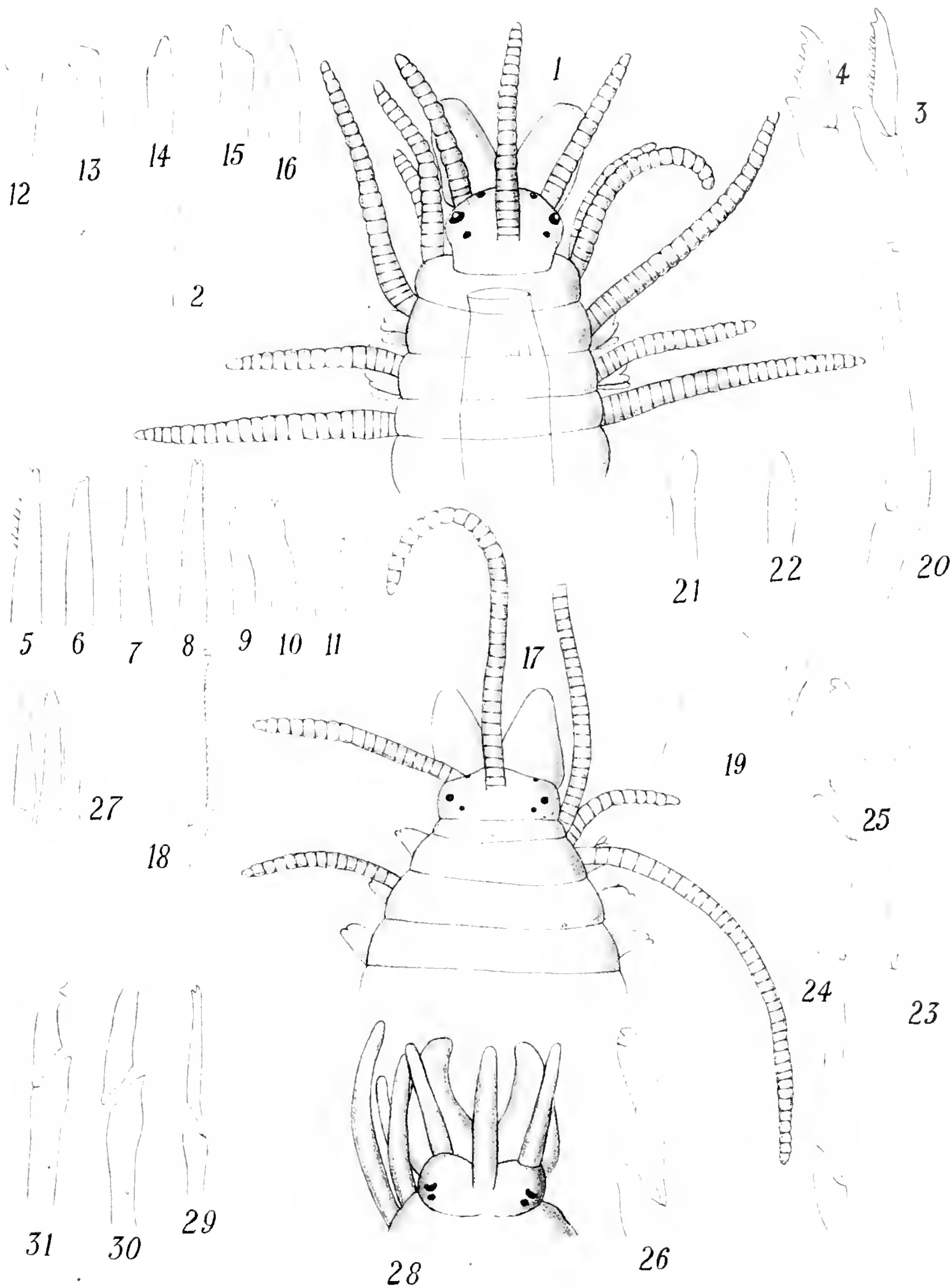
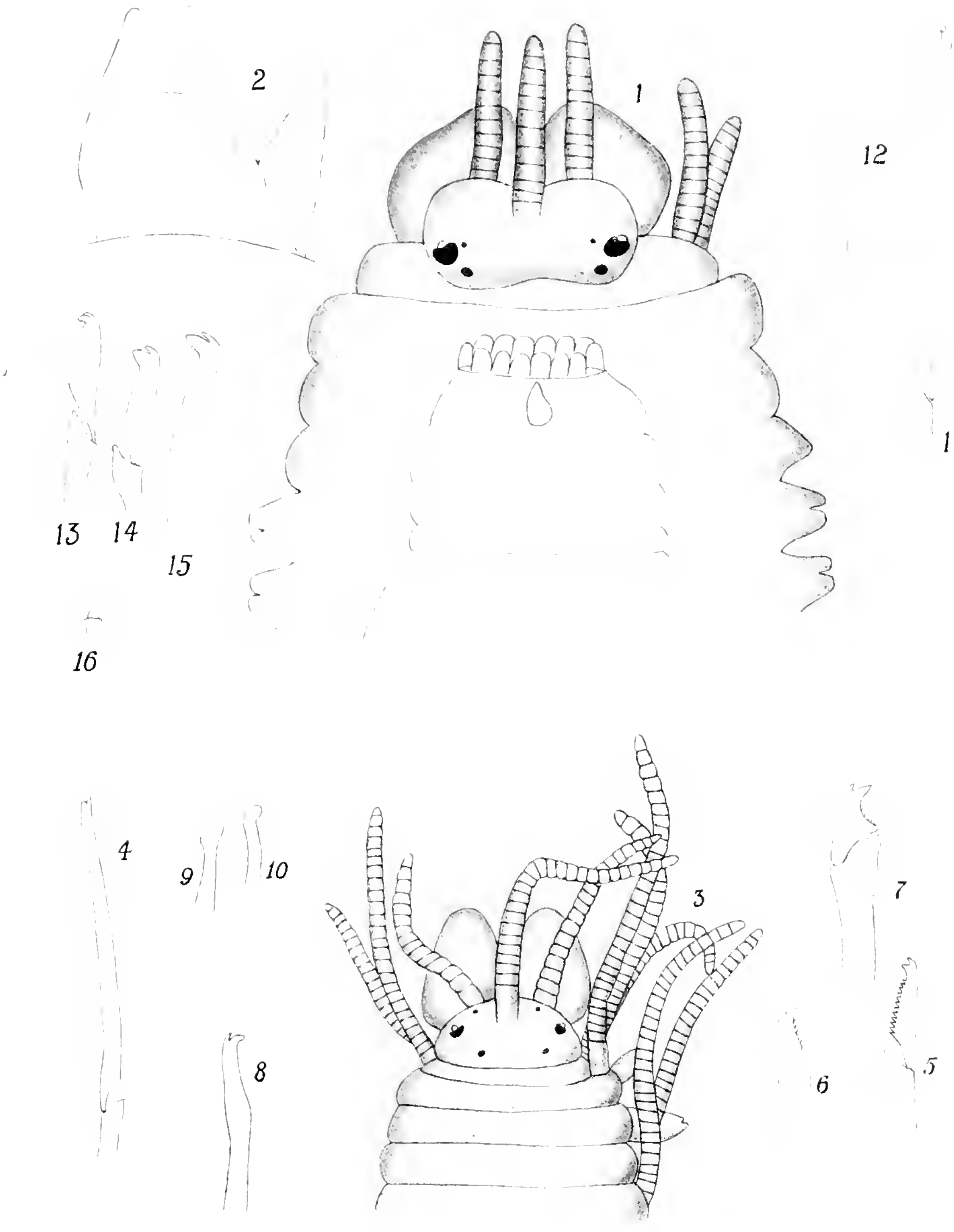
Bacteria causing Ropiness in Wattle Bark Infusions.



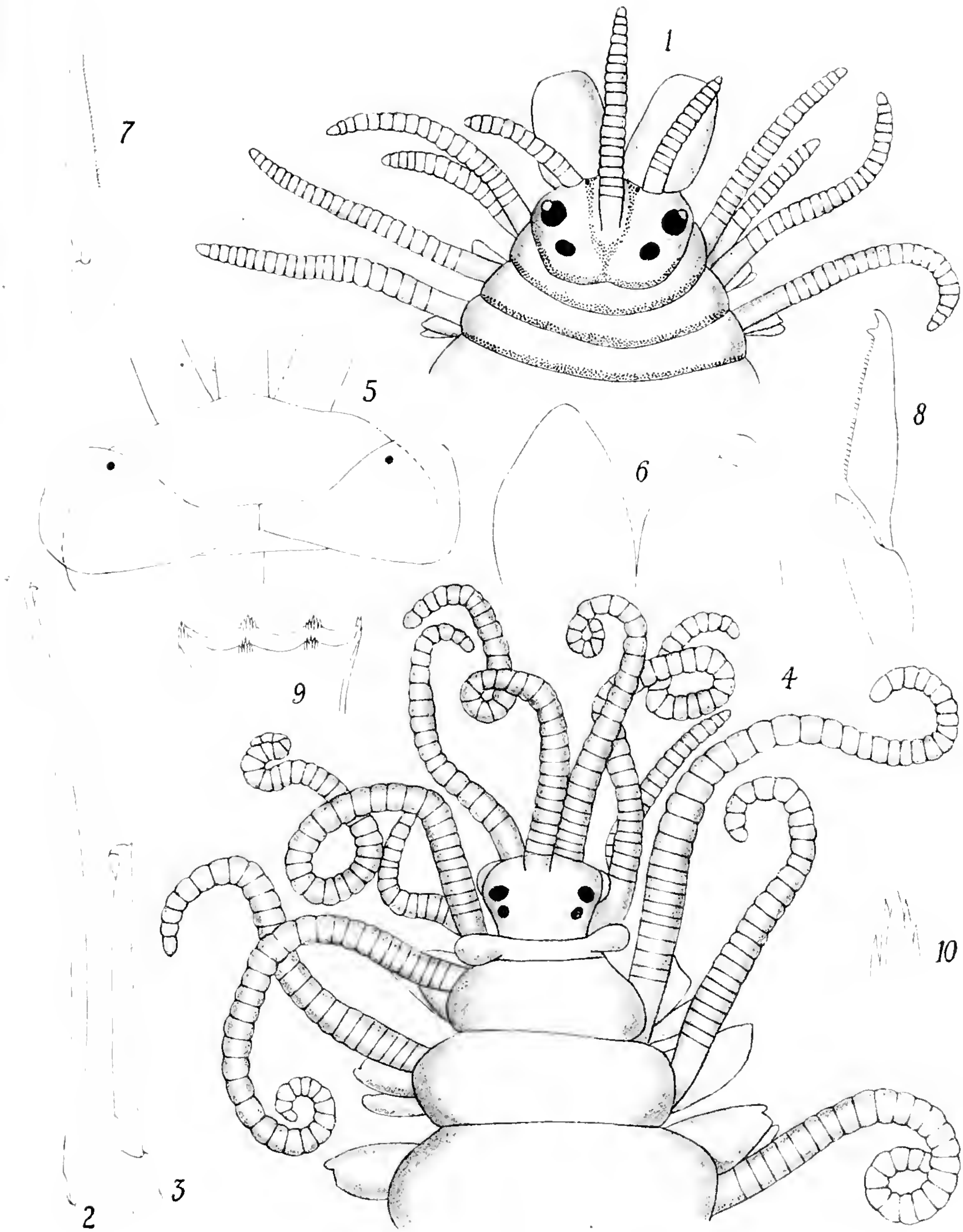
1-2. *Syllis variegata*. 3-6. *S. pectinans*. 7-14. *S. truncata*. 15. *S. gracilis*.



1-16. *Syllis punctulata.* 17-18. *S. parturiens.* 19-22. *S. augeneri.* 23-27. *S. kinbergiana.* 28-31. *S. coruscans.*



1-2. *S. kinbergiana.* 3-10. *S. ferruginea.* 11-16. *Pionosyllis melaenonephra.*



1. *Pionosyllis melaenonephra.* 2-3. *P. divaricata.* 4-10. *Amblyosyllis spectabilis.*

DESCRIPTIONS OF AUSTRALIAN FLIES OF THE FAMILY *ASILIDAE*, [DIPTERA] WITH SYNONYMS AND NOTES.

BY G. H. HARDY.

In this paper synonyms are recorded, and two new species of the genus *Neoitamus* are described. Other species of the genus *Neoitamus* are given a better taxonomic treatment than has hitherto been attempted.

Australian species of the family *Asilidae* were revised by Miss Ricardo in 1912-13, but a number of descriptions were left outstanding, as the types were either missing or not in a condition suitable for recognition. Since then, considerable attention has been given to the Tasmanian *Asilidae*, chiefly by the late Arthur White, and as Tasmania is the type locality of much of the described material, it has become possible to establish the identity of many of the outstanding descriptions of species recorded from there.

Sydney is also an important type locality, but the *Asilidae* of this district require further attention and a number of common species have yet to be described. Only a few of the outstanding descriptions of species recorded from this locality, and from New South Wales generally, have been identified.

Considerable further knowledge, accumulated since Miss Ricardo's work requires to be incorporated with a new revision founded upon a better taxonomic treatment of the species.

I am indebted to Dr. E. W. Ferguson for the loan of his collection of the genus *Neoitamus*, which contains many specimens identified by Miss Ricardo and Arthur White.

Subfamily DASYPOGONINAE.

CABASA PULCHELLA Macquart.

Dasypogon pulchellus, Macquart, Dipt. Exot., suppl. 1, 1846, p. 62, Pl. 7, fig. 9 (wing).

Cabasa pulchella, Walker, List Dipt. Brit. Mus., vi., suppl. 2, 1854, p. 499; Ricardo, Ann. Mag. Nat. Hist. (8), ix., 1912, p. 479; White, Proc. Roy. Soc. Tas., 1916, p. 155.

Dasypogon venno, Walker, List Dipt. Brit. Mus., ii., 1849, p. 359.

Cabasa venno, Walker, List Dipt. Brit. Mus., vi., suppl. 2, 1854, p. 500.

Cabasa rufithorax, Walker, Ins. Saund. Dipt., i., 1850, p. 100, Pl. iii., fig 5; Walker, List Dipt. Brit. Mus., vi., suppl. 2, 1854, p. 499.

Dasypogon rubrithorax, Macquart, Dipt. Exot., suppl. 4, 1850, p. 66, Pl. vi., fig. 10.

Cabasa rubrithorax Ricardo, Ann. Mag. Nat. Hist. (8), ix., 1912, p. 480; White, Proc. Roy. Soc. Tas., 1916, p. 155.

Synonymy.—Miss Ricardo has identified *Cabasa rufithorax* Walker with *Cabasa pulchella* Macquart, and also *Cabasa venno* Walker with *Cabasa rubrithorax* Macquart. All the types are described from Tasmania.

A long series of Tasmanian specimens, collected by Mr. C. E. Cole, shows a complete merging of *Cabasa rubrithorax* Walker into *Cabasa pulchella* Macquart, and establishes beyond dispute this long suspected synonymy.

Hab.—Tasmania, Victoria, New South Wales and Queensland.

A specimen with semi-hyaline wings was taken at Blackheath, New South Wales, on the 27th November, 1919.

Subfamily ASILINAE.

The outlines for the classification of Australian genera of the subfamily *Asilinae* were laid down by White in 1917. White's scheme offers the only practical solution for the present treatment of Australian species of the genus *Neoitamus*, under which group he includes species placed previously in this and allied genera.

White's scheme for the classification of the *Asilinae* is accepted here for the genera. The subgenera of the genus *Neoitamus*, however, are not satisfactory, and for further remarks see under the genus *Neoitamus* below.

OMMATIUS PILOSUS White.

Ommatius pilosus, White, Proc. Roy. Soc. Tas., 1916, p. 169.
Ommatius levis, White, *ibid.*, p. 170.

The holotype of *O. levis* White is in the Australian Museum. A long series of specimens shows that this form completely merges into *O. pilosus* White, and therefore it cannot be considered distinct.

Genus NEOITAMUS Osten-Sacken.

Itamus, Loew, Lin. Ent., iv., 1849, p. 84 (preoccupied).
Neoitamus. Osten-Sacken, Cat. Dipt. N. America, edit. 2, 1878, pp. 82, 235; Ricardo, Ann. Mag. Nat. Hist. (8), xi., 1913, p. 431; White, Proc. Roy. Soc., Tas., 1913, p. 274; 1916, p. 173; 1917, p. 91.

Under the genus *Neoitamus* a number of diverse Australian species which have a similar general appearance are grouped. The generic name is used for convenience, and the species do not necessarily conform to the description of the genus given by Loew.

When structural characters of the described species are published, and a general survey is made of the allied genera of the world, it will become possible to give this group of Asilids an adequate treatment for generic and subgeneric division.

White proposed the three following subgenera:—*Trichoitamus* White (type, *Dysmachus rudis* Walk.), *Neoitamus* Loew (type, *N. cyanurus* Loew), and *Rhabdotoitamus* White (type, *N. brunneus* White).

Neoitamus cyanurus Loew is a European species.

The type species of *Rhabdotoitamus* was not fixed by White, but *R. brunneus* White (= *N. vittipes* Macquart) conforms best to the subgenus as White described it, and also it has the advantage of being widely distributed and common.

In the present paper the species are dealt with as belonging to one genus *Neoitamus*, so as to avoid the confusion that would otherwise arise, due to the species being placed in arbitrary subgenera that have unsatisfactory or even no structural differences; and, moreover, the collection shows a number of species that could be divided into subgenera, or even genera, upon apparently sound structural characters. It is premature, however, to subdivide the genus until adequate study has been made of all the described forms.

The exoskeleton shows differences of specific value in the characters discussed below.

Head.—On the face there is a tubercle varying in size in the different species, and on this is situated the moustache which varies in density approximately in relation to the size of the tubercle. *N. clavipes* White, *N. volaticus* White, and *N. australis* Ricardo have a very small tubercle and moustache, whilst the other species have these characters generally much more pronounced.

A row of bristles is situated behind the eyes in most of the species, but in a few apparently undescribed forms they are absent. Some species have these bristles arranged in two rows or more.

Thorax.—The presutural bristles are those lateral bristles situated anterior to the transverse suture; they are always two in number close to the suture, and anterior to these there are sometimes one or more further bristles.

The superalar bristles are those situated above the wings, between the transverse suture and the postalar callus. They may be one, two, or three in number, rarely more.

The postalar bristles are those situated on the postalar callus, and may be from one to four in number.

The dorsocentral bristles are confined to two rows on the dorsum placed on each side of, at some little distance from, and parallel to the median line. These bristles are usually regularly placed and alternate with a row of hairs placed in a closely adjacent or a contiguous line; if one of the bristles is suppressed or obsolete, the hair on each side of it becomes much stronger and bristle-like. When counting, allowance must be made for these suppressed bristles, but sometimes specimens will be found too irregular for the alternating hair and bristle character to be seen.

As these dorsal thoracic bristles appear to have a definite limit of variation in each species, they afford important characters for identifying female specimens.

The metapleural bristles are situated below the halteres; these are erect and are arranged in a vertical line. Below, above the hind coxae, and continuing in the same line, are also erect hypopleural bristles. The metapleural bristles are invariably present, but sometimes the hypopleural bristles are reduced to depressed hairs, or are completely missing. Both sets of bristles are very thin and hair-like, but as they stand erect on an otherwise bare surface they are very conspicuous.

Scutellum. The scutellar bristles are situated on the margin of the scutellum, and are from two to six, rarely more, in number.

Abdomen. A row of bristles may be present on most of the abdominal segments. These bristles are generally in a complete line on the first segment, but are interrupted by a bare space on the dorsum of the other segments; they are placed parallel and anterior to the posterior margins; they are smallest towards the centre, and become longer laterally, where they are often erect and conspicuous.

Legs. The femur is more or less oval in cross section, and when the legs are at right angles to the thorax, that flattened surface which faces towards the head is known as the anterior side; the other three sides are called the dorsal, posterior and ventral sides.

The anterior femur is generally spineless, but occasionally a spine is to be found towards the apex of the posterior side, and *N. armatus* Macquart has four spines on the ventral side.

A complement of spines on the intermediate femur appears to consist of a row on the anterior side, one subapical spine on the posterior side, and a ventral row. The row on the anterior side may vary in the number of spines, and may even be reduced to one or two; this row often runs on to the dorsum, and, in such a case, if the last spine is isolated with a bare space between it and the other remaining spines, it will appear to be a subapical dorsal spine.

A complement of spines on the posterior femur consists of two rows on the anterior side and one ventral row. Besides these there are a few subapical spines.

In a long series of specimens a wide range of variation will generally be found, but in a few species the variation is limited.

Wings. The wings are hyaline, or more or less tinted with fuscous, and fuscous spots are present in a few species. The venation is constant with regard to the veins and cells, but slight variations occur in the relative shape and length of some of the cells.

Male genitalia. The exposed genital forceps of the male afford the only satisfactory characters for identifying a species. This organ has a wonderful variety of characters that have been all but overlooked by earlier authors, and it is the purpose of the present paper to utilise them as the main objective for establishing species. The females in such a system of classification are, necessarily, of secondary consideration; nevertheless, they can generally be identified by other characters by comparison with their respective males.

The male genitalia contain *a pair of upper forceps,* between the two branches of which is situated the *dorsal median lamella,* and a *pair of lower forceps*—in all, five visible parts

The upper forceps vary considerably in shape in the various species, and may contain a terminal process, or may be simple and without a process, and, finally, may contain bristles.

The genitalia of *A. exilis* Macquart, *A. filiferus* Macquart and *Cerdistus australis* Ricardo are described as having bristles.

Female ovipositor. Few descriptions convey any real idea of the length of the ovipositor, yet sometimes females of closely related species can be separated by the comparative length of this organ. White refers to the ovipositor as being long in all his species except *N. abditus*, where, he states in the original description, it is rather short, and in 1917 he refers to it as unusually short. This species, however, has a very distinctive ovipositor, and, on the strength of this organ, it should be placed in a separate genus; it is somewhat compressed ventrally, but has a conspicuous dorsal surface which decreases posteriorly, and at the apex there is a pair of small, separated, conical lamellae. All the other species in the collection contain one, more or less cylindrical, styliform lamella at the apex of the eighth abdominal segment which is usually entirely compressed. Sometimes the seventh abdominal segment is black, shining, and compressed on the dorsal surface, but shows a ventral area; this character is called *subcompressed* in the descriptions given below. In two species, one described below as new, the sixth abdominal segment is also black, shining and subcompressed.

Both White and Miss Ricardo refer to these subcompressed segments as forming part of the female ovipositor, but as gradations in the various species make the line of demarcation difficult to determine, it is not advisable to interpret the character in that manner.

There are forty-seven specific names, all of which probably belong to the group of species here classed as the genus *Neoitamus*, and in this paper twenty of these names are distributed among twelve species, and two new specific names are proposed. Twenty-seven further specific names require more adequate description than has yet been given to them; these, under their respective authors, are given in the following list:—

Macquart: *Asilus acutangulatus*, *A. australis*, *A. exilis*, *A. feriferus*, *A. fulvipubescence*, *A. longiventris*, *A. nigrinus*, *A. rufocoxatus*, *A. rufometatarsis*, *A. varifemoratus* and finally *A. laticornis*, which does not conform to any known species, and Miss Ricardo states that the ovipositor is short and conical.

Walker: *Asilus coedicius*, *A. clicitus*, *A. maricus*, *A. obumbratus*, *A. cilicatus* and *Dysmachus rudis*.

Schiner: *Glaphyropyga australiasiae*.

Ricardo: *Cerdistus australis* and *Neoitamus australis* (both of which specific names are preoccupied by Macquart's *A. australis*), *N. gibbonsi* and *N. hyalipennis*; the species described as *N. hyalipennis* by White may not be identical with Miss Ricardo's species.

White: *Neoitamus divaricatus*, *Rhabdotoitamus lautus*, *R. lividus*, *R. rusticanus* and *R. volaticus*.

There are four other outstanding descriptions belonging to the *Asilinae* and, judging from the described characters, they cannot belong to the group dealt with here. These must be retained in the *Asilus* group *sensu lato*, and are as follows:— *Asilus ferrugineiventris* Macquart, *A. alligans* Walker, *A. belzebulb* Wiedemann and *A. regius* Jaennicke.

Asilus crabroniformis Meigen is cancelled from the Australian list. This is a well known European species that was erroneously recorded from Tasmania by Macquart in 1847.

Key to the species of the genus *Neoitamus* described below, of which both sexes are known.

1. The female ovipositor short, with two small separated lamellae. Male genitalia without an apical process. Two super- and one post-alar bristles . . . *abditus* White.
   The female ovipositor with one styliform lamella. Male genitalia with or without an apical process . . . 2.
2. The upper forceps of the male genitalia with a terminal process . . . 3.
   The upper forceps of the male genitalia without a terminal process . . . 6.
3. The male genitalia short and globular, the apical process is above the centre of and more or less at right angles to, the outer margin. Female ovipositor short. Two super- and three post-alar bristles . . . *sydneyensis* Schiner.
   The male genitalia elongate, the apical process rarely at right angles to the apical border; if at right angles, it is situated below the centre of the apical border . . . 4.
4. The seventh segment of the female abdomen black, shining and subcompressed, and as long as the moderately long ovipositor. Seen laterally, the apical half of the male genitalia is more swollen than the basal half. Super- and post-alar bristles three each (?) . . . *flavicinctus* White.
   The seventh segment of the female abdomen normal. Seen laterally, the apical half of the male genitalia is not swollen. Female ovipositor short . . . 5.
5. The dorsal and ventral surfaces of the male genitalia are more or less parallel. Super- and post-alar bristles two each . . . *fraternus* Macquart.

The dorsal and ventral surfaces of the male genitalia taper towards the apex which is truncate. Two super- and one, rarely two, post-alar bristles *vittipes* Macquart.

6. The male genitalia with bristles . . . . 9.
The male genitalia without bristles . . . . 7.

7. The anterior femora with a conspicuous row of ventral spines. Female ovipositor very long. Two super-, one, rarely two, post-alar bristles *armatus* Macquart.
The anterior femora without ventral spines. Female ovipositor short . . . . . . 8.

8. The female ovipositor entirely compressed. Super- and post-alar bristles one each *claripes* White.
The female ovipositor compressed ventrally, but with a dorsal surface. Two super- and one or two post-alar bristles . . . . *maculatoides*, n.sp.

9. The upper forceps of the male genitalia with a row of about ten slender dorsal bristles. Female ovipositor short. Two super-,one or two post-alar and two scutellar bristles . . . . *margites* Walker.
The upper forceps of the male genitalia with one long, ventral, subapical bristle, and a row of ventral bristles on the lower forceps. The female ovipositor is short, and the sixth and seventh abdominal segments of the female are subcompressed, black and shining. Two or three superalar, three or four postalar and four scutellar bristles . . . . *setosus*, n.sp.

NEOITAMUS ABDITUS White. (Text-figs. 1-3.)

Neoitamus abditus, White, Proc. Roy. Soc. Tas., 1916, p. 178, text-fig. 29 (wing); and 1917, p. 93 (in key).

Synonymy. Outstanding descriptions of the *Asilinae* are not sufficient for *N. abditus* White to be identified as one of them, but it is possible that *A. acutangulatus* Macquart may belong here.

Description. The species will be readily recognised by the small separated lamellae of the female ovipositor.

♂. The face has a large tubercle containing black hairs which increase in length towards the centre; the centre of the tubercle contains six, shorter, black bristles; below these bristles there are slender white hairs which are sometimes bordered laterally by a row of very fine black hairs. Behind the eyes there is a row of black bristles.

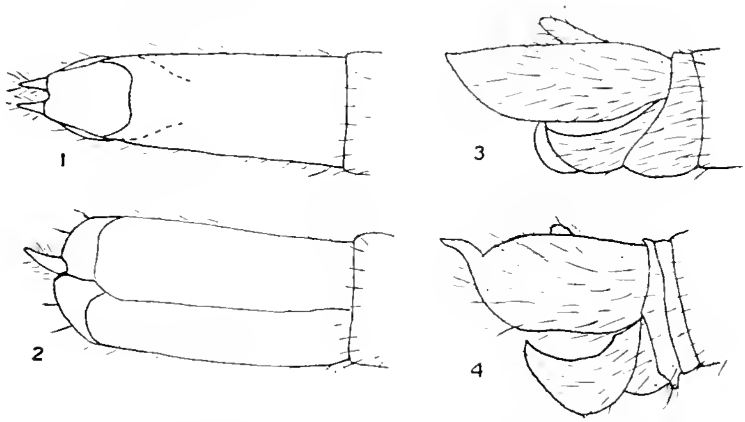
The dorsal bristles of the thorax are disposed on each side of the median line as follows:- two presutural; two superalar, one of which is weak; one postalar; about six dorsocentral, between each of which there is a thin bristle-like hair.

The hypopleural and metapleural bristles are present, and the scutellar bristles are two or four in number. All the bristles of the thorax and scutellum are black.

The bristles towards the apex of the abdominal segments are mostly white, but black bristles occur on the posterior segments. The second to fifth segments have two conspicuous, erect, lateral white bristles. The upper forceps of the male genitalia are simple and moderately hairy; seen laterally, they are more or less parallel-sided.

The legs have the anterior femora without spines; the intermediate femora have a row of spines on the anterior side, but this row is often reduced in number to two spines; the subapical spine on the posterior side is present; the posterior femora have only one row of spines present on the anterior side; there is one subapical dorsal spine and a ventral row of spines.

The wings have a normal venation; the intermediate crossvein is situated about the middle of the discal cell; the second posterior cell is long and considerably constricted subapically.



Text-figs. 1–3.—*Neoitamus abditus*. 1, female ovipositor seen dorsally; 2, the same seen laterally; 3, the male genitalia seen laterally. (x 25).
Text-fig. 4.—*Neoitamus sydneyensis*. The male genitalia. (x 25).

♀. The female differs from the male in having the abdominal bristles obsolete. The ovipositor is short, compressed ventrally only, the dorsal portion tapering apically and terminating in a pair of small, more or less conical, separated lamellae.

Hab.—Tasmania and Victoria. (February to April.)

Type.—White only described the female of this species. The holotype female was purchased by the British Museum with White's collection. The allotype male, described above, is in the Australian Museum. There are five paratype males.

Note.—The collection under revision contains six males and seven females. One of the females was originally identified by White, and two pairs were taken in copula at Hobart and Melbourne respectively, thus establishing the sex relationship. All the specimens were taken by the writer.

NEOITAMUS SYDNEYENSIS Schiner. (Text-fig. 4.)

Cerdistus sydneyensis, Schiner, Reise Novara, Dipt., 1868, p. 187; Ricardo, Ann. Mag. Nat. Hist., (8), xi., 1913, p. 436; and (9), i., 1918, p. 63.

Description. ♂. The face has a moderately large tubercle; the moustache is composed of stiff black bristles, with black hairs above and on each side; below, there are longer white hairs bordered laterally by a row of very fine black hairs. There is a row of black bristles behind the eyes.

The dorsal bristles of the thorax are disposed on each side of the median line as follows:—two presutural; two superalar; three postalar, composed of one long bristle in the centre and one hair-like bristle on each side of it; four to six dorsocentral; all the above bristles are black. The metapleural bristles are black and the hypopleural bristles are usually white. There are two black scutellar bristles.

The abdominal bristles are long, mostly black, and very pronounced as far as the fifth segment. The upper forceps of the male genitalia are short, and have a process situated slightly above the middle of the outer border and turning at right angles to it.

The legs have the anterior femora without spines; the intermediate femora have the system of spines more or less complete, but the spines on the anterior sides are usually reduced to two or three; the posterior femora have a complete system of bristles but the upper row on the anterior side is reduced in number. The bristle system is explained in the introduction.

The wings have a normal venation. The intermediate crossvein is situated about the middle of the discal cell and, beyond this vein, there is a conspicuous hyaline area. The second posterior cell is short and normal.

♀. The female is similar to the male. The ovipositor is short, compressed, and contains a cylindrical styliform lamella.

Hab.—New South Wales: Sydney, Milson Island, Palm-beach, and Blackheath. (October to December.)

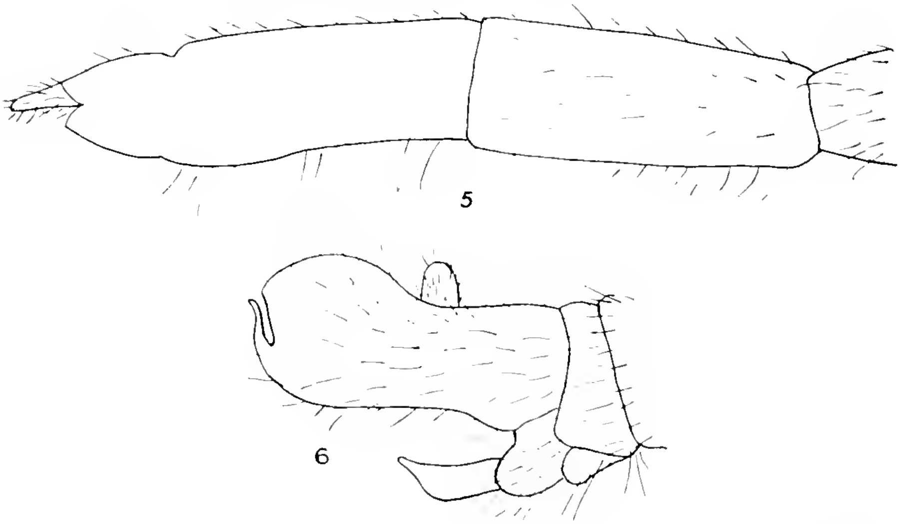
Note.—In the collections under revision, there are seventeen males and fifteen females. One of the females is labelled *Cerdistus sydneyensis* Schiner in Miss Ricardo's handwriting

NEOITAMUS FLAVICINCTUS White. (Text-figs. 5, 6.)

Neoitamus flavicinctus, White, Proc. Roy. Soc. Tas., 1913 (1914), p. 275; 1916, p. 174; 1917, p. 92 (in key).

Description. ♂. The face has a large tubercle and a black moustache There is a row of black bristles behind the eyes.

The thorax has abundant black bristles which extend towards the anterior margin, gradually diminishing in size. Besides the usual two presutural, there are four more bristles situated between the humeral angle and the transverse suture. Above the wings there are three or four bristles, referred to here as the



Text-figs. 5, 6. *Neoitamus flavicinctus*. 5, female ovipositor; 6, male genitalia. (x 25).

superalar. The postalar bristles are three in number, and the dorsocentral bristles are represented by a complete line of mixed hairs and bristles that do not conform to the usual alternating hair and bristle order. The scutellum has six marginal bristles. All the bristles, including the hypopleural and metapleural, are black.

The bristles on the abdomen are long and mostly white; they are very prominent as far as the fifth segment. The upper forceps of the male genitalia are long, and seen laterally the apical half is swollen, and terminates in a digitate process which branches about the middle of the apical border.

The legs have the anterior femora without spines; the intermediate femora have, besides the complete system of spines, a second row of spines on the anterior side. The posterior femora have a complete system of spines. These spine systems are explained in the introduction.

The wings have a normal venation; the intermediate crossvein is situated at about half the length of the discal cell; the second posterior cell is rather long and slightly constricted subapically.

♀. The female appears to be similar to the male, but the bristles are somewhat flattened and broken. The sixth abdominal segment is partly bare of tomentum, and appears to be slightly compressed. The seventh abdominal segment is sub-compressed, bare and shining, and as long as the moderately long ovipositor which has a terminal style-like lamella.

Hab.—Tasmania: Cradle Mt. (January, 1917, 1 male, 1 female.)

Note.—The collection under revision contains only two specimens that can be referred to this rare species. The identification is probably correct, as the specimens agree entirely with White's description. The female ovipositor (text-fig. 5) is drawn as it appears on the insect, and it seems probable that the sixth abdominal segment is distorted at the apex.

NEOITAMUS FRATERNUS Macquart. (Text-figs. 7 and 8.)

Asilus fraternus, Macquart, Dipt. Exot., suppl. 1, 1846, p. 91; Walker, List Dipt. Brit. Mus., vii., suppl. 3, 1855, p. 738; White, Proc. Roy Soc. Tas., 1913, pp. 274 (in key) and 275.

Asilus luctificus, Walker, Ins. Saund. Dipt., i., 1851, p. 144; Ricardo, Ann. Mag. Nat. Hist., (8), xi., 1913, p. 447.

Neoitamus varius, Ricardo (*nec* Walker), Ann. Mag. Nat. Hist., (8), xi., 1913, p. 431 (part).

Neoitamus vulgatus, White, Proc. Roy. Soc. Tas., 1913 (1914), p. 276, 1916, p. 177, text-fig. 28 (wing); 1917, p. 93 (in key).

Synonymy. The types of *A. fraternus* Macquart, *A. luctificus* Walker, and *N. vulgatus* White are from Tasmania. Miss Ricardo placed *A. fraternus*, female as a synonym of *N. varius* Walker, a New Zealand species, but this is probably not correct. Miss Ricardo also suggests that *A. luctificus* Walker should be expunged from the list of species as the type is lost, but the description conforms well with this common Tasmanian species.

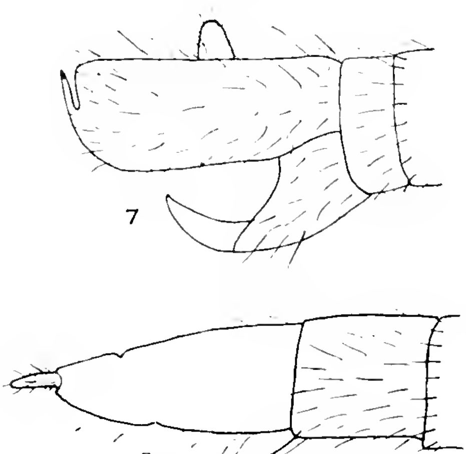
According to his key characters, White took his description of *N. fraternus* Macquart from Miss Ricardo's description of *N. varius* Walker, and he further states that he did not meet with any species agreeing with Macquart's description. It is possible, however, that White did not refer to Macquart's description, as there is not a copy of Macquart's "Diptères exotique" in Tasmania, and moreover, if he had had access to this work, he would not have overlooked so many species of Diptera described from Tasmania.

In the collection under revision, there is a male cotype of *N. vulgatus* White, and this is identical with a male of a pair taken in copula, and thus establishes the sex relationship; the female has a short ovipositor, not long, as stated by White in his description.

New South Wales specimens identified by White, and represented by various specimens in the collection under revision, have longer ovipositors, and therefore *N. vulgatus* var. White cannot belong to the same species, and, moreover, *N. vulgatus* White is only known from Tasmania, although White's description covers more than one species occurring on the mainland of Australia.

Description. ♂. The tubercle of the face is large, and the moustache consists of white hairs below, and black hairs above; sometimes there is a lateral row of small black hairs bordering the white hairs. Behind the eyes there is a row of black bristles.

The dorsal thoracic bristles are disposed on each side of the median line as follows:—two presutural, two superalar and two postalar, and, besides these, there may be one or two extra presutural and superalar bristles present, and also an extra postalar bristle; about six dorsocentral bristles alternating with black hairs; all bristles black. The two scutellar and the metapleural bristles are black, the hypopleural bristles are mostly white.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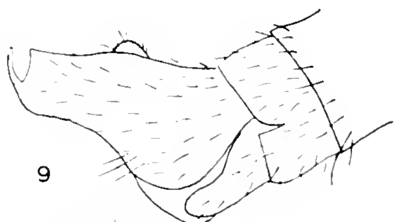
Text-figs. 7–8. *Neoitamus fraternus.* 7, male genitalia; 8, female ovipositor. (x 25).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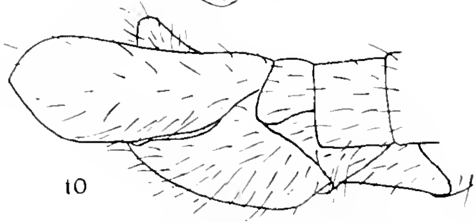
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Text-fig. 8. —*Neoitamus vittipes*, male genitalia. (x 25).
Text-fig. 10.—*Neoitamus armatus*, male genitalia. (x 25).

The bristles of the abdominal segments are mostly white, and there are two erect, white, lateral bristles on the second to fifth segments. The upper forceps of the male genitalia are elongate, and have a digitate apical process which branches about the middle of the apical border; seen laterally they are more or less parallel-sided.

The legs have the anterior femora without spines; the intermediate and posterior femora have the system of spines more or less complete; these spine systems are explained in the introduction.

The wings have a normal venation; the intermediate crossvein is situated at about half the length of the discal cell, and the second posterior cell is short.

♀. The female is similar to the male and the ovipositor is short.

Hab.—Tasmania.

Note.—The collection under revision contains twenty males and eighteen females, all Tasmanian. Other specimens, labelled *N. vulgatus* by White belong to widely different species, and are dealt with under their respective names.

NEOITAMUS VITTIPES Macquart. (Text-fig. 9.)

Asilus vittipes, Macquart, Dipt. Exot., suppl. 2, 1847, p. 43; Walker, List Dipt. Brit. Mus. vii., suppl. 3, 1855, p. 741.

Asilus cognatus, Macquart, Dipt. Exot., suppl. 4, 1850, p. 94.

Asilus alicis, Walker, List., Dipt. Brit. Mus., vii., suppl. 3, 1855, p. 738.

Neoitamus brunneus, White, Proc. Roy. Soc. Tas., 1913 (1914), p. 279, 1916, p. 180.

Rhabdotoitamus brunneus, White, Proc. Roy. Soc. Tas., 1917, p. 100.

Synonymy. Macquart's types of *A. vittipes* and *A. cognatus* are from Tasmania, and their descriptions conform to two colour forms of White's variable species, *N. brunneus*, which is the genotype of the subgenus *Rhabdotoitamus*.

Walker's type of *A. alicis*, from Australia, is recorded as lost by Miss Ricardo, and was therefore placed by her amongst the species she proposed to cancel from the list, but the description conforms to Australian specimens of White's genotype, and in this way establishes its probable identity with *A. vittipes* Macquart.

Description. ♂. The moustache is white, and occupies a moderately large tubercle; occasionally there are one or two black hairs above. There is a row of white bristles behind the eyes.

The dorsal thoracic bristles are disposed on each side of the median line as follows:—two presutural, two superalar, one, rarely two, postalar, and about four dorsocentral; all the bristles black. There are two black scutellar bristles, and the metapleural and hypopleural bristles are white.

Both sides of each abdominal segment from the second to the fifth contain two long, erect, white bristles; the other abdominal bristles are black.

The upper forceps of the male genitalia are short, tapering apically, and terminating in a digitate process which branches from the ventral posterior angle. The upper and lower forceps are reddish-brown in colour, and are partly darkened with fuscous.

The legs have the anterior femora without spines; the intermediate and posterior femora have their system of spines more or less complete.

The wings have a normal venation; the intermediate crossvein is situated at a little beyond the middle of the discal cell, and the second posterior cell is short.

♀. The female is similar to the male; the ovipositor is short.

Hab.—Tasmania, Victoria, and New South Wales. (January to March.)

Note.—The collection under revision contains thirteen specimens, four males and one female from Tasmania, three males and four females from New South Wales, and one male without locality. A female from Sydney was labelled by White as his *N. brunneus*.

NEOITAMUS ARMATUS Macquart. (Text-fig. 10.)

Asilus armatus, Macquart, Dipt. Exot., suppl. 1, 1846, p. 91, Pl. 8, fig. 17; Walker, List Dipt. Brit. Mus., vii., suppl. 3, 1855, p. 737.

Asilus setifemoratus, Macquart, Dipt. Exot., suppl. 5, 1854, p. 65.

Asilus antileo, Walker. List Dipt. Brit. Mus. ii., 1849, p. 458; vii., suppl. 3, 1855, p. 737.
Machimus antileo, Ricardo, Ann. Mag. Nat. Hist., (8), xi., 1913, p. 423.
Itamus planiceps, Schiner, Reise Novara, Dipt., 1868, p. 189.
Neoitamus planiceps, Ricardo, Ann. Mag. Nat. Hist., (8), xi., 1913, p. 434; White, Proc. Roy. Soc. Tas., 1913, p. 275.

Synonymy.—Asilus armatus Macquart is described from Tasmania, but Walker gives Australia and Tasmania for Macquart's species. *A. setifemorata* Macquart is from Adelaide. *A. antileo* Walker is from Port Stephens. *N. planiceps* Schiner is from Sydney. In the collection under revision there are specimens from Sydney and Tasmania which cannot be separated from each other or from the various descriptions.

In describing *I. planiceps*, Schiner states that his species does not agree with the descriptions of Macquart's *A. setifemorata* and *A. rufotarsis;* Schiner's description, however, appears to agree with *A. setifemorata* in spite of his statement to the contrary.

The reference to *A. rufotarsis* Macquart is not traceable: *A. rufometatarsis* Macquart is not described as having spines on the anterior femora, and therefore *A. rufotarsis* evidently is not a misprint for that name.

In describing the male genitalia, Schiner states that the posterior border is serrated: as this does not conform to the illustration of the male genitalia given here, it is necessary to point out that when the two obtuse points, one at the apex of each branch of the upper forceps, are seen laterally, one above the other, the posterior border of the genitalia has a bi-toothed serration.

A. armata Macquart is described with, and the drawing shows, four ventral spines on the anterior femora. There can be little doubt but that the Tasmanian specimens in the collection belong to this species, and specimens from Sydney are identical, making *I. planiceps* Schiner an undoubted synonym.

A. setifemorata Macquart and *A. antileo* Walker, from their descriptions, are referable here.

Description. ♂ The tubercle of the face is large; the moustache is mostly black, but there are about six white bristles in the centre. There is a row of black bristles behind the eyes.

The dorsal thoracic bristles are disposed each side of the median line as follows:—two presutural; two superalar; one postalar, but sometimes a second, very thin, postalar bristle is also present; about six dorsocentral; all these bristles black.

There are two black scutellar bristles. The metapleural bristles are black or white, and the hypopleural bristles are white and not very prominent.

The abdominal bristles are mostly white. The upper forceps of the male genitalia are simple, and without a process; they broaden apically, and the posterior margin is obliquely angled or rounded.

The anterior femora have four conspicuous, thick, black, ventral spines; the intermediate and posterior femora have their respective spine systems sometimes complete, but the rows generally have a reduced number of spines

The wings have a normal venation; the intermediate crossvein is situated at nearly two-thirds the length of the discal cell, and the second posterior cell is long and slightly constricted subapically.

♀. The female is similar to the male, but the moustache and abdominal spines are very variable in colour. The ovipositor is very long and ribbon-like.

Hab.—New South Wales and Tasmania. (October to January. April.)

Note.—In the collection under revision there are twenty specmens; two males and eight females from Sydney, one female from Milson Island which is labelled by White as his *N. vulgatus;* two males and four females, in the Macleay Museum, from New South Wales, and three females from Tasmania, one of which was taken in April.

Becker* described a species from British East Africa under the name *N. armatus.* This appears to be a true *Neoitamus* for which a new specific name will be required if Macquart's species, described above, is allowed to remain within this genus.

NEOITAMUS CLARIPES White. (Text-fig. 11.)

Rhabdotoitamus claripes, White, Proc. Roy. Soc. Tas., 1917 (1918), p. 98.

Description. ♂. The face has a small tubercle. The moustache is small, and composed of about twenty bristles and hairs. There is a row of small, thin, yellowish bristles behind the eyes.

The dorsal thoracic bristles are disposed on each side of the median line as follows:—one black a second yellow or black, presutural; one yellow, rarely black, superalar and sometimes a second yellow or black bristle is present; from two to five dorsocentral, of which the two posterior are always yellow, the others, if present, are black. There are two yellow scutellar bristles; the metapleural bristles are yellow, and the hypopleural bristles are suppressed.

The abdominal bristles are mostly black on the first segment, and long, prominent and yellow on the second to fifth segments. The upper forceps of the male genitalia are rather long, and thin; they curve upwards apically, and are without a process.

The legs have the anterior femora without spines; the intermediate femora with only three spines, one of which is placed about one-third and the second about two-thirds the length of the anterior side; the third is placed subapically on the posterior side; the posterior femora have the spines on the anterior side reduced to two or three representing the lower row, and one or two representing the upper row; there is a complete ventral row, but the spines are often reduced in size to bristles.

The wings have a normal venation; the intermediate crossvein is situated a little beyond the middle of the discal cell, the second posterior cell is long and slightly constricted subapically.

♀. The female is similar to the male, and the ovipositor is rather short.

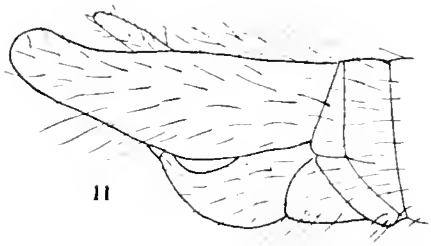
Hab.—New South Wales: Sydney and Blackheath.

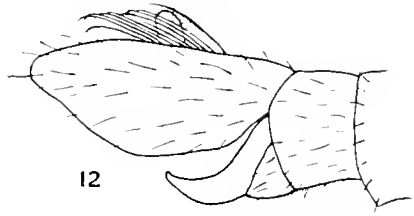
Note.—The collection under revision contains nine males and eleven females from Blackheath, taken from the 14th to the 25th November, 1919, and one female from Sydney taken on the 30th March, 1919; there are also two females from New South Wales in the Macleay Museum. They agree in every respect with White's description.

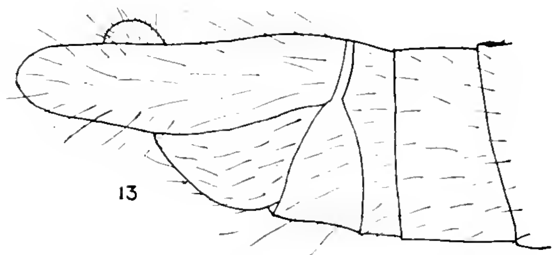
NEOITAMUS MACULATOIDES, n.sp. (Text-fig. 13.)

Description. A black species with a superficial resemblance to *N. maculata* White, but the female ovipositor is shorter and only slightly compressed. There is no description amongst the Australian species of *Neoitamus* that can in any way be associated with this species.

* Bull. Mus. Paris, 1909, p. 144, and Ann. Soc. Ent. France, lxxix., 1910, p 22.







Text-fig. 11.—*Neoitamus claripes*, male genitalia. (x 25).
Text-fig. 12.—*Neoitamus margites*, male genitalia. (x 25).
Text-fig. 13.—*Neoitamus maculatoides*, n.sp., male genitalia. (x 25).

♂. The front, face and most of the tubercle are brownish; from the oral margin to behind the eyes, the head is covered with a light grey tomentum. The hair on the front is black. The tubercle is large, and contains a large moustache of mostly black hairs, but at the oral margin the hairs are white. The beard is white. There is apparently a double row of bristles behind the eyes. The antennae are black, the first joint is twice the length of the second, the third is elongate and tapering, and without any apparent differentiated style, and this is longer than twice the length of the two basal joints united. The eyes, proboscis and palpi are black, the latter has white hairs.

The thorax is black, with traces of four darker, thin, median stripes and light grey tomentum stripes and spots. The dorsal thoracic bristles are disposed each side of the median as follows: two presutural; two supra-alar; two postalar; and about seven dorsocentral. There are also numerous bristle-like hairs on the dorsum. All the bristles including the two scutellar, the metapleural and hypopleural are black. The hairs on the thorax are mostly black, but there are long, thin, white hairs posteriorly and on the shoulder tubercles.

The abdomen is black, with the incisions and sides dark grey. The hair above and below is white. The bristles are long, black and prominent as far as the sixth segment. The upper forceps of the male genitalia are long, narrow and without a process.

The legs have the anterior femora without spines, and the intermediate and posterior femora with their respective spine systems more or less complete.

The wings have a normal venation: the intermediate crossvein is situated a little beyond the discal cell, and the second posterior cell is short. The lower branch of the cubital fork is rather strongly curved upwards, and there are fuscous spots situated at the usual positions, one each at the apices of the marginal, first and second posterior, and the discal cells, and also one at the cubital fork.

♀. The female is similar to the male; the ovipositor is very short and only subcompressed; it shows a ventral surface as linear, but the dorsal surface is convex and tapers apically and in transverse section a "V" is formed by the two sides.

Length.—Male, 14 mm.; female, 18 mm.

Hab.—New South Wales: Sydney; holotype male and allotype female, 31st March, 1918; one paratype male, 29th March, 1918.

Type.—The holotype and paratype are in the Australian Museum.

NEOITAMUS MARGITES Walker. (Text-fig. 12.)

Asilus margites, Walker, List Dipt. Brit. Mus., ii., 1849, p. 461; vii., suppl. 3, 1855, p. 737; Ricardo, Ann. Mag. Nat. Hist., (8), xi., 1913, p. 448.

Neoitamus caliginosus, White, Proc. Roy. Soc. Tas., 1913 (1914), p. 277; 1916, p. 176; 1917, p. 93 (in key).

Synonymy.—Walker's type is from Melbourne, and White's type is from Tasmania. In the collection under revision there are specimens from Sydney identified by White as his *N. caliginosus;* these agree with the Tasmanian specimens, and also with Walker's description of *A. margites.*

Description. ♂. The face has a large tubercle, and a moustache composed of mostly white hairs. There is a row of black bristles behind the eyes.

The dorsal thoracic bristles are disposed on each side of the median as follows:—two presutural; two superalar; one postalar; five dorsocentral. The number of bristles appears to be constant, and normally they are black. There are two scutellar bristles which are normally black, but often one or both are white. The metapleural bristles are black and the hypopleural bristles are white and weak or obsolete.

The abdominal bristles are mostly black, small and not very conspicuous. The upper forceps of the male genitalia are simple and without a process, but they have a row of about ten long, slender, dorsal bristles which somewhat conceal the median lamella.

The legs have the anterior femora without spines; the intermediate femora with the row on the anterior side usually reduced to two spines, a subapical spine on the posterior side, and the ventral row of spines complete; the posterior femora with the system of spines complete.

The wings have a normal venation; the intermediate crossvein is situated about the middle of the discal cell, and the second posterior cell is short. Sometimes fuscous spots are present on the wing.

♀. The female is similar to the male and generally has a few black hairs above the white in the moustache; the ovipositor is short.

Hab.—Tasmania and New South Wales.

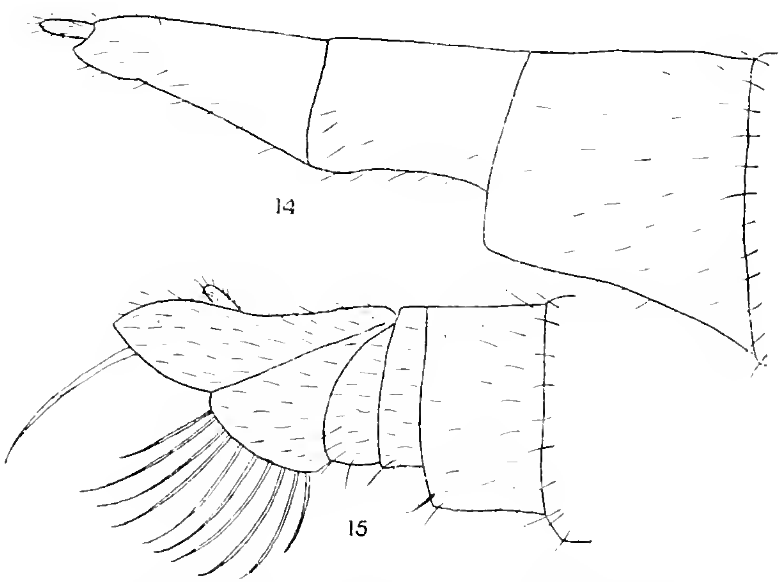
Note.—In the collection under revision there are twenty-five specimens; three males and four females from Tasmania, and five males and thirteen females from New South Wales. One female from Sydney and one from the Hawkesbury River are labelled by White as his *N. caliginosus.*

NEOITAMUS SETOSUS, n.sp. (Text-figs. 14, 15.)

Description. ♂. The tubercle of the face is large, the moustache is mostly white, and the hairs above and laterally are black. The front is black, covered with grey tomentum, and contains some long black hairs on the ocelli; these hairs extend in two rows parallel to the eyes. The antennae are black; the first joint contains some short black bristles and some long black ventral hairs; the second segment is half the length of the first and contains some short black bristles; the third segment is as long as the second and tapers into an apparently unjointed arista, the whole length of the joint and arista is slightly longer than the two basal joints united. The proboscis is black, and the palpi are black with black hairs. The beard is white. Behind the eyes there is a double row of black bristles.

The thoracic markings are of the usual form containing a pair of median stripes and an interrupted lateral stripe on each side. The dorsal thoracic bristles are disposed on each side of the median as follows:—two presutural; two, rarely three, superalar; three, rarely four, postalar; seven dorsocentral. All these bristles, the four scutellar bristles, the metapleural and hypopleural bristles are black. The thorax ventrally is covered with grey tomentum and white hairs

The abdominal bristles are yellowish, long, and conspicuous from the third to the sixth segments only. The segments are black dorsally, with mostly black hairs; the incisions, sides and ventre are grey, with grey tomentum and long yellowish hairs. The upper forceps of the male genitalia widen apically, and each branch has a long, strong, ventral bristle placed subapically, and anteriorly to these there are a few long hairs. The lower forceps have a row of eight ventral bristles each; the first and eighth bristles are weakest.



Text-figs. 14-15.—*Neoitamus setosus*, n.sp. 14, female ovipositor; 15, male genitalia. (x 25).

The legs have the coxae covered with grey tomentum and hairs, and the intermediate coxae have two black bristles; the femora are black with white pubescence. The anterior femora are without spines; the intermediate and posterior femora have their respective system of spines more or less complete.

The tibiae are reddish with the apical fifth black, all bristles black. The tarsi are black, with black bristles and reddish pubescence beneath.

The wings are slightly infumed and have a normal venation; the intermediate crossvein is situated before the middle of the discal cell and the second posterior cell is rather long and slightly constricted subapically.

♀. The female is similar to the male; the abdominal bristles are smaller; the ovipositor is short, and contains a cylindrical styliform lamella. The sixth and seventh abdominal segments are black, shining and subcompressed; sometimes the seventh segment is quite compressed, and both the sixth and seventh segments are as long as the ovipositor.

Length.—Males, 15—16 mm.; females, 13—19 mm.

Hab.—New South Wales: Sydney and Katoomba. (November to January.)

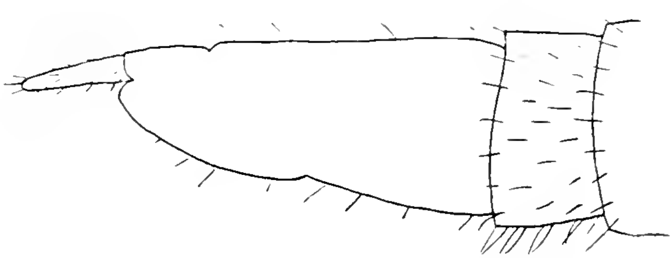
Type.—The holotype male and the allotype female were presented to the Australian Museum by Dr. E. W. Ferguson. They were taken in Sydney, at Roseville, on the 17th and 8th November, 1919, respectively. There are eleven paratypes, four males and three females from the type locality, also taken by Dr. Ferguson; one male taken at Katoomba during 1912, by Mr. E. Green, a pair taken by Mr. F. H. Taylor in Sydney, and one in the Macleay Museum.

Note.—This species cannot be made to agree with any description so far published. *A. exilis* Macquart has bristles on the apex of the male genitalia, but differs according to its description in several respects and is from Kangaroo Island. *Asilus villaticus* Walker from New South Wales, and *Cerdistus australis* Ricardo also do not conform to this species, although the latter, and probably the former, have bristles on the male genitalia. The females of both these are known to Miss Ricardo, and it is taken for granted that no species known to that author has the sixth abdominal segment of the female ovipositor-like. Both Miss Ricardo and White state that the sixth abdominal segment does not form part of the ovipositor in Australian species. *Asilus filiferus* Macquart, from Sydney Island, has also filaments to the male genitalia, but Macquart's drawing of this organ differs considerably from that of the species described above.

NEOITAMUS MACULATUS White. (Text-fig. 16.)

Neoitamus maculatus, White, Proc. Roy. Soc. Tas., 1913 (1914), p. 278; 1917, p. 93 (in key).

Description ♀. The face has a large tubercle; the moustache is composed chiefly of long black hairs, but there are white hairs along the oral margin. There appears to be a double row of black bristles behind the eyes.



Text-fig. 16. *Neoitamus maculatus*, female ovipositor, drawn from the holotype. (x 25).

The dorsal thoracic bristles are disposed on each side of the median line as follows:—two superalar, and anterior to these there is a third but very weak bristle; the postalar are represented by three in the holotype and two in the paratype; about five dorsocentral; all these bristles are black. The two scutellar and the metapleural and hypopleural bristles are black.

The abdominal bristles are mostly black, but some white occur laterally. The ovipositor is short and compressed; the lamella is cylindrical, styliform, and slightly longer than usual in the genus.

The legs have the anterior femora without spines; the intermediate femora have about four conspicuous black spines on the anterior side and one subapical spine on the posterior side; the posterior femora have about three subapical spines and a few black spines on the anterior side, and also a row of white, ventral, bristle-like spines.

The wings have a normal venation; the intermediate crossvein is situated at about two-thirds the length of the discal cell and the second posterior cell is rather short and slightly constricted subapically. Fuscous spots are present in the usual positions; one each at the apices of the marginal, first and second basal, and the discal cells, and also one at the cubital fork.

♂. The male is unknown.

Hab.—Western Australia: Armidale and Darlington, near Perth; King George's Sound.

Type.—The holotype, in the Australian Museum, was taken at Armidale on 1st October 1912. The paratype is smaller and was taken at Darlington on 7th October, 1912.

Note.—Two female specimens, from King George's Sound, are in the Australian Museum collection, and agree with the type. This makes four specimens so far known, but it is probably quite a common species.

NEOITAMUS MISTIPES Macquart.

Asilus mistipes, Macquart, Dipt. Exot., suppl. 4, 1850, p. 94, Pl. 9, fig. 3 (wing).
Neoitamus graminis, White, Proc. Roy. Soc. Tas., 1913 (1914), p. 278; 1916, p. 179.
Rhabdotoitamus graminis, White, Proc. Roy. Soc. Tas., 1917, p. 99.
??*Neoitamus mistipes*, Ricardo, Ann. Mag. Nat. Hist., (8), xi., 1913, p. 433; White, Proc. Roy. Soc. Tas., 1913, p. 275 (in key).
??*Rhabdotoitamus mistipes*, White, Proc. Roy. Soc. Tas., 1917, p. 100.

Synonymy.—*Asilus mistipes* Macquart is described from Tasmania, and the description agrees with White's *R. graminis*.

Miss Ricardo described a species from Mt. Gambier, South Australia, and referred it to Macquart's name. White overlooked Macquart's locality, and in his references he refers to Miss Ricardo's description only, using the locality given there. It is doubtful if Miss Ricardo's species is the same as Macquart's.

Unfortunately there is not a specimen of *R. graminis* White in the collection under revision, nor a specimen of *N. mistipes* Ricardo from South Australia, nevertheless the above synonymy appears to be convincing enough from a comparison of their respective descriptions.

ORDINARY MONTHLY MEETING.

26TH MAY, 1920.

Mr. J. J. Fletcher, M.A., B.Sc., President, in the Chair.

Mr. ROBERT JACKSON NOBLE, B.Sc., Biological Branch, Dept. of Agriculture, Sydney, was elected an Ordinary Member of the Society.

The President offered the congratulations of Members to Dr. L. A. Cotton (in absentia) on attaining the Doctorate of Science.

A circular was read from the Hon. Secretaries of the Institute of Pathological Research of New South Wales, calling attention to the establishment of the Institute, and appealing for funds.

The Donations and Exchanges received since the previous Monthly Meeting (28th April, 1920), amounting to 8 Vols, 65 Parts or Nos., 20 Bulletins, 1 Report and 3 Pamphlets etc., received from 41 Societies and Institutions and three private donors, were laid upon the table.

NOTES AND EXHIBITS.

Mr. F. H. Taylor exhibited specimens of *Lucilia fucina* Walker, *Neopollenia papua* Walk.,—both recorded for the first time from Australia, the former being originally described from S. Africa, the latter from Papua. *L. fucina* is one of the sheep maggot-flies in Queensland, and probably in other States, and seems to have been confused with *L. sericata*.—*Chrysomyia rufifacies* (Macq), *C. varipes* (Macq.), and *Ophyra analis* Macq., also sheep pests, *C. dux* Esch., *Lucilia solaia* Walk., *Pyrellia naronea* Walk., and *Chaetodacus tryoni* (Frogg.), a fruit fly which breeds in grenadillas in North Queensland; also *Binellia tayloriana* Bezzi and *Euprosopia punctifacies* Bezzi.

Mr. E. Cheel exhibited specimens taken in October last, from a cultivated plant of a so-called double flowering peach-tree (*Prunus persica* var. *dianthiflora*) showing, in addition to the ordinary flowers with an increased number of sepals and corresponding number of petals and single pistils, quite a number of flowers with two, three and four carpels distinct from the calyx and from each other in the one flower. An illustration, together with a note, is published by M. J. Berkeley in the Gardener's Chronicle for 1852, p. 452, of a similar occurrence in a "Golden Drop Plum," but the number of carpels according to the drawing was usually two, or occasionally three, in the one flower. Kerner and Oliver (Vol. ii., p. 548) refer to this peculiar growth under the term "Antholysis," whilst Berkeley's drawing and note is quoted by Masters (Teratology, p. 365, fig. 186), under the term Polyphylly of the flower. Worsdell (The Principles of Plant Teratology, vol. 2, p. 93, 1916) mentions that in double flowers of the cherry, two carpels are almost invariably present. Daydon Jackson defines the term "Antholysis" as a loosening or a retrograde metamorphosis of a flower.

Mr. A. R. McCulloch exhibited a small collection of fishes recently presented to the Australian Museum by Mr. David G. Stead, general manager of the State Trawling Industry. These had been trawled in 150 fathoms, East of Sydney, on the edge of the continental shelf, and included several species not hitherto recorded from New South Wales waters.

Mr. A. A. Hamilton exhibited a series of specimens of Aroids from the National Herbarium, illustrating Chromatism, Virescence and Multiplication of Spathes. (1) *Anthurium chelseiensis* Hort., Botanic Gardens, Sydney (E. N. Ward, April, 1914). (2) *A. Andreanum* Linden, "Uralla," Concord (J. H. Horton, July, 1917). In both examples the highly coloured pigment, which under normal conditions covers the spathe, is only partially developed. On a portion of the surface the chlorophyll is disclosed (virescence) indicating the leafy origin of the spathe. In the example of *A. Andreanum* the spadix is suppressed and the spathe slightly malformed. (3) *Richardia africana* Kunth., Manly (W. Ellison, August, 1914), showing (*a*) a coloured leaf (chromatism) on the flower stem simulating the spathe, (*b*) drawing by Miss M. Flockton of a flower grown at Summer Hill by Mrs. W. H. Hughes, depicting a supernumerary spathe enfolding the normal floral envelope. (4) *Richardia Elliottiana* × *Pentlandii*, Sydney Botanic Gardens (C. Woolnough, January, 1920) from a seedling raised by H. H. B. Bradley. In this example the colouring pigment of the spathe is partially developed in the supporting leaf. Worsdell (Prin. of Plant Teratol., i., Pl. xvii.) figures a similar example of chromatism in *R. Elliottiana*, and it is interesting to note that a seedling of this stock raised in Australia has perpetuated the abnormality.

Mr. Fletcher exhibited a remarkable leaf of *Jacaranda ovalifolia*, 12½ inches long, apparently bifurcated apically for 3 inches, one branch having 9½, and the other 8½ pairs of pinnae, with 13½ pairs of pinnae on the undivided proximal portion; and he raised the question whether it was really a case of division of the growing point; or, seeing that the apparent bifurcations have pairs of pinnae, whether it was a case of the incomplete fusion of two leaves. He showed also flowering branches of *A. discolor* with leaves with one pair, two pairs, and three pairs of pinnae; leaves of advanced seedlings which had not yet flowered, with ten and eleven pairs of pinnae; and reversion-shoots and seedlings of euphyllodineous Acacias, to illustrate the importance of taking account of the terminal setae.

REPORT ON THE NEUROPTEROID INSECTS OF THE HOT SPRINGS REGION, N.Z., IN RELATION TO THE PROBLEM OF TROUT FOOD.

By R. J. Tillyard, M.A., D.Sc., F.L.S., F.E.S., Linnean Macleay Fellow of the Society in Zoology.

(With two Text-figures.)

On arrival at Auckland from Sydney on November 5th of last year, I was met by Mr. D. Miller, Government Entomologist, and Mr. H. Hamilton, Zoologist to the Dominion Museum, and proceeded with them to Rotorua, where I met Mr. Moorhouse, in charge of the Fish Hatchery in Lake Rotorua, and Mr. Hill, Head of the Tourist Department. All these gentlemen offered me every assistance in carrying out my investigations, and I desire to thank them very sincerely for their aid.

Three weeks were spent in the Hot Springs Region, the following being the itinerary:—

Nov. 7th-10th: Rotorua. Visited Te Wairoa, Whakarewarewa and portions of the Lake.
Nov. 11th-17th: Te Wairoa and Lake Tarawera.
Nov. 18th-19th: Rotorua. Visited Fairy Spring, Hamurana Spring, Lake Rotoiti and Okere Rapids.
Nov. 20th-21st: Wairakei and Taupo.
Nov. 22nd-26th: Tokaanu.
Nov. 27th: Lake Roto-Aira.
Nov. 28th: Waimarino.

It was hoped that a return visit might have been arranged later in the season (February) in order to see the other lakes and streams of this region, and to study the insects in the height of summer. Circumstances, however, made it impossible to carry out this plan.

The work done in the field may be divided into two parts:—

(i.) Examinations of the contents of trout-stomachs.
(ii.) Collection of the larvae and imagines of Neuropteroid Insects from the streams and lakes.

(i.) The Contents of Trout-Stomachs.

An examination of a considerable number of trout-stomachs during the month of November showed a great diversity of food eaten. The Green Manuka-Beetle, *Pyronota festiva*, was found to be the most abundant food. This beetle visits the Manuka bushes fringing the lakes and streams, and frequently falls or is blown off into the water, when it is at once seized and swallowed by the trout. Next in importance to this were found to be the larvae of the Caddis-flies of the family *Leptoceridae*, which form their cases of the green weed *Nitella*. The stomachs of a number of trout were found to be filled with this green weed, which, on being placed in a basin of water was seen to consist entirely of caddis-fly cases, many of the larvae being still alive within the trout's stomach. Another important food was a small Mollusc, *Potamopyrgus* sp., of which no less than 140 were counted in the stomach of a "slab" taken at Rotorua. Other foods found less commonly were the larvae of Dragonflies, Mayflies, Stoneflies and the other families of Caddis-flies, occasional remains of the Crayfish, small fish, and a number of insects of various kinds which may be considered to have no definite value as trout-food being only chance captures.

Besides these, it is important to note that some trout-stomachs were found containing nothing but pebbles, and several were quite empty.

A considerable number of the trout examined were definitely "slabs." The slabby condition appeared to be due, not only to the usual poor health of the fish for some months after spawning had taken place, but more definitely to both semi-starvation and indigestion. It was not surprising to find that fish with their stomachs empty, or only filled with pebbles were in poor condition. But there were also cases in which the slabby condition appeared to have been caused by the indigestibility of the food. In one case the large claws of a crayfish were found fixed inside the stomach of a trout in such a way as to block the passage of other food; and they had evidently been there a considerable time, seeing that all the rest of the animal had been completely digested. This led me to conclude that the crayfish is only a good food for trout when it is of not too large a size Consequently the introduction of any larger or more vigorous species of crayfish than the one endemic in the region ought not to be encouraged.

(ii.) The Neuropteroid Fauna of the Streams and Lakes.

The Neuropteroid Insects inhabiting the streams and lakes of the Hot Springs Region may be divided into six Orders, three of which belong to the more primitive division of the winged insects, viz., those that have no true pupal or resting stage (Hemimetabola) and three belong to the more highly evolved division, possessing a true pupal stage (Holometabola). They may be classified as follows:—

Division Hemimetabola: (Winged insects without a true pupal or resting stage).

Order 1. Perlaria or Stone-flies.
„ 2. Plectoptera or May-flies.
„ 3. Odonata or Dragonflies.

Division Holometabola: (Winged insects possessing a true pupal stage).

Order 4. Megaloptera or Alder-flies.
„ 5. Planipennia or Lacewings.
„ 6. Trichoptera or Caddis-flies.

(*Note.*—The Scorpion-flies, Order Mecoptera, are not represented in the Region under discussion.)

Of the six Orders enumerated we may omit from the discussion Order 5 (Lacewings) whose larvae are either terrestrial, or else lurkers along the moist borders of streams. They attack the larvae of the other Orders which are of value as food for trout. Thus, in so far as they affect the problem at all, they act detrimentally to the food-supply. But they are exceedingly rare in the Hot Springs Region, and were only found by me in two localities, viz.: Hamurana Spring, and the waterfall at Wahi, near Tokaanu.

Order 4 (Alder-flies) is only represented in New Zealand by a single species, *Archichauliodes dubitatus*, an insect of large size, whose fat, succulent larva is found under rocks in streams, and forms an excellent food for trout. This larva is called the "Black Creeper," or sometimes the "Toe-biter." Though very abundant in most parts of New Zealand, it appears to have been exterminated by the trout in most parts of the Hot Springs Region, though it is still fairly abundant on the Tongariro River and tributaries.

The other four Orders, Stone-flies, May-flies, Dragon-flies and Caddis flies, are of the greatest importance as trout-food, and we have to consider them in somewhat greater detail.

The Stone-flies.

These insects confine themselves to running water, preferring rocky streams, with a fairly fast current. Their larvae live on rocks and stones, where they wander freely in search of food. The perfect insects, or imagines, are sluggish, and seldom fly, preferring to sit about on the vegetation overhanging the streams. Nevertheless, they frequently fall into the water, and are eagerly seized by the trout. Both larvae and imagines are soft-bodied insects with a plentiful supply of fat, and form an ideal and easily digested food for trout.

Except along the Tongariro River and its tributaries, where the Stone-fly fauna is still abundant, these insects are very rare in the Hot Springs Region; and it is very clear that they have been greatly reduced in number by the trout.

The large green Stone-fly, *Stenoperla prasina*, generally abundant throughout New Zealand, and one of the best of trout-foods, was only to be found in streams above high waterfalls, where trout were absent. It has been almost completely annihilated in the Hot Springs Region.

The Black Stone-fly, *Austroperla cyrene*, the most abundant Stone-fly throughout New Zealand, has likewise been almost eliminated by the trout. A colony of larvae was discovered at the extreme head of one of the small streams at Hamurana. There are also a few larvae left here and there in the Tongariro River.

Of the slender Stone-flies (family *Leptoperlidae*) a number were found on the Tongariro River and its tributaries. Some of these are new to science, and will be described later. But, generally speaking, it may be said that these valuable flies, like the rest of the Perlaria, are on the verge of extinction in the Hot Springs Region.

It would, I think, be well within the mark to estimate that more than 80 % of the original Stone-fly fauna of the Region has already been destroyed by the trout.

The May-flies.

These insects inhabit both streams and lakes. In all parts of the world they form one of the most important articles of diet for the trout. Both the larvae and the imagines are soft-bodied and easily digested. In the Northern Hemisphere, where the evolution of the May-flies has taken place alongside that of the native trout, the larvae have resorted to many cunning devices in order to escape their rapacious enemies. Those of the larger species mostly burrow into the banks of streams, and thus secure immunity from attack; while the smaller forms hide under rocks and stones, and evade attack by their quick running powers. Thus the trout only secure the May-flies in their winged stages (subimago and imago).

In New Zealand, the native May-fly fauna has been evolved without exposure to the attacks of rapacious fish such as the trout. There is only one large species whose larva burrows into the river-banks, viz., *Ichthybotus hudsoni*; and it is clear, for many reasons, that this May-fly did not evolve this habit in New Zealand, but migrated thither long after the adoption of it. All the rest of the large May-flies, forming together a magnificent fauna unequalled in any other part of the world, have evolved little or no protective habits against such a fish as the trout. The larvae of *Oniscigaster*, one of the finest May-flies in the world, sit about on rocks or on the gravelly bottoms of streams; and, when attacked, they only wriggle forward like a shrimp. Consequently they have become an easy prey to the introduced trout, which gorged themselves for some years on this large supply of choice food. This magnificent genus is now quite extinct throughout the Hot Springs Region, and also in the streams around Christchurch, though still to be found here and there in out-of-the-way places in both Islands. Another fine genus, *Ameletus*, has larvae capable of quicker movement, and is therefore still fairly abundant in most parts of New Zealand. But these larvae are also on the verge of extinction in the Hot Springs Region. I did not discover a single *Ameletus* larva throughout my investigations, though I caught a fine imago of a new species belonging to this genus above the high waterfall at Wahi, near Tokaanu, where trout are absent. A third May-fly genus of great importance is *Coloburiscus*. The larvae have a certain amount of protection against the trout, owing to their bizarre form, their gills being arranged so that they look like a small piece of tangled moss or weed. They are very sluggish and hide under rocks and stones in running water. *Coloburiscus humeralis* is one of the most abundant May-flies in New Zealand; yet it has been practically eliminated from all parts of the Hot Springs Region, except only on the Tongariro River and its tributaries, and on those small streams where trout are absent, from some cause or other, such as the intervention of a high waterfall, as at Wahi.

Besides the larger May-flies mentioned above, there are two genera of smaller May-flies, *Atalophlebia* and *Deleatidium*, containing numerous species which are very abundant all over New Zealand. The larvae live under rocks and stones in streams and lakes, and are fairly active. Most of them are vegetable feeders, but a few are carnivorous. A number of species of these genera were collected, some of them new to science. These latter will be described later. Throughout the Hot Springs Region, a very considerable diminution of the supply of the small May-flies is noticeable; and this cannot fail to exercise a serious effect upon the future of the trout.

To sum up the position, we may say that the largest May-flies, which form the very finest possible food for trout, have been practically exterminated, while the smaller forms have been reduced, at a moderate estimate, by over 50 %.

The Dragon-flies.

New Zealand is poor in species of Dragonflies, but most of them are common. Seven species are found very commonly throughout the Hot Springs Region. Of these the largest (*Uropetala carovei*) is of no importance as trout food, the larva dwelling in holes in the moss and peat of swamps. The larvae of the bright red *Diplacodes bipunctata*, dwelling in still back-waters, may also be left out of account. The larvae of the other five were all found by me in the stomachs of trout, the most frequently occurring being those of *Procordulia smithii*, *Pr. grayi* and *Xanthocnemis zelandica*. No doubt, later on in the season, the trout would also feed upon the imagines, as in Tasmania.

In certain parts of New Zealand, I found Dragonfly larvae to be the principal food of the trout. In the Hot Springs Region, the trout seem to have considerably diminished the number of larvae, and they do not form so important an article of diet, perhaps because they are more protected by their peculiar colouration and habits than are some other aquatic insect larvae, such as those of May-flies. It seems clear that their numbers have been much decreased since the trout were freed in these lakes and rivers, although I am unable to estimate this reduction as clearly as in the cases of Stone-flies and May-flies.

The Caddis-flies.

Observations in other parts of the world, as well as in other parts of New Zealand, show that Caddis-fly larvae form one of the most important articles of diet for the trout. Most of these larvae construct cases for themselves out of weeds, sticks, sand or small pebbles; and one would imagine that such habits as these would serve as efficient protection for them. But this is not the case. The trout know well the habits of the Caddis larvae. They watch carefully for any suspicious movement amongst the weeds, sticks, etc., that strew the bottoms of the lakes and streams, and they pounce upon the larvae and swallow them whole in their cases. The substance of the case is usually indigestible; but the larva itself is a succulent, fat morsel, and an excellent food for the fish. Those most sought after are the elongated, more or less cylindrical cases of the *Leptoceridae* and *Sericostomatidae*, the former usually made from weeds, pieces of leaves or sticks, the latter from grains of sand or a thin transparent substance secreted by the larva itself. In the *Leptoceridae*, the genera *Notanatolica*, *Triplectides* and *Oecetis* are abundant throughout New Zealand; in the *Sericostomatidae* the same is true of *Olinga* and *Pycnocentria*. Throughout the Hot Springs Region the trout have most seriously diminished the number of these and other Caddis-flies. Only two species now remain at all common, viz., *Oecetis unicolor*, whose larva is still common, feeding in the green *Nitella*-beds in the lakes, and *Hydropsyche colonica*, whose larvae form fixed houses of small pebbles attached to rocks. This latter species still exists in great numbers in such places as the Okere Rapids, where the rush of water is too swift for the trout to search for it. Its comparative absence in other parts is strong evidence of the reduction of the Caddis-fauna, due to the trout.

The most striking instance of the almost complete loss of the original rich Caddis-fauna is afforded by the condition of the Te Wairoa stream, flowing into Lake Tarawera. Except in the rough water below the Falls, where no trout exist, it is almost impossible to obtain any caddises in the stream. But a short distance off there is a much smaller stream, rising from a hill near the lake. This stream has been dammed off by boards, and the water drawn off close to its exit into the lake by a force-pump. No trout pass up this small stream. On examining it I found that it was swarming with caddis-larvae under every stone and stick, and upon the gravelly bed and sides of the stream these little creatures were most abundant. Yet a day's search in the Te Wairoa stream yielded far less than I was able to pick out in the course of ten minutes in this tiny stream a mile away from it.

It would not be overestimating the depredation caused by the trout amongst the Caddis-fauna of the Hot Springs Region, if the loss were put at 90 % of the original fauna.

THE STATE OF THE INSECT FOOD SUPPLY.

My survey of the insects of the Hot Springs Region quickly convinced me that the balance of nature has been completely upset by the introduction of the trout. By comparison with the state of affairs in most parts of the South Island, where the fauna, though seriously reduced in many places, is usually found to be more abundant than it is in this Region, it appears certain that the Rainbow Trout has had a greater share in the eating-out of the insect fauna than has the slower and less greedy Brown Trout. The history of the Trout-fisheries of the Region may be briefly stated as follows:—

(i.) Before the introduction of the trout the rivers of New Zealand swarmed with an aquatic insect fauna as abundant as that to be found in any part of the world. The lakes carried a less abundant fauna of fewer species.

(ii.) The great majority of these insects, having evolved to their present state without the stimulus of the predatory action of any rapacious fish, possessed no means of defence against the trout when they were introduced.

(iii.) The introduced trout, and especially the Rainbow, gorged themselves at leisure upon the rich food; so that, in the course of a few years, trout of record size were being caught, and the fisheries obtained a world-wide reputation.

(iv.) No scientific attempts have been made to conserve or renew the food-supply. On the contrary, the only idea seemed to be to put in more and more fry.

(v.) As soon as the food supply began to fail, some of the trout became weakened; "slabbiness" became noticeable; and disease in the form of thread-worm and fungoid growths appeared. There is also considerable evidence of actual starvation of trout in certain streams.

(vi.) Some attempts have been made of late years to reduce the number of trout by netting and trawling. These efforts may be said to have brought about some slight improvement in the condition of the fish. At the same time, the destruction of shags has diminished the prevalence of the thread-worm (of which the shag is said to be the intermediate host). But the disease is by no means stamped out, and most certainly requires further careful study.

The present position of the trout-fisheries of the Hot Springs Region is that there is, throughout most of the Region, *not enough food* for the trout present. Many of the streams, especially those in which the fish spawn regularly, are almost totally "eaten-out," and the amount of food in the lakes is woefully deficient. The only part of the Region in which the state of affairs can be described as at all hopeful, so far as my investigations go, is the Tongariro River and its tributaries, where the supply of food is still fairly abundant.

One might sum up the position, somewhat caustically, by comparing it with that of a grazier who put 10,000 head of cattle into a very rich 1000-acre paddock, left the animals to feed, and, when the food supply began to fail, prepared to remedy it by putting in a fresh supply of calves every year, without making any attempt to improve the impoverished food supply!

(iii.) Recommendations.

It is clear that improvement in the Trout fisheries of the Hot Springs Region can be effected along two distinct lines, viz.:—*improvement of the food supply* and *reduction in the number of trout*. No considerations of the attractions to tourists or anglers, from a super-abundant supply of trout, should be allowed to cloud the main issue, which is this: that, *unless a natural balance can be brought about* *between the introduced trout and the food supply, the fisheries are sooner or later doomed to failure.*

With regard to the improvement of the food supply, the position is at present a very serious one, in so far that the balance has been so greatly upset, that no measures for the introduction of fresh types of food can be expected to succeed, unless such food is most carefully protected until it becomes well established. It is, therefore, necessary to adopt at once measures which will not only help to conserve the remnant of the food supply still existing, but will also give the aquatic fauna a chance of multiplying and approximating towards its original abundance. To bring this about I would make the following recommendations:—

1. A badly impoverished stream should be selected, and should be completely blocked by means of specially designed trap-nets, so as to prevent any trout passing up it to spawn; also any trout at present in it should be taken out. Aquatic insects should then be introduced from neighbouring small streams where no trout exist (e.g., such parts of streams as lie above high waterfalls), and a careful record kept by means of annual or biennial visits, upon the progress of the aquatic insect life in the stream. I estimate that it will take at least *three years*, possibly *five*, for such an impoverished stream to return to its original condition. If, at the end of two or three years, it becomes evident that the aquatic fauna is increasing, steps should then be taken to block off in the same way each spawning stream in turn; so that, in any given year, there will only be certain streams open to the trout for spawning, while the rest will be given a chance of recuperation.

For this purpose I would recommend either of the following two streams:—

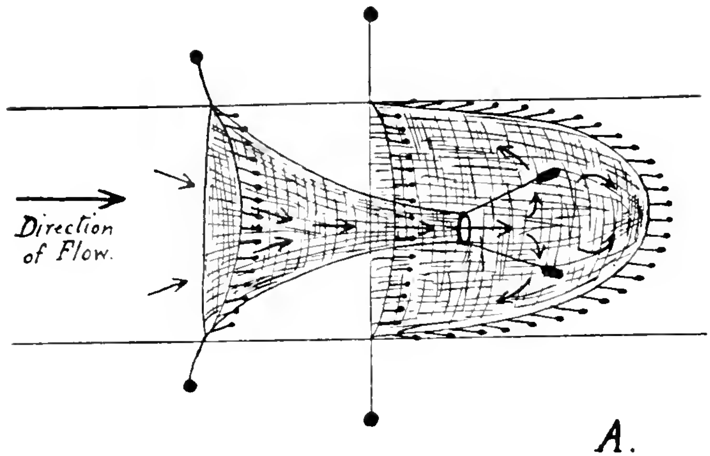
(*a*) The Te Wairoa stream, from the waterful to the outlet of Lake Tarawera. (There is an abundant supply of aquatic insects in the small creek on the left-hand side of the road leading down to the wharf, about a mile from the Te Wairoa stream).

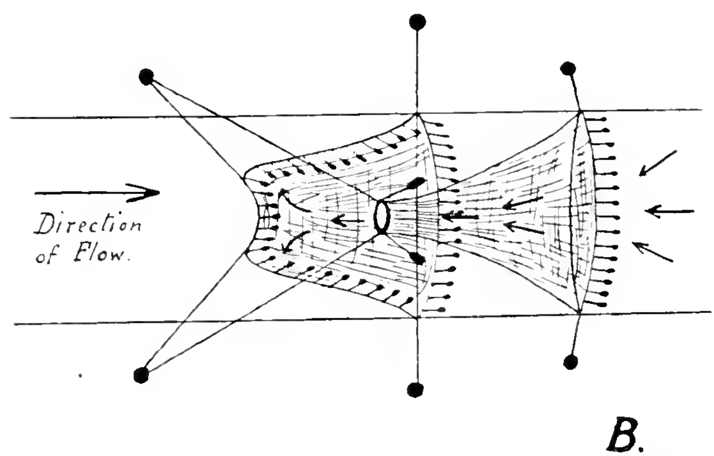
(*b*) The Tokaanu stream. (Aquatic insects are abundant in the small streams around Wahi, two miles away.)

In both cases, the nature of the river-bed (pumice) and frequency of flood water make it impossible to block the stream by means of stake or pile-nets. I would, therefore, recommend that the nets be strung on strong supports driven into the banks, and that their lower ends should hang freely into the stream, and carry lead weights at short intervals. The accompanying diagrams (p. 212), show the type of net to be used.

If at the end of three years there is no sign of the native aquatic insect fauna reasserting itself, I would recommend that an attempt be made to introduce the English "Green Drake" Mayfly, *Ephemera danica*, or such other species as are known to be of great value as food for trout. These could be set free in the larval condition in the streams selected as a sanctuary under recommendation (2) following this below.

2. It is of the greatest importance that one lake, together with the streams flowing into it, should be set aside as a sanctuary for the natural food-supply. Most unfortunately, this aspect of the question was not considered when the stocking of the streams with trout was undertaken. The result is that there is at present no lake in the Rotorua District which does not contain trout. In the Taupo District, an undertaking was given by the Government to the Maoris that Lake Roto-Aira should be kept free from trout. Unfortunately, trout were surreptitiously introduced into this lake two years or more ago, and have grown to a





A. Double trap-net with leaded bottoms, suitable for river with unstable pumice bed, and set so as to catch trout running *downstream*.

B. The same net, set with two extra pairs of steel-rope braces, so as to catch trout running *upstream*.

The arrows indicate the courses taken by the trout.

N.*B*. The nets should be so designed that plenty of "slack" is allowed for above the leaden weights, so that, if a flood washes the pumice bottom out, the slack will allow the net to sink without lifting the weights from the bottom.

considerable size. Roto-Aira is at present the only possible lake that could be maintained as a sanctuary.

I would therefore recommend that this Lake, together with all streams flowing into it, and the Pouto River flowing out of it, to within a mile of its entry into the Tongariro River (or to such point as will be suitable for the erection of nets to prevent access of trout) *should be proclaimed as a sanctuary for the native aquatic fauna*, and that immediate steps should be taken to eliminate from this area any of the trout that were surreptitiously introduced.

3. Following upon (2), steps should be taken to have an exhaustive scientific survey made of the natural trout-food existing within the bounds of the sanctuary, and experiments made with a view to improving it. I think this could be done by erecting a small Biological Station in a convenient locality near the sanctuary lake, and either placing it under the charge of a competent biologist, or else affording facilities for leading scientists to visit the station and study the fauna. In this connection I should like to point to the Cass Biological Station, which is under the charge of Prof. C. Chilton, and is owned by Canterbury College, as an excellent example of what can be accomplished in this direction at a very moderate cost.

With respect to methods for reducing the number of trout, I would point out, in particular, that over-sized fish are a serious menace to the success of a trout-fishery, because they not only consume far more food than do their equivalent weights of smaller fish, but they also take possession of the best feeding grounds, prevent the younger fish from obtaining an adequate food supply, and frequently themselves make inroads upon the smaller trout. With the maximum possible native food-supply, *a New Zealand fishery ought not to be expected to produce anything beyond a steady and assured supply of reasonable-sized fish;* and it should be one of the chief aims of a scientific directorate to produce this very desirable result. Consequently means must be devised, not only for reducing the general very obvious conditions of overstocking in the lakes which I visited, but also for removing "pirates" and over-sized fish wherever possible.

4. A more vigorous policy of netting the trout, either by the use of trawlers or small launches, on Lakes Taupo, Rotorua, and Tarawera. The money realised by the sale of such trout, either fresh or smoked, should be devoted to objects which might further the scientific study and direction of the fisheries; as, for instance, the provision of a Biological Station advocated under Recommendation (3).

5. The adoption of the regulations generally in use in the South Island concerning permissible baits; i.e., besides the artificial fly, it should be allowable to take trout on the natural fly, grasshopper, etc. I am well aware that all true sportsmen abhor anything but the artificial bait; but it is time that they realised that every inducement must now be offered to get a marked reduction from the present seriously over-stocked condition of the lakes.

6. Limitation of spawning to certain selected streams, which should be changed from year to year when practicable. This has already been dealt with in connection with Recommendation (1).

The above recommendations, if adopted, may be expected to show good results, in the case of the Taupo fisheries, within a few years' time. The fisheries of Lakes Rotorua and Tarawera are a more formidable problem; and it would be advisable to attempt the solution, in these cases, only in the light of the experience gained from the treatment of the Taupo fisheries.

THE PANORPOID COMPLEX.

Additions and Corrections to Part 3.

By R. J. Tillyard, M.A., D.Sc., F.L.S., F.E.S., Linnean Macleay Fellow of the Society in Zoology.

(With one Text-figure.)

During my recent visit to New Zealand, I was fortunate in obtaining fairly plentiful supplies of the larvae and pupae of a Thyridid moth, *Morova* (*Siculodes*) *subfasciata* (Walk.). The dissection of the pupal wings of this species has enabled me to fill in one of the gaps in the evidence in Part 3 of this work.

This moth lays its eggs, which are flat, circular, fringed discs, somewhat similar to the Tortricid type, on the stems of the *Parsonsia* vines which are found commonly in the bush throughout both North and South Islands. The young larva bores into the stem and feeds there, causing a noticeable swelling in it. It pupates in its own tunnel in the stem.

The imago is not unlike *Rhodoneura scitaria* in appearance, but the forewings are distinctly falcate at their tips. The genus *Morova* differs from *Rhodoneura* in having M_1 of the hindwing not directly connected with Rs, but joined to it through the cross-vein *m-r*, while in the forewing it has R_3 and R_4 anastomosing, the cross-vein *ir* being absent. In these characters, as Dr. A. J. Turner has pointed out to me, this genus resembles the Australian genus *Addaea* very closely.

In view of the above differences, it seems scarcely necessary to figure the imaginal venation of *Morova subfasciata* here. Reference should be made to Text-fig. 98 on p. 677 of Part 3 (these Proceedings, xliv., 1919, part 3), where the imaginal venation of *Rhodoneura scitaria* is shown.

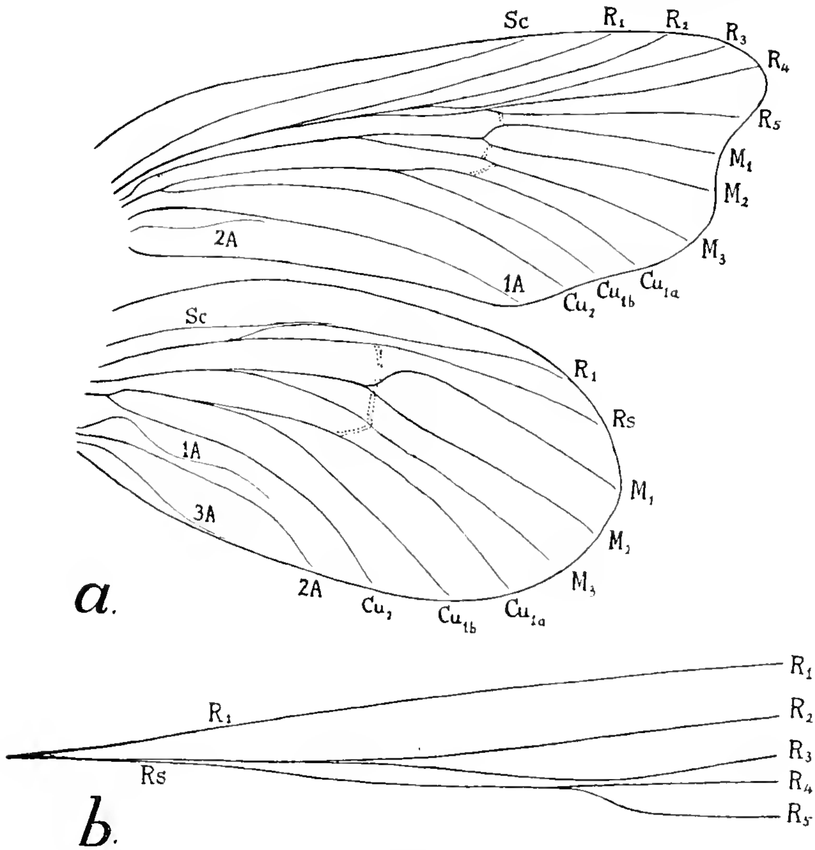
Text-fig. 113 shows the pupal tracheation, as drawn by me from dissections made from pupae taken on January 1st of this year in the Woodhaugh Gardens, Dunedin. For help in obtaining these specimens I am much indebted to my friends, Mr. G. Howes and Mr. C. Clarke, of that city.

The chief point of interest in the forewing is the condition of the radius and its sector, which is shown enlarged in Text-fig. 113 *b*. There is only a single radial sector, which forks in the normal Heteroneurous manner; the radial cell, or areole, is present, but exceedingly narrow, and is not closed distally. The condition in the imago, in which R_4 anastomoses with R_3, is evidently due to the suppression of the main stem of R_{4+5}, and the non-development of the cross-vein *ir*. Comparing the imaginal conditions of this region in *Morova* and *Rhodoneura*, we are able to deduce from this that, in *Rhodoneura* pupal wings, the condition of the radial sector of the forewing would be the typical one found in the Tortricina and many Tineina, viz., a single Rs with an areole formed between its two branches, this areole being closed distally by *ir*. Further consideration shows us that, in *Rhodoneura*, as in *Morova*, the main stem of R_{4+5}

does not chitinise in the imago; and hence the cell of the forewing is a true *areocel* of the Tortricid type.

Thus this portion of the forewing indicates some affinity with the Tortricina, as does also the form of the egg.

The contrast between the form of the radial sector of the forewing in *Morova* and in the Butterflies can be noted at once by comparing Text-fig. 113 with Text-figs. 99 and 101 of Part 3 of this work already referred to. I think that this character alone should put out of court any suggestion that the *Thyrididae* can possibly be ancestral to the Butterflies. It is only in the *Cossidae*, the oldest ex-



Text-fig. 113.

Morova (Siculodes) subfasciata (Walk.), (fam. *Thyrididae*). *a*, tracheation of pupal wings (x 18). *b*, the condition of the radial trachea and its sector in the forewing, further enlarged (x 45).

isting family of Heteroneura, that we find conditions at all approximating to those of the Butterflies with respect to the separation of Rs into two stems arising well apart from R1. This should incline us to look for the origin of the Butterflies much further back, almost certainly in some group that has long ago become extinct, and has left no very close relatives existing to-day.

Another point of interest in the forewing is that Cu_1 forks very far distad, well beyond the level of the forking of M_{1-4}. This should be compared with the condition to be seen in *Euschemon*, where the fork of Cu_1 is placed much nearer to the base; and, consequently, in the imago, Cu_{1a} and Cu_{1b} leave the areocel much further apart than they do in the *Thyrididae*. There can be little doubt that the condition to be seen in *Euschemon* and in other Butterflies is the more primitive of the two.

In dissecting the forewing of the pupa of *Morova*, I looked carefully for the trachea 3A, but failed to find it. This trachea is quite easily seen in the pupal wing of *Euschemon*. Thus there is here a third character in which the *Thyrididae* are more highly specialised than the oldest forms amongst the Butterflies.

In the hindwing, trachea R_1 is dominant over trachea Sc, as in the Tortricid *Carpocapsa* (Part 3, p. 665, Text-fig. 89) the Oecophorid *Wingia* (Part 3, p. 666, Text-fig. 90), and the Butterfly *Euploea* (Part 3, p. 685, Text-fig. 101), but not as in *Euschemon* (Part 3, p. 680, Text-fig. 99), where the reverse is the case. This character is not, however, of much importance, as we do not yet know how variable it may prove to be in the different families. Of more interest is the absence, in *Morova*, of any sign of a humeral veinlet in the hindwing. Such a veinlet is to be seen in the pupal wings of many Butterflies.

The very strong arching up of M_1 towards Rs in the hindwing of *Morova* appears to be a somewhat more specialised condition than that found in *Euschemon*.

The anal area of the hindwing in *Morova* is of very great interest. The pupal tracheation fully confirms my original interpretation of the anal veins in the imago of *Rhodoneura*. Trachea 1A is present in the pupal wing, in much the same condition as in the Cossid *Xlyeutes* (Part 3, p. 661, Text-fig. 87), but slightly more specialised by reduction, in that it fails to reach much more than half-way towards the wing-border. It has, as in *Xyleutes*, lost its original contact with Cu_2, and makes a strong downward curve towards 2A, without actually coming into contact with it. In the imago, 1A and 2A become fused, thus forming the basal anal Y-vein shown in Text-fig. 98.

This condition is much more primitive than that to be seen in the pupal hindwings of Butterflies, where 1A is completely absent, and consequently there is no basal anal Y-vein present. It would seem to indicate a close connection between the *Thyrididae*, and the more primitive types of Heteroneura, in which trachea 1A is preserved in much the same condition.

Trachea 3A is present in the pupal hindwing of *Morova*, as in that of the Butterflies, and becomes chitinised in the imaginal venation. Trachea Cu_2 is also present in the pupal hindwings of both groups, but fails to become chitinised in the Butterflies, though it is sometimes partially and very feebly indicated in the imagines of *Thyrididae*.

To sum up, then, there are three characters in the forewing of the *Thyrididae* which are more highly specialised than the corresponding conditions to be found in the oldest Butterflies. The hindwing, on the other hand, is in most respects more archaic than that of the Butterflies.

We may conclude from this that, while there are obvious affinities between the *Thyrididae* and the older groups, especially the Tortricina, and also between the *Thyrididae* and the *Pyralididae* (though the pupal wings of this latter family still remain to be studied), yet there is no evidence that the *Thyrididae* stand in any direct ancestral line to the Butterflies, as Meyrick and Hampson have averred. There is, on the contrary, very distinct evidence, in the form of three characters in the forewing, against this claim. The proper degree of relationship between the *Thyrididae* and the Butterflies is probably best expressed if we say that the old Protocossid stem gave origin in ascending order to (*a*) the Zygaenoid group of families (Meyrick's superfamily Psychina), (*b*) the Pyraloid group of families, of which the most archaic, having very distinct affinities with the Tortricina is the *Thyrididae*, though these are not even to be considered as *directly* ancestral to the *Pyralididae* themselves, and (*c*) the Rhopalocera, as a very distinct series whose origin is to-day lost to us.

At this stage we must leave this interesting problem, until such time as pupae of the *Zygaenidae* and *Pyralididae* can be obtained and their wings studied with a view to obtaining further light upon it. Sufficient evidence has, however been obtained to show the extreme unlikeliness of any existing Heteroneurous type representing even a close approximation to the original archetype of the Rhopalocera

CORRIGENDA TO PART 3.

p. 561, line 14 from bottom, for "one" read "two."
p. 588, for "Text-fig. 53" read "Text-fig. 58."
p. 594, remove the Lepidoptera from (C) to (D).
p. 623, interchange lines 26 and 27.
p. 635, in Table II., to the characters given under (4) add "veinlet *dcr*."
p. 647, line 19, for "Homoneura" read "Heteroneura."
p. 650, in last line, the percentage for *Hepialidae* should be 57.5, and that for *Prototheoridae* 32.5.
p. 676, lines 3, 7, and 14, for "1A" read "2A," as in Text-fig. 97.
p. 682 and p. 686, in Text-figs. 100 and 102, in hindwing, for "ac" substitute "bc"=basal cell. There is no true areocel in the hindwing.
p. 685, line 6 from bottom, complete the bracket after "*Euschemon*."
p. 689, lines 4 and 5 from bottom, the percentage for *Hepialidae* should be 68.5, that for *Prototheoridae* 50.0.
In Text-fig 110, the forks of R_{4+5}, M_{1+2} and M_{3+4} should be labelled
p. 701, line 2 for "M" read "M_5".
x, y, z, respectively, to conform with the text.
p. 707, in Table V (2), under Lepidoptera, for "C" read "D".
p. 708, in the Phylogenetic Diagram, for "CRETACECUS" read "CRETACEOUS", and alter the bracket for "Sialoidea" so as to enclose only the *Sialidae* and *Corydalidae*.
p. 711, line, 13, for "evolutions" read "evolution".
p. 717, in the explanation of Plate xxxi., fig. 16, for "The arrows point to" read "The arrow indicates the position of".

I have to thank my friend Mr. A. Philpott, of Invercargill, N.Z., for reading through Part 3 very carefully several times, and thus discovering a number of the above errors.

SPECIAL GENERAL MEETING.

14th June, 1920.

In Commemoration of the Centenary of the Birth of Sir William Macleay.

Mr. J. J. Fletcher, M.A., B.Sc., President, in the Chair.

Presidential Address, "The Society's Heritage from the Macleays."

Brief Synopsis, and List of Some of the Exhibits.

Yesterday (Sunday), the one hundredth anniversary of the birth of Sir William Macleay, at Wick, County Caithness, 13th June, 1820—Came to Australia with his cousin, W. S. Macleay, in March, 1839—His scientific usefulness, and how he came to be useful: in the first stage of his scientific career largely the product of family influence and family example: the youngest and last of a succession of Macleays interested in Science—Other reasons for the Society's interest in the Macleays: its Hall stands on part of the old garden, in proximity to the old home—The Macleay collections are now in the possession of the University of Sydney: the accessibility of the collections to members of the Society for study provided for by Sir William—The Society's memorials of all of them, and of some of their friends—Their long connection with the Linnean Society of London, 1794-1891: and with the Australian Museum, *ab inito* (1826) to 1877—Both branches of the family in which it is interested have now come to an end in the direct line; the Society may be considered to have inherited the family scientific traditions.

The Macleayan Succession: Alexander Macleay, F.R.S., F.L.S. (1767-1848)—William Sharp Macleay, M.A., F.L.S., eldest son (1792-1865)—Sir George Macleay, F.L.S., third son (1809-1891)—Sir William Macleay, Kt., F.L.S., M.L.C., nephew (1820-91).

Details of the development of their interest in science, and of their scientific work—History of the old garden and of Elizabeth Bay House; records of scientific and other visitors—Records of their scientific and other friends—History of the Macleay Collections up to the year 1874 [The account of their later development, based on Sir William's own records, is reserved for another occasion]—Memorials of all of them.

Exhibits.

Mementoes of Alexander Macleay: Portrait—Portraits of the Tradescants (father and son), Linnaeus (in his Lapland dress), Buffon, Peter Collinson (Botanist), George Edwards, Dr. William Hunter, Sir Ashton Lever, Dr. A. Russell, Captain Cook, and William Curtis (with an inscription, from Dr. Sims).

Books: Fr. Willughbeii Ornithologia (1626); Linnaei Systema Naturae (1767)—Four author's reprints inscribed "from his affectionate friend," "from his attached friend R. Brown"—Original made-up copy of J. W. Lewin's "Lepidopterous Insects of New South Wales," with the MS text and title page, as sent to England; original drawings of Lepidopterous larvae—Sale catalogue of collections.

Mementoes of W. S. Macleay—Books, reprints of his papers—Author's reprints presented to him by Robert Brown, Charles Lyell, and others—John Vaughan Thomson's "Zoological Researches" (1828-30)—His copy of Robert Lowe's famous macaronic poem composed on the visit of the Princess Victoria, and her mother, the Duchess of Kent, to Oxford in 1833—Original Drawings of Tunicates, and of the Fruit-fly (*Ceratitis citriperda*) for the illustration of two of his papers—Coloured drawings of Cuban lepidopterous larvae, spiders, etc.—Miscellaneous sketches—Sketch-book containing drawings of pelagic organisms caught in the townet on the voyage to Australia—Sketch of a pelagic tunicate (*Appendicularia*) taken in the townet by Mr. Huxley in Torres Straits—Charles Curtis' original drawings of Paussid beetles, and spiders, for the illustration of two papers—Original drawings of remarkable spiders and Membracid insects sent by Dr. Cantor, of Calcutta—Dr. James Stuart's collection of drawings of Australian animals, chiefly Port Jackson fishes, bequeathed to W. S. Macleay—Original drawings of Lepidoptera, spiders, and of a "Vegetable Caterpillar," by the Misses Scott of Ash Island—Sketch of a Pselaphid beetle by the Rev. R. L. King, 1858—Gerard Krefft's original drawing of *Chaeropus*, and etchings of Aboriginals and marsupials seen in the Lower Murray and Darling country, about 1857—Letter to Miss Harriet Scott, explaining the synonymy of the species of *Charagia*—Letters from scientific friends—Original sketch of *Phyllirhoe* by Dr. J. Denis MacDonald, H.M.S. Herald—Dissecting microscopes.

Memento of George Macleay, donor of some of W. S. Macleay's entomological books, and of the Stuart collection of drawings to William Macleay: his portrait.

Mementoes of William Macleay—Portraits—Bust presented by Members—The Society's home, much of its library, and of its other possessions, including nearly all the foregoing.

OTHER EXHIBITS (not Macleayan relics).

Photo of the bust of W. S. Macleay, kindly sent by Dr. B. Daydon Jackson, General Secretary of the Linnean Society of London, by permission of the Council—Photographs of original drawings, by Conrad Martens, of the Colonial Secretary's official residence in Bridge Street, and of Elizabeth Bay House viewed, from Darling Point, kindly sent by Mr. Clive Lord, Hon. Secretary of the Royal Society of Tasmania, by permission of the Council.

Portraits of Rear-Admiral P. P. King and Mrs. King, and their son, the Hon. P. G. King, M.L.C., an early Member of the Society, Member of the Council, and donor of his father's author's copy of J. D. Hooker's "Flora Antarctica" (the photos kindly lent by Mr. G. Goldfinch).

Portrait of Mrs. Charles Meredith, who, with her husband, came out to Sydney in 1839, and afterwards removed to Tasmania: authoress, some of her books illustrated with her own drawings of plants and animals.

Portraits of Mr. A. W. Scott, and of his younger daughter, Mrs. Edward Forde, entomologists and artists, formerly of Ash Island.

Professor J. T. Wilson unveiled the Society's Honour Roll, on which are inscribed the names of members who served abroad during the Great War, 1914-1919.

A cordial vote of thanks was tendered to Professor Wilson for unveiling the Honour Roll.

The President, on behalf of Members, offered Professor Wilson hearty congratulations on his appointment as Professor of Anatomy in the University of Cambridge, at the same time expressing their keen regret at his departure from Sydney, and also asked him to convey a message of remembrance and regard to Professors Martin and Hill.

Professor Wilson expressed his appreciation of the invitation to be present and unveil the Honour Roll; he also thanked Members for their congratulations on his recent appointment.

On the motion of Professor David a hearty vote of thanks to the President, Mr. J. J. Fletcher, was carried by acclamation.

The Meeting closed with cheers for His Majesty the King, and H.R.H. the Prince of Wales.

ORDINARY MONTHLY MEETING.

30TH JUNE, 1920.

Mr. J. J. Fletcher, M.A., B.Sc., President, in the chair.

The President announced that a telegram had been received from the Royal Society of Tasmania wishing the Society a successful Macleay Centenary Meeting.

A letter was read from Dr. L. A. Cotton, returning thanks for congratulations on his attaining the Doctorate of Science.

The Donations and Exchanges received since the previous Monthly Meeting (26th May, 1920), amounting to 8 Vols., 65 Parts or Nos., 20 Bulletins, 1 Report and 3 Pamphlets, etc., received from 41 Societies and Institutions and 3 private donors, were laid upon the table.

NOTES AND EXHIBITS

Mr. E. Cheel exhibited herbarium specimens, together with samples of timber taken from two distinct forms of *Callistemon riminalis* (Sol.) Cheel, showing the following distinctive characteristics:—

(1) Calyx-tube glabrous; bark of a thick corky appearance similar to that of the common "Broad-leaved Tea-Tree" (*Melaleuca leucadendrom* var. *albida* Sieb. Cheel). (2) Calyx-tube silky-hairy; bark of a more or less fibrous nature.

He also exhibited specimens of two forms or varieties of *Callistemon pachyphyllus* Cheel, showing the following characters:—

(1) Flowers of rich dark crimson similar to the type specimens, but the leaves very narrow. (2) Flowers of a greenish-yellow colour and leaves narrower than the type. The two latter forms are from Coff's Harbour, whilst the type is to be found at Bullahdelah, Byron Bay, and in Queensland

Mr. G. A. Waterhouse exhibited a male *Tisiphone rawnsleyi*, which he had mated with a female *Tisiphone abeona*, together with the five butterflies reared from eggs laid by the female. The male *T. rawnsleyi* was reared from a larva found at Mooloolah, Queensland, which pupated at Sydney on 9th September, 1919, and emerged on 18th October, 1919; the female *T. abeona* from Sydney emerged on 19th October, and the pairing took place the same day. The butterflies were placed in a mosquito net hung on a clothes line, and the actual mating was observed, the female was then caged over a growing plant of swordgrass (*Gahnia* sp?) and ten fertile eggs were laid on 20th and 21st October, which emerged in 15 and 16 days. The young larvae were left undisturbed, the only artificial condition being the surrounding wire of the cage. Early in February, 1920, five pupae were found, and these produced three males and two females from 21st to 29th February, all being very similar in markings. Two further matings of these first generation hybrids were obtained and the young second generation larvae are now under observation. As seen from the specimens exhibited the first generation hybrids combine the characters of both parents, the broad orange band of the forewing of *abeona* being very much reduced in size and much paler in colour. When it was necessary to keep the specimens alive for more than a day, they were artificially fed with a mixture of honey and water. He also exhibited for comparison a series of *Tisiphone abeona* from Eastern Australia showing the northern and southern forms and the wonderful variation existing at Port Macquarie.

NOTES ON SOME AUSTRALIAN *TENEBRIONIDAE*, WITH DESCRIPTIONS OF NEW SPECIES;—ALSO OF A NEW GENUS AND SPECIES OF *BUPRESTIDAE*.

By H. J. Carter, B.A., F.E.S.

(With fourteen text-figures.)

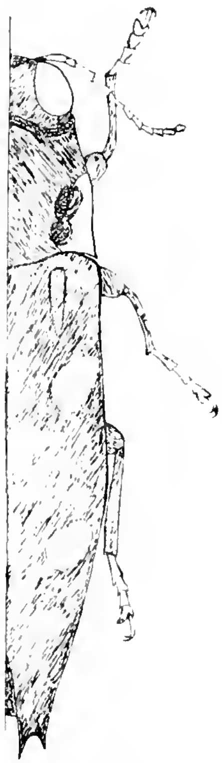
Family BUPRESTIDAE.

Cyrioides, n. gen. Chrysochroinorum (Text-fig. 1).

Near *Cyria*, but differs from that genus in the following particulars. Anterior margin of prosternum straight, without medial notch or lobe; prosternum furrowed in middle, narrowed and rounded at apex to fit into mesosternal excision. *Antennae*.—1st joint long, bent and thickened at apex, 2nd shortly obconic, 3rd longer than 4th, but considerably shorter than 1st; 4th-8th subequal, elongate subtriangular and flattened, 11th elongate ovoid.

Posterior tarsi with 1st joint not as long as the two following combined; last abdominal segment of ♂ with wide triangular excision at apex between two rounded lobes; of ♀ round and subacuminate.

Following Kerreman's table of the tribe in the "Genera Insectorum," *Cyrioides* is separated from all other described genera, except *Cyria* and *Epistomentis* by having its antennal cavities small and rounded. From *Epistomentis* it differs in having the 3rd antennal joint decidedly shorter than the 1st; the strongly bisinuated front of prothorax; the proportions of the hind tarsal joints; and the abdomen *not* carinated in any part.



Text-fig. 1.
Cyrioides sex-spilota, n.sp.

Cyrioides sex-spilota, n.sp. (Text-fig. 1.)

Navicular, rather flat, smooth; nitid black above with the posterior sides of pronotum sanguineous and each elytron with 3 yellow spots, the first small, posthumeral (not seen from above), the second large and ovate, opposite lateral tooth and nearer sides than suture, the third of same size and form as the second on posterior third. Legs and underside with long white hair, the smooth parts nitid black with metallic reflections. *Head* carinated in front furrowed on vertex, with large sparse punctures. *Prothorax* 5 × 4½ mm., widest at base, bisinuate at base and apex—more strongly so at apex—the median lobe of this produced forward; scarcely (in ♂) or not (in ♀) excised, anterior angles acute (as seen from above), sides very little rounded in middle and sinuate behind, base with medial lobe subangulate, posterior angles widely acute (about 80°); disc with medial furrow strongly impressed, terminating in a wide depression near base, sparsely punctate with large and deep geminate foveae near posterior sides. *Scutellum* invisible from above. *Elytra* slightly wider than prothorax at base, and thrice as long, gently sinuate at sides and slightly widened behind middle, thence narrowed to apex—each apex strongly bidentate, the interior tooth longer; posterior sides entire; disc striate-punctate, the punctures large on basal third, thence smaller and almost evanescent at apex; prosternum and apical segment of abdomen coarsely, the rest of underside finely and sparsely punctate; fore-tibiae curved. *Dimensions*: ♂. 18 × 6, ♀. 21 × 7 mm.

Hab.—Johnstone River, Queensland (Mr. H. W. Brown.)

A pair of this fine species, sent for identification from the South Australian Museum, are the only examples I have seen.

Types in the South Australian Museum.

STIGMODERA AENEICORNIS Saund.

Specimens from N.W. Victoria (Hattah, Sea Lake, etc.), are so labelled in the National Museum, Melbourne, and exactly correspond with the description and figure. The name is of no value for purposes of identification.

Family TENEBRIONIDAE.

Through the helpful co-operation of Mr. K. G. Blair, of the British Museum, and by the specimens compared with type, sent for inspection, I am now able to correct mistakes of identification and to indicate further synonymy. Mr. Blair's notes have further led me to a close re-examination of the species belonging to the closely allied genera *Daedrosis*, *Licinoma*, *Brycopia* and their allies, and this necessitates a considerable modification of the tabulations published by me.*

CAEDIUS. *C. sphaeroides* Hope = *C. tuberculatus* Cart.

This beach-dweller is found on both the East and West coasts of Australia. I was misled by a comparison between fresh and abraded specimens.

HYOCIS. The species of this genus, though commonly found at the roots of maritime plants on the sandy sea beaches, are not so restricted. Thus I have received *H. pallida* Macl. from Narromine, N.S.W., and have taken *H. pubescens* Macl. (described, like the former, from Gayndah) in my garden at Darling Point. *H. bicolor* Cart., originally from Botany, I found again at Burnie, Tasmania. The species vary much in colour and pattern, and while pointing out at least two synonyms, it is probable that a further reduction in the number of names may be desirable.

H. bakewelli Pasc. = *H. occidentalis* Blackb. var.

H. sub-parallela Champ. = *H. variegata* Blackb. var.

Regarding the first of these it is evident that Champion's notes† refer to *occidentalis* Blackb. which varies much in colour and markings, but is inseparable in form from concolorous examples that are found from Victoria to Albany. Re *sub-parallela* Champ., Mr. Blair writes "at my request he [Mr. Champion] "has looked at the type and finds it identical with *variegata* Blackb. except that in the latter the pale spots are a little more extensive. The other form is completely dark, with the elytra curiously irregular." A new species is described below.

*Trans. Roy. Soc. S. Aus., xxxviii., 1914, p.388-391.

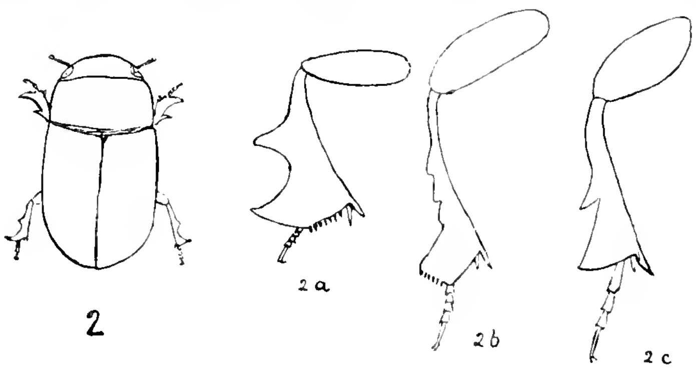
†Trans. Ent. Soc. Lond., 1894, p.363.

Phaennis fasciculata Champ. The female only of this species was described. I have lately seen a male example from Zeehan, Tasmania [Simson Coll., South Australian Museum] and I possess another taken by Dr. Ferguson in the Blue Mountains, N.S.W. The head has pronounced sexual characters as follows:

♂. Head with three prominent horns; one, sharply conical, on centre of forehead, pointing obliquely backwards, and one on each side of head, triangular, forming a projection over the points of insertion of the antennae.

ANEMIA CAULOBIOIDES, n.sp. (Text-fig. 2.)

Short, rather squarely ovate, black, pronotum sub-opaque, elytra rather nitid, upper surface sparsely clothed at sides with upright reddish hair. *Head* wide, labrum evident, epistoma with circular excision in front, without defined sulcus behind, and rounded in a single curve from the apical excision to behind the eyes; apical joints of palpi subulate, eyes large, almost completely divided by a narrow canthus; closely punctate; antennae short, joints trapezoidal, gradually enlarging to the 10th; apical narrower than preceding and widely ovate. *Prothorax* widely transverse, truncate at apex and base, slightly narrowed at the former, sides rounded, all angles obtuse, densely and finely punctate, without medial line or foveae. *Scutellum* triangular. *Elytra* convex laterally, of same width as pro-



Text-fig. 2.
Anemia caulobioides, n.sp. *2a*, front leg; *2b*, mid leg; *2c*, hind leg.

thorax at base, sides parallel, without evident margin, the whole finely punctate, with some transverse strioles; the punctures larger and less dense than on pronotum. Epipleurae narrow, body winged, metasternum coarsely punctate, tibiae dentate on outside margin, spinose and pectinate at the enlarged apex; tarsi with a few spiny bristles, claws very fine. *Dimensions*: 5—6 × 2½—3 mm.

Hab.—W.A.: Swan River and Geraldton (J. Clark), Yallingup. (R. E. Turner, in British Museum).

Twenty specimens examined of this scarab-like Tenebrionid, sent to me, as also to the South Australian Museum, by Mr. Clark. I had already described this as a new genus and species, but a timely note from Mr. Blair, to whom I had sent a specimen, brought an additional example taken by Dr. Turner, with the information "*Anemia* sp.(prob)n., near *A. sardoa* Géné and *A. denticulata* Woll; but differs from both in having thorax much more finely and closely punctate. From *A. sardoa* it differs also in its shorter, more squat shape." The genus *Anemia* is widely distributed in S. Europe, Asia (Syria to India), Africa (widely) and America (California). The above record is the first for Australia. It is found in sandy beaches or sandy soil.

Types in the Coll. Carter.

HYOCIS MINOR, n.sp.

Shortly ovate, convex, opaque brownish black, elytra with some undefined reddish markings, chiefly in humeral region, antennae and legs red. *Head* coarsely punctate, antennae stout, joints 9 and 10 transverse, 11th oblong oval. *Prothorax* emarginate at apex, front angles rounded but prominent, sides rounded, slightly sinuate behind, posterior angles rectangular, base bisinuate, disc coarsely and closely punctate, very sparsely pilose towards sides, with well marked medial sulcus. *Elytra* wider than prothorax at base, oval and convex, deeply punctate-striate, the punctures moderately large and round, more widely separated than usual in the genus, underside more finely punctured than upper surface. *Dimensions*: 2—2⅓ × 1½ mm.

Hab.—Stradbroke Island, Queensland (Mr. Pottinger and H. J. Carter); Sydney (Dr. E. W. Ferguson).

Six examples taken on the sea-beach near Dunwich (Stradbroke Is.), seem inseparable from the Sydney specimen, which has long been in my collection as a probable sp. nov. It shares with *H. nigra* Blackb. the distinction of being consistently smaller than the other described species, while distinguished from *nigra* by its more convex and wider form and rounded sides of prothorax. *H. bakewelli* Pasc. is larger and has much coarser elytral sculpture with cancellate ridges between the square seriate punctures, and with more angulate humeri.

Type in Coll. Carter.

ALPHITOBIUS BLAIRI, n.sp.

Sub-parallel, depressed, piceous above (elytra nearly black), underside, legs and antennae castaneous. *Head* closely punctate, eyes rather large, antennal orbit not prominent, antennae submoniliform, slightly and successively widened outwards, not extending to base of prothorax. *Prothorax*: apex truncate (as seen from above), base bisinuate, anterior angles rounded, posterior angles sub-rectangular, widest at base, sides arcuately narrowing to the front; disc closely, not very finely punctate, with two small basal foveae. *Elytra* of same width at base and about two and a-half times as long as the prothorax; finely striate-punctate, intervals flat and minutely punctate; underside closely punctate, the prosternum coarsely, abdomen more finely so, tibiae very little enlarged at apex, their margins entire. *Dimensions*: 3½ × 1⅓ (approx.) mm.

Hab.—Townsville, Queensland (F. P. Dodd).

Two specimens were sent from the British Museum, labelled as above, of a species that is difficult to place; and which I was inclined to think was a *Ulomoides*, but the shorter body and antennae, more transverse prothorax preclude this.

Type in British Museum.

ALPHITOBIUS XAMIAPHILA, n.sp.

Elongate-ovate, sub-nitid; head, prothorax, underside and appendages red, the first often blackish; elytra piceous, more or less suffused with red, tarsi luteous. *Head* coarsely and confluently punctate, eyes large, prominent and coarsely faceted, epistomal suture arcuate and well-impressed; antennae extending nearly to half the length of prothorax; basal joints sub-cylindric—3rd slightly longer than 4th; gradually enlarging from 5th to 8th; 8th—10th wider than long, 11th largest, ovoid. *Prothorax* strongly transverse, truncate at apex, feebly bisinuate at base, sides evenly rounded, all angles obtuse, disc closely and coarsely punctate, without medial line, two large, shallow, foveate depressions near base. *Scutellum* large, curvilinear triangular. *Elytra* wider than prothorax at base and about 3 times as long, sub-parallel (or feebly ovate) moderately convex (narrow border not evident from above), striate-punctate, intervals lightly convex on disc, more markedly so at sides; seriate punctures large; intervals thickly punctate (giving semi-opaque appearance to surface). Underside coarsely, metasternum more sparsely punctate Prosternum narrowly compressed between coxae, the apex produced backwards forming an ellipse, fitting an arcuate triangular depression in mesosternum, metasternum channelled; middle and post intercoxal processes arcuate; legs clothed with longish yellow hair; tibiae with short spine at apex, posterior tarsi with claw-joint nearly as long as the rest combined. *Dimensions*: 4 × 1½—2 mm.

Hab.—N. Territory: Stapleton (Mr. G. F. Hill); also British Museum; in both cases taken in ♂ flowers of *Zamia*.

Five specimens from Mr. Hill, and two sent from the British Museum show a species that I place with much diffidence under *Alphitobius*.

Type in Coll Carter.

PLATYCILIBE INTEGRICOLLIS, n.sp.

Short, broad, depressed, sub-parallel, nitid brown above and below; antennae, palpi and tarsi reddish. *Head* wide and convex, eyes small, surface — as also that of pronotum—closely and rather coarsely punctate; antennae short, with 3-jointed club—less enlarged than in *P. brevis* mihi. *Prothorax* truncate at base, squarely emarginate at apex, anterior angles rather sharply advanced, sides straight—slightly wider at base than at apex, with narrow, horizontal, lateral border bounded internally by a fine sulcus, *the external edge entire*, disc without medial line or foveae. *Scutellum* small. *Elytra* of same width as and closely adapted to prothorax, punctate-striate, the intervals a little convex and smooth, the punctures in striae round, regular and close. Under surface of head and sternum strongly punctate, abdomen sparsely punctate; fore-tibiae (at least) spinose on outside edge. *Dimensions*: 4 × 2 mm.

Hab.—Acacia Creek, MacPherson Ranges, N.S.W. (H. J. Carter), National Park, Q'land. (H. Hacker) and Queensland. [British Museum (Challenger Expedition).]

Six specimens examined show a species so close to *P. brevis* Cart. that my own two specimens had been placed under that label in my cabinet. The two Queensland examples sent by Mr. Blair, who called attention to their difference from *P. brevis*, made me examine them more closely and the following distinctions were noted: Head and pronotum more coarsely punctate, antennal club 3-jointed; sides of prothorax entire; underside less coarsely and more sparsely punctate; size smaller. (*N.B.*—In my description of *P. brevis*, I omitted the fact that the sides of prothorax are finely, irregularly crenulated, while the antennal club, as seen in figure, is more or less 4-jointed.)

Types in Coll. Carter.

PTEROHELAEUS.

Synonymy.

(*a*) *P. planus* Bless. = *P. hepaticus* Pasc = (?) *P. bagotensis* Blackb.
(*b*) *P. piceus* Kirby = *P. pascoei* Macl. = *P. pruinosus* Pasc
(*c*) *P. dispar* Pasc. = *P. abdominalis* Lea.
(*d*) *P. tristis* Germ = *P. memnonius* Pasc. = *P. tenuistriatus* Lea.
(*e*) *P. geminatus* Blackb. = *P. sub-punctatus* Cart.
(*f*) *P. dispersus* Macl. = *P. fraternus* Blackb. = (?) *P. oralis* Blackb.

(*a*) *fide* Blair (*b*) Mr. Blair writes: "The type of *P. piceus* Kby appears to be lost, but I send a specimen of what passes with us for this species, and with which I consider *P. pruinosus* Pasc. and *P. pascoei* Macl. (det. H.J.C.) identical." (*c*) My own examples have been compared with Lea's type and secondly with an example of *dispar* (♀) from the British Museum. An example of *P. dispar* ♂ (?) much smaller than the ♀ (14 × 9 mm.) is identical with *P. broadhursti* Lea, but I consider this specimen to be doubtfully conspecific with the female example sent, and Mr. Lea's name should stand till further evidence is adduced. (*d*) Mr. Blair states "The type of *memnonius* Pasc. certainly has quite distinct granules (= *tristis* Germ.)." An example of *memnonius* sent me from the British Museum agrees with my own example that has been compared with *P. tenuistriatus* Lea. (*e*) is certain from example sent of *geminatus*. (*f*) *fide* Blair, with some doubt as to *oralis*.

P. serrus Pasc.—A specimen sent from the British Museum is identical with examples in my collection from Walgett and Narrabri, N.S.W. The type was described as from Victoria.

P. agonus Pasc.—An example sent is quite new to me, and in size and form near *peltatus* Erichs., but has head and thorax more clearly punctate, the elytral margins narrower, all intervals quite flat, and seriate punctures much finer.

PTEROHELAEUS INTERRUPTUS, n.sp.

Elliptic, depressed, subnitid, black, tarsi and apical joints of antennae reddish. *Head* very minutely punctate, eyes separated by a space of about the diameter of one eye, antennae with last 4 joints enlarged, 9th-10th round, 11th oblong, elliptic. *Prothorax* 3 × 7½ mm., length measured in middle, base bisinuate, apex deeply emarginate, anterior angles sharply produced—though slightly blunted at extreme end; sides continuing the elliptic curve of elytra but slightly sinuate before the anterior angles; posterior angles acute and falcate; disc nearly smooth or merely microscopically punctured; foliate margins a little concave, rather wide medial basal impression and shallow foveae on each side of this. *Scutellum* equilatero-triangular. *Elytra* of same width as prothorax at base, widely ovate and depressed, foliate margins wide and sub-horizontal; irregularly linear-punctate, with nine more or less raised intervals of which the 1st, 3rd, 5th and 9th are more raised than the others, the 1st bifurcating at scutellum, the 9th costiform; from halfway to apex these intervals broken up into rows of nodules; between the intervals are double rows of small punctures, those near suture very irregular; outside the 9th and limiting the foliate margins, a row of large punctures; abdomen finely strigose. *Dimensions*: ♂ 14 × 9, ♀ 15 × 10 mm.

Hab.—Forest River District, W.A. (Western Australian Museum), also Kimberley District W.A.

Two examples examined show a species rather closely allied to the Queensland species *P. arcanus* Pasc., having rather similar elytral sculpture, but the form is more regularly elliptic, the foliation less wide, the sides of prothorax feebly sinuate. In *P. arcanus* the lines of nodules are continuous throughout, except for the costate 3rd interval.

Type (♂) in the Western Australian Museum, Perth.

PTEROHELAEUS NODICOSTIS, n.sp.

Widely ovate, convex, reddish brown, head and pronotum black, palpi and legs red, antennae wanting. *Head* and pronotum very finely punctate, eyes moderately distant (as in *P. piceus* Kirby). *Prothorax* transverse, foliage margins wide and horizontal, anterior angles widely rounded, posterior angles produced, but widely blunted at apex, medial line faintly indicated. *Elytra* of same width as prothorax at base, sides sub-parallel to halfway, widely rounded behind; very convex, foliate margins wide and horizontal, little narrowed behind; disc with 17 rows of punctures, besides a short scutellary row: all, except this and extreme lateral row, in pairs between costate intervals; the seriate punctures fine near suture, much finer than in *piceus*, larger towards sides, there as large as in *piceus*; the suture raised, the 1st and 3rd costae flattening out on basal half, the rest carinate-crenulate on basal half; all costae nodulose on apical half, a single row of nodules forming a crest on each raised interval. Underside lightly strigose, apical segment punctate. *Dimensions*: 21 × 13½ mm.

Hab.—Moree District, N.S.W. (Mr. F. C. Morse).

A single specimen lately sent by its captor, is a very distinctly differentiated member of Macleay's Sect. 1.2. Species of broadly ovate form, and largely expanded margins to both thorax and elytra. It is the only one besides *arcanus* Pasc., *raucus* Blackb., and *interruptus* (*supra*) in which the elytra have granules; *arcanus* is, however much more widely oval, with the wide sutural interval confusedly punctate, and the suture itself nodulose *inter multa alia; raucus* has a totally different sculpture. In size and foliation it is near *piceus* Kirby, but is more convex. It differs from *interruptus* (*supra*), which has the costae clearly interrupted, leaving island nodules.

Type in Coll. Carter.

PTEROHELAEUS OBLONGUS, n.sp.

Elongate parallel, whole surface rather nitid black, legs very nitid; antennae —especially apical half—and tarsi reddish. *Head* finely punctate, eyes separated by a space of about half the diameter of one; antennae with third joint as long as 4th and 5th combined, 2nd–6th linear, 7th obconic, 8th—10th enlarged, ovate, 11th elongate ovate. *Prothorax* (4 × 9 mm.), emarginate at apex, bisinuate at base, widest a little in front of base, thence converging lightly to base, more strongly and arcuately to apex; base nearly twice as wide as apex (9:5); foliate margins wide and slightly concave, extreme margin reverted; anterior angles prominent but bluntly rounded, posterior sharp and sub-rectangular (feebly falcate); disc nearly smooth, very minutely punctate, medial line clearly impressed; two deep triangular foveae at base. *Scutellum* very large, curvilinear triangular. Elytra slightly wider than prothorax at base and about four times as long, sides parallel for the greater part, margins very narrow, slightly widened at the shoulders, there forming an obtuse angle; disc coarsely striate-punctate, with about 18 sub-obsolete striae, including a short scutellary and a lateral row of larger punctures, seriate punctures round and deep, becoming finer at shoulders and apex, humeral gibbus pronounced, intervals flat, except the sutural, 4th, 8th, and 12th, these wider than the rest and more or less costate, the sutural costa bifurcating at the scutellum and continuous to the base; prosternum sharply carinate and lightly transversely rugose, basal segments of abdomen punctate and strigose, apical segments very finely punctate. *Dimensions*: 21—22 × 10 mm.

Hab.—Gingken, Blue Mountains (R. B. Carter), Blue Mountains (Mr. Deuquet).

Two examples show a species that I have hitherto hesitated to distinguish from *memnonius* Pasc. (= *tristis* Germ.), but with the information lately acquired from examples sent by Mr. Blair, it is evidently not that species. It belongs to Macleay's Sect. ii., Sub-section 1, and is nearest to the Tasmanian species *P. reichei* Breme, from which it is chiefly distinguished by (1) more nitid surface, and wider form, (2) more clearly channelled and foveate pronotum, (3) narrower elytral margins, (4) considerably larger seriate punctures.

Type in Coll. Carter.

HELAEUS LATIFOLIUS, n.sp.

Widely obovate, sub-nitid brown black, elytra with short upright fine bristles; tarsi, apical joints of antennae and tarsi reddish, underside opaque black. *Head* densely and finely punctate, antennae with 3rd joint as long as 4th-5th combined; joints beyond 8th wanting. *Prothorax* 5 × 9 mm.; foliate margins wide, in ♂ arcuately narrowed from base to apex, in ♀ expanding in front of base, thence widely rounded to apex; disc and margins very finely and sparsely punctate; the punctures on margins bearing each a short bristle, foliate margins a little concave and raised at the edges, anterior processes concave above, overlapping and rather sharply rounded at apex, posterior angles falcate and overlapping elytra; disc with feebly-raised carina terminating behind in a small, narrow, rounded knob in front of base, the latter widely bisinuate. *Scutellum* widely transversely oval. *Elytra* of same width as prothorax at base and more than twice as long; obovate, shoulders obtusely rounded, margins wide, concave and reflexed, more minutely setose than those of the prothorax, each elytron separately rounded at apex, disc with suture carinate and two strongly raised carinate costae, these sub-parallel, less than 2 mm. apart, slightly diverging at scutellum, and suddenly terminating at apical third; space between costae, as also area between costae and margins, coarsely punctate, each puncture producing a short reddish bristle, the extra-costal spaces with two or three ill-defined longitudinal ridges. Abdomen densely punctate, prosternum finely shagreened, epipleurae coarsely and closely punctate. *Dimensions*: 18 × 11½ mm.

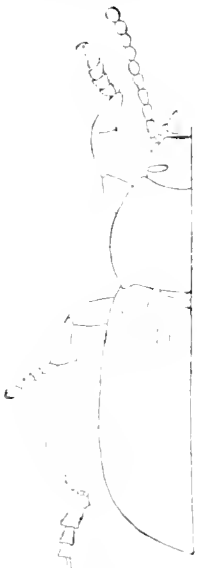
Hab.—Margaret River, Western Australia (Mr. J. Clark).

Two examples, the sexes, show a species near *H. gilesi* Cart., but differing in (1) much wider foliate margins of prothorax and elytra, (2) shorter and less widely separated elytral costae, (3) much more coarse punctures on both elytra and epipleurae. Though the dimensions appear the same as those of *H. gilesi*, the species is really more elongate and nearer *H. frenchi* Cart. in outline, the width being largely due to the very wide margins shown by the following comparison. In *H. gilesi* the width of body and of combined margins are 9 and 2 mm. respectively. In *H. latifolius* the corresponding widths are 7½ and 3½ mm.

Type ♂ in Coll. Carter; ♀ in that of Mr. Clark.

MENEFARCHUS, n.gen. Tenebrioninarum. (Text-fig. 3.)

Lightly obovate, depressed; antennae long (extending nearly to base of prothorax), 3rd joint very little longer than 4th, apical joints widely oval and flattened; epistoma arcuate (concave) in front, without marked sulcus separating forehead; mentum carinate in middle, its sides straight and narrowing to apex—this bilateral, forming a triangular notch; all palpi with apical joints securiform. Front coxae round, posterior transverse, all coxae furnished with trochantins. Prosternum convex, produced between fore-coxae into a blunted process, received into a triangular mesosternal notch; mid-intercoxal process widely, post-intercoxal process squarely rounded, abdomen with wide longitudinal depression; fore-tibiae strongly bent and enlarged at apex, post-tibiae curved and strongly tomentose within, all tibiae shortly bispinose at apex, elytra sulcate-sub-punctate. A genus quite at variance with any other yet described. More ovate than *Hypaulax*, less so than *Asphalus*, more depressed than either, its most striking features are the combination of the usual *Tenebrioninae* characters of the head, body, and strongly curved tibiae, together with more elongate antennae and a sculpture *sui generis*.



Text-fig. 3.|
Menearchus impresso-sulcatus.

MENEARCHUS IMPRESSO-SULCATUS, n.sp. (Text-fig. 3.)

Opaque black above, nitid beneath, glabrous; antennae, oral organs and tarsi piceous. *Head* large and flat, labrum emarginate, epistoma arcuate, its sides advanced; antennal orbits wide and depressed; eyes narrow and transverse; upper surface—like that of pronotum— uniformly very densely and finely punctate. *Prothorax*: 5 × 7 mm. (length measured in middle), arcuate emarginate at apex, bisinuate at base, anterior angles sub-acute, tips blunted; sides evenly rounded, widest at middle, posterior angles rather widely acute and produced so as to overlap slightly the elytra; lateral border narrowly raised—not sulcate within—still narrower at base and obsolete at apex; disc with a faint indication of medial channel. *Scutellum* convex, strongly transverse, punctate. *Elytra* slightly wider than prothorax at base and two and a-half times as long, widest behind middle, epipleural fold forming a marked but wide humeral angle; with 9 sulci, including extreme lateral one (besides a very short scutellary sulcus); the intervals evenly and roundly convex and impressed on sides by shallow sub-punctate impressions, these more pronounced laterally, the two outside sulci definitely punctate; intervals everywhere covered with dense system of fine punctures as on head and pronotum. Undersurface and legs closely punctate, abdomen more coarsely and less closely than upper surface, hind femora dentate—a line of tomentum extending from base to this tooth; fore-tibiae having apical third abruptly bent inwards and thence much enlarged, mid-tibiae triangularly enlarged at apex, posterior tibiae strongly curved, widely dentate near base, with a line of coarse tomentum on inner edge; three basal joints of front tarsi enlarged, basal joint of hind tarsi about as long as the 2nd and 3rd combined. *Dimensions*: 19—20 × 7½—8 mm.

Hab.—New South Wales (Mr. Denquet).

Two ♂ specimens taken by Mr. Denquet, one of which has been generously placed at my disposal. The tibial characters alone would distinguish this unusual insect from any other Australian member of the *Tenebrionidae*.

Type in Coll. Carter. It is unfortunate that the captor of this fine species did not affix a locality label to his specimens, and in consequence there is some doubt as to the exact habitat, but Mr. Deuquet *thinks* that he took them near Mulgoa (Upper Nepean River).

MENEPHILUS LONGICOLLIS, n.sp.

Elongate, sub-parallel, nitid black; antennae, palpi and tarsi castaneous. *Head* closely and finely punctate, widest in front of eyes, these not prominent. *Prothorax* very convex laterally, strongly and widely produced in middle at apex, base truncate, anterior angles obsolete (widely rounded off); sides nearly straight (or feebly arcuate) on apical half, narrowing considerably and rather abruptly to base, posterior angles widely obtuse; basal border narrowly raised, lateral border not seen from above, disc evenly and finely punctate, without any sign of foveae or medial line. *Scutellum* triangular, punctate. *Elytra* wider than prothorax at base, and about twice as long, humeri sharply rounded and prominent and a little produced forward; sides parallel to near apex, with very narrow horizontal border; disc striate-punctate, with 8 deep striae besides a short scutellary stria on each elytron, containing rows of large punctures crenulating the sides of interstices and rather irregularly placed, those near suture more closely placed, more widely separated in external striae; intervals raised but somewhat flattened above, and minutely punctate. Pro- and meta-sterna smooth, the latter with medial depression; abdomen finely punctate, *each segment with a row of large punctures on front margin, a similar row surrounding the hind coxae*. *Dimensions*: 10—11 × 3½—4 mm.

Hab.—Kellerberrin, Western Australia (Mr. W. Crowshaw).

Three specimens examined show a very distinct species nearest to *M. coerulescens* Haag, but clearly differentiated by the longer and more cylindric prothorax, wider head (in *coerulescens* the head is widest *at the eyes;* in *longicollis* the canthus extends laterally in front of but beyond the eyes), coarser elytral sculpture, besides the unusual character of the rows of large punctures at the margins of abdominal segments.

Type in Coll. Carter. (N.B.—The colour of *M. coerulescens* Haag varies from blue to black—the latter being more often seen.)

Brises. In my revision of the *Tenebrioninae** the table of *Brises*, line 4. should read "4(6) Elytra *tri*costate" (for bicostate).

Cyphaleinae. In my revision of this sub-family† the numbers on Plate vi., corresponding to the index, p. 105, were misplaced, and should be read in *vertical columns* downwards instead of in horizontal rows.

Ospidus. From a comparison with type, it is clear that my original identification of *O. chrysomeloides* Pasc. was erroneous.

In consequence, *O. chrysomeloides* Pasc. = *O. paropsoides* Cart., and *O. chrysomeloides* Cart. (*nec* Pasc.) requires a name, and is defined below. The genus *Ospidus* placed by its author in the *Helaeinae*, should be classed, as I now consider, with the *Cyphaleinae*, near *Bolbophanes*.

OSPIDUS MAJOR, n.sp.

Widely ovate, very convex, nitid castaneous bronze above, less nitid beneath and rather densely clothed with short recumbent golden hairs. Compared with *O.*

*These Proc., xxxix., 1914, p.46.
†These Proc., xxxviii., 1913.

chrysomeloides Pasc. the head is less coarsely rugose, the pronotum is minutely and lightly punctured and more nitid—the former rather strongly depressed between the eyes, the latter with only a faint depression near base to indicate the medial channel, the foliate margins transversely rugose. *Elytra* with shoulders obtuse, the sub-obsolete costae even less obvious, the disc much more finely punctate, without anywhere a sign of linear arrangement. *Dimensions*: 15 × 10 mm.

Hab.—Cooktown, Cairns, etc., N. Queensland.

A species easily separated from *O. chrysomeloides* by its larger form, brighter colour and much finer puncturation. I have *O. chrysomeloides* from Townsville, Brisbane and Tambourine Mountain, S. Queensland. *O. gibbus* Blackb. from Cape York is even more convex than *major*, is castaneous, not metallic, with black markings, and coarse irregular punctures. The three species may be distinguished as follow:—

1—3 Concolorous and metallic.

2. Coppery bronze, pronotum closely and finely rugose.
Hab.—S. Queensland .. .. *chrysomeloides* Pasc.
paropsoides Cart.

3. Castaneous bronze, pronotum very lightly punctate .. .. *major*, n.sp.

4. Non-metallic castaneous with black maculae .. .. *gibbus* Blackb.

ADELIINAE.

Cardiothorax.

(*a*) *C. acutangulus* Bates = *C. constrictus* Cart. = *C. aeripennis* Blackb., var.

(*b*) *C. aeneus* Bates = *C. coeruleo-niger* Cart., var. A = *C. macleayensis* Cart., var. B.

(*a*) The first of these is certain by a comparison of specimens by Mr. Blair. I was misled by three inaccuracies in Bates's description.—(1) the colour is not black, (2) there *is* a sulcus between margin and disc of prothorax, (3) the habitat is not Brisbane. In general *C. aeripennis* Blackb. differs from *acutangulus* Bates in the following respects,—hind angles of thorax less wide, narrower sinuation, extreme border thicker, with a characteristic carina at anterior angles, noted by author. However, these differences are so modified in some examples that it must be confessed that the distinctions are in some cases evanescent. I took a large number of *acutangulus* at Capertee, N.S.W., and some dozens of the typical *aeripennis* at Mount Wilson, Blue Mountains.

(*b*) These are well-marked colour variations in fresh examples, but I can find no structural differences whatever between the three. I found the first two, *aeneus* and *coeruleo-niger*, in separate batches—never in company—some mile or two apart at Bullahdelah, Port Stephens, while *macleayensis* occurs from the Macleay River to Coraki on the Richmond. The typical *aeneus* has a blue-black thorax, with brassy elytra; *coeruleo-niger* is wholly blue-black, while *macleayensis* is a bright bronze, often with brassy gleam at sides. The varietal names should be retained. Four new species are described below.

Adelium calosomoides Kirby = *A. bicolor* Cart. (The latter is, I think, only one of the many varieties of the former having red antennae.)

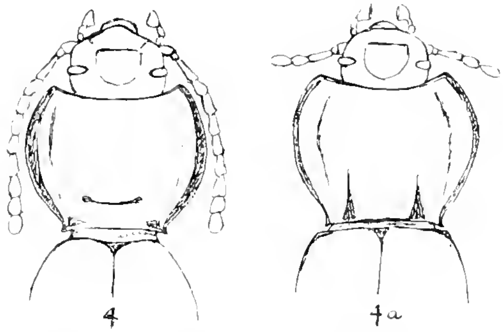
Adelium angulatum Blackb. My notes on this species* were based on a misnamed specimen given me as *angulatum* by the late Canon Blackburn. This is certainly *angulicolle* Casteln. The type of *angulatum*, Mr. Blair writes, "is certainly not *A. angulicolle* Casteln. It resembles in thorax and elytra *A. scutellicum* Pasc., and is, I think, the same species."

*These Proc., xxxii., 1908, p.269, and Trans. R. Soc. S. Aust., xxxviii., 1914, p.403.

Seirotrana crenicollis Pasc. = *S. denticollis* Cart. I now consider the latter as merely a variety of the former (a Victorian species); and that Mr. Dubonlay was mistaken as to the locality of capture.

CARDIOTHORAX MARGINATUS, n.sp. (Text-fig. 4.)

Elongate-ovate, polished black, antennae reddish-brown, tarsi with red tomentum beneath. *Head* smooth on front, minutely punctate on clypeus, the latter produced in middle, the usual frontal impression deep. *Prothorax* cordate, widest before middle, arcuate-emarginate at apex, front angles rounded, sides well rounded, sinuate behind, dentate posterior angles pointing obliquely backward; foliate margins divided from disc by sulcus, lateral border wide and round, disc with fine medial sulcus, a transverse sulcate impression parallel to and near base, and two deep triangular foveae near hind angles. *Scutellum* with a single large puncture. *Elytra* slightly wider than prothorax at base, humeri obsolete, sulcate, intervals of uniform width, flat on disc, a little convex at sides and apex; underside smooth. *Dimensions*: 16—17 × 5½—6 mm.



Text-fig. 4. *Cardiothorax marginatus.*
Text-fig. 4*a*. *Cardiothorax walckenaerii* Hope.

Hab.—Mittagong (Mr. Denquet); also Blue Mountains (H. J. Carter).

Two examples from Mittagong, and a specimen I have from Newnes, which I think is conspecific, are allies of the common Sydney species *C. walckenaerii* Hope. The following distinctions necessitate a specific name:

	marginatus.	*walckenaerii* (Text-fig. 4*a*.)
Colour.	Polished black.	Sub-nitid bronze-black.
Clypeus.	Produced in middle.	Widely rounded.
Prothorax.	Border wide.	Border narrow.
	Transverse sulcus near base.	None.
	Latero-basal foveae triangular, running into lateral depression.	Basal foveae elongate (parallel to medial line), not connected with lateral depression.
Elytra.	With 7 flattish intervals on disc; space beyond these smooth, with the usual lateral striae.	With 8 convex intervals; space beyond these with 2 rows of large punctures.

The sexual distinction is very similar but less definite than is the case with *C. walckenaerii.*

Types in Coll. Carter.

CARDIOTHORAX METALLICUS, n.sp. (Text-fig. 5.)

Elongate-oval; above metallic blue, sometimes with violet or brighter sheen towards margins, underside black, antennae fuscous, tarsi clothed beneath with red hair. *Head* finely punctate, frontal impression sharply angulate, a seta near each angle on epistoma; a round fovea between eyes and a few foveate punctures on forehead, antennal joints pear-shaped, 3rd much longer than 4th, and subcylindric, 11th half as long again as 10th, ovate-acuminate. *Prothorax* 3 × 4 mm. widest in front of middle, arcuate-emarginate at apex, base angulate and narrowly marginal, sides moderately rounded, converging to base, anterior angles rounded, posterior obtuse, undentate; lateral foliation narrow, without separating sulcus, and bearing two or three setae; disc with well marked medial sulcus, and basal impression near angles, sometimes with a few shallow impressions on each side of middle. *Scutellum* convex, elongate, rounded behind. *Elytra* rather narrowly ovate, shoulders obsolete, epipleural fold very narrow, with 9 well-marked sulci on each (the 9th on the sides), intervals evenly convex, the first two and sixth continuous to apex, 3rd joining 5th on declivity. Underside smooth; legs without sexual characters. *Dimensions*: 13—14 × 4—4½ mm.

Hab.—Bunya Mountains, S. Queensland (Mrs. Hobler, Mr R. Illidge and H. J. Carter).

Twenty specimens taken by the author, besides those taken by the above, during a camp of the Royal Austsalasian Ornithologists' Union. The species can only be confused with *C. coeruleo-niger* Cart., which, however, has a truncate base to the prothorax, with dentate posterior angles, each elytron with only five clearly defined sulci *inter alia.*

Types in Coll. Carter.

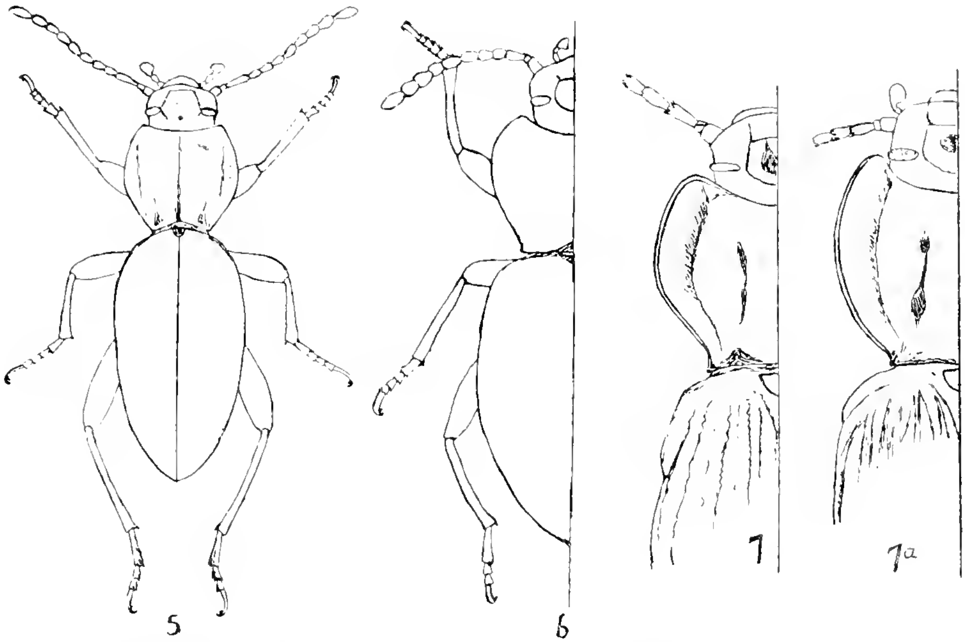
CARDIOTHORAX REGULARIS, n.sp. (Text-fig. 6.)

Elongate-ovate, opaque brown-black, antennae and tarsi brown, legs and underside nitid black. *Head* with epistoma rather sharply produced in front, with rhomboidal frontal impression; antennae having joint 3 half as long again as 4. *Prothorax* arcuate-emarginate at apex, feebly arcuate at base, anterior angles rounded, sides well rounded at middle; posterior angles narrowly dentate, with a small blunt tooth directed downwards and outwards; foliate margins horizontal with narrow nitid border throughout; disc rather flat, with a medial sulcus, two small foveae on each lobe (more or less connected by a depressed line), and a wide depression between disc and foliate margins. *Scutellum* oval. *Elytra* sulcate, with nine regular convex intervals, the lateral three narrow; epipleurae and underside smooth. *Dimensions*: 15—17 × 5—5½ mm.

Hab. Toronto (Lake Macquarie), 90 miles N. of Sydney (Mr. Denquet).

Five specimens examined—showing no marked sexual distinction of a species very near *C. alternatus* mihi but clearly differentiated as follows:—

	regularis.	*alternatus.*
Head.	Narrower and more pointed.	Wider and squarer.
Antennae.	More slender.	Stouter.
Prothorax.	Anterior angles rounded.	Anterior angles sub-acute.
	Posterior tooth narrow.	Posterior tooth wide.
Elytra.	Intervals* sub-equal.	1st, 3rd & 5th evidently wider than rest.



Text-fig. 5 *Cardiothorax metallicus.*
Text-fig. 6. *C. regularis.*
Text-fig. 7. *C. undulaticostis.*
Text-fig. 7a. *C. humeralis* Bates

*The 3rd and 5th elytral intervals are slightly wider than the adjacent intervals near the base in many spp. (including *regularis*), but this is quite different from the evident alternate inequality shown in *alternatus*.

Types in Coll. Carter.

CARDIOTHORAX UNDULATICOSTIS, n.sp. (Text-fig. 7).

Elongate, opaque black, costae of elytra and abdomen nitid black, tarsi and apex of tibiae clothed with golden tomentum. *Head*: frontal impression square in front, rounded behind, containing a triangular impression within, clypeus rounded in front, rather prominently angulated at sides in front of eyes; antennae stout, 3rd joint not much longer than 4th, 4th—10th more or less oblong ovoid, 11th scarcely longer than 10th. *Prothorax* (5 × 6½ mm.) cordiform, wider at apex than at base, widest about middle, arcuate-emarginate at apex, base subtruncate (except at angles), anterior angles widely rounded, sides gradually widening to half-way, then strongly sinuately narrowed, the posterior angles forming a strong triangular tooth bent diagonally outwards and a little backwards; foliate margins wide and up-turned, separated from disc by a wide depression; extreme border nitid and thick; disc with deep medial sulcus, and a linear depression on each side of this, besides two large, triangular, basal foveae. *Elytra* considerably wider than prothorax at base and nearly 2½ times as long, obovate and flat, humeri (formed by epipleural fold) very prominent and irregular (the right clearly angulate, the left rounded and ear-like); each elytron with nine raised, crenulate or wavy costae—the 1st, 2nd, 3rd, 5th and 7th more sharply raised than the rest.

especially the 7th: the 9th (on side) not visible from above; the external costae less wavy than those near suture; the wide depression between costae of irregular width, the 6th and 7th wider than the rest, and showing faint, obsolescent, punctures; underside smooth, prosternum opaque. *Dimensions*: 19 × 7 mm.

Hab.—Moruya, New South Wales (E. H. MacD. Murray).

Two examples were obtained by Mr. W. DuBoulay, of which one was kindly given me some years ago. At the time, I erroneously identified it as *C. humeralis* Bates, but the true *humeralis* has lately been clearly identified by the courteous help of Mr. Blair, to whom I sent drawings of the two species to compare with the type (no Australian Museum possesses a specimen). Bates's species has a very differently shaped prothorax (*see* fig. 7*a*), while the elytra have 8 uniform costae, scarcely, or very feebly, crenulate, with narrower sulci of equal width. The only example I have seen (except the type, in 1907) was taken at Port Macquarie by Dr. E. W. Ferguson and generously given to me. The two species are, however, allied and belong to the same section of my tabulation. (*N.B.*—In this section there are no external sexual characters.)

Type in Coll. Carter.

CARDIOTHORAX EXCISICOLLIS, n.sp.

Obovate, depressed, opaque black above, underside nitid. *Head* with pronounced stirrup-shaped impression on front, this outlined by deep sulcus; antennae very stout, joints oval, 3rd longer than 4th; clypeus sub-truncate. *Prothorax*—length in middle slightly less than width; widest near front; foliate margins wide and obliquely raised, separated from disc by wide sulcus, anterior angles widely rounded and produced, lateral recurved border moderately wide; sides arcuately converging behind, with a wide notch or excision preceding the acute, outwardly-directed hind angles; base sub-angulate (scarcely coarctate); disc with wide and deep medial sulcus and a short sulcus on each side of this. *Scutellum* transverse, with a triangular depression behind it. *Elytra* widely obovate and rather flat, considerably wider than prothorax at base, shoulders formed by epipleural fold squarely rounded, each elytron with 9 rather sharply raised nitid costae, those near suture feebly undulate, 1st to 5th subgeminate, divided by fine sulcate line, the 8th short, extending from half-way to the apical declivity, the 9th starting immediately behind epipleural fold and forming a limiting border to the elytra throughout; between the 9th and the epipleural fold a wide convex interval bounded on each side by a row of foveate punctures. Underside smooth, legs simple. *Dimensions*: 21 × 8 mm.

Hab. Eidsvold, South Queensland (Australian and Queensland Museums).

Two examples in the Australian Museum and one in the Queensland Museum can only be confused with *C. quadridentatus* Waterh. from Port Bowen, which they resemble in form, colour and in the curiously excised posterior sides of thorax. The following comparison will distinguish them.

	C. quadridentatus.	*C. excisicollis.*
Prothorax.	Anterior angles acute and prominent.	Widely rounded, less prominent.
	Lateral border sub-obsolete; base sub-truncate.	Lateral border moderately thick; base sub-angulate.
Elytra.	Alternate intervals costate.	All costae uniformly raised.

Licinoma, Daedrosis, Brycopia and *Dinoria.*

Pascoe's genera were insufficiently defined, while he omitted *Daedrosis* from his tabulation of the group* though Bates's genus was published some six months earlier. Of *Dinoria* its author stated "very similar to *Brycopia* and only to be distinguished by the pilose tarsi." Of this distinction Mr. Blair writes "on an examination of the types I fail to perceive." My own specimens, gummed on cards, had not hitherto been critically examined; but having now closely examined *D. picta* Pasc. and *B. pilosella* Pasc. under a Zeiss binocular, I cannot separate them on this tarsal character, both showing hairs together with a short tomentum. It is clear, therefore, that the name *Dinoria* should be sunk as a synonym. From a specimen sent from the British Museum it is certain that *B. diemenensis* Cart. is the same species as *D. coelioides* Pasc. Of the latter Mr. Blair writes "the type is from Queensland though we have 8 specimens from Tasmania, and one from K. George's Sound." I think that the Queensland and Western Australian localities are probably label mistakes, the species of *Brycopia* being, in general, localised; though I have one species, *B. minuta* Lea, from Sydney, Mulwala (Vic.), and Barossa (South Australia). I had always been puzzled over *D. coelioides*, and my difficulty was enhanced by the fact that another species from Tasmania, described below as *B. hexagona*, has, in the form of the prothorax, a much closer affinity to *D. picta* than the real *D. coelioides*.

A close re-examination of all the species of *Daedrosis* and *Licinoma* available, in conjunction with Bates's very detailed generic description, has had a somewhat disturbing effect on my previous ideas, which had been formed on a too prominent consideration of what now appear to me as secondary characters, antennae and sculpture. My predecessor Blackburn evidently held similar views, since the two insects he described as *Daedrosis* are both *Licinoma*, and indeed one of them, *D. victoriae*, is a synonym of *L. nitida* Pasc., the genotype of *Licinoma*. Mr. Blair's note on this is "*L. nitida* Pasc. is certainly generic with Blackburn's type of *Daedrosis victoriae* . . . . and in my opinion *victoriae* should not be more than a var. of *nitida* (the puncturation of the thorax is a little coarser and less regular.") The two genera are to be distinguished as follows:—

	Daedrosis.	*Licinoma.*
Prothorax.	Emarginate at apex; sides crenulate.	Not emarginate at apex; sides entire.
Humeri.	Prominently dentiform.	Rounded.

Other characters which differentiate the great majority of species lie in the antennae, tarsi, sculpture and clothing. In *Daedrosis* the antennal joints are round and coarse with an unusually large terminal joint. In *Licinoma* the joints are obconic or triangular with terminal joint of moderate size. Concerning the tarsal joints, Bates states (under *Daedrosis*) "The comparative length of the first and last joints of the posterior tarsi does not appear to be a character possessing any generic value. In *Thoracophorus* [now *Cardiothorax*] the first joint is longer, equal to, or shorter than the last, according to the species, and even, I believe, according to the sex." I have just examined both sexes of 16 species, including 7 species of that author, and find *in every case* that the first joint is longer than the last. Again it would appear that this comparative length of joints *is* a generic test. In *Daedrosis* (*i.e.* in the species included below), also generally in

* Ann. Mag. Nat. Hist., (4), iii., 1869, p.133.

Leptogastrus, the first joint is shorter than the last, while in *Licinoma* and *Brycopia* the first joint is either greater or (in a few cases) of equal length to the claw joint. The sculpture of *Daedrosis* is generally coarse, with more or less pilose clothing, while the species of *Licinoma* are generally glabrous, with fine sculpture. *Brycopia* is distinguished from both *Daedrosis* and *Licinoma* by the round (as seen from above) and generally prominent eyes, the prothorax is not emarginate at apex, and the species are generally smaller, and of shorter form. The sculpture is generally coarse (except in the *femorata*, *minor* group), and the surface glabrous, or pilose; the apical joint of the antennae is of moderate size, the other joints in general more or less moniliform. In this difficult group of genera there are cases where some compromise is necessary,* at least so far as the secondary characters, referred to above, go, as the preferable alternative to the erection of new genera on fine distinctions.

The following *synonymy* of the group has been investigated:—

Brycopia = *Dinoria*.

Brycopia (*Dinoria*) *coelioides* Pasc. = *B. diemenensis* Cart.

Licinoma nitida Pasc. = var. *Daedrosis victoriae* Blackb.

L. (*Daedrosis*) *monticola* Blackb. = *L. puncta-latera* Cart.

L. elata Pasc. = *L. violacea* Macl.

In the last case I compared the specimen of *elata* from the British Museum with specimens labelled *elata* Pasc., and the type of *violacea* in the Australian Museum, and note that *elata* was correctly named and that the type *violacea* is merely a larger specimen of the same species.

On the Bunya Mountains (S. Queensland) last October, I took 3 examples of a *Licinoma* which may at present be called *L. elata* Pasc. var., but which differ from the typical form in the following characters:—(1) Antennae and tarsi black (or nearly so)—red in *L. elata*; (2) sides of prothorax less widened in middle, less abruptly narrowed behind. I had described this as new, but its sculpture and form approach that of *elata* so closely that it is inadvisable to separate it by name.

In *Daedrosis* my table† must be cancelled; eight of the nine species recorded there being disposed as follows: *Daedrosis crenato-striata* Bates = *D. ambigua* Bates = *D. pygmaea* Haag.

D. angulata Cart. is a *Brycopia*, while *Leptogastrus* was incorrectly placed as synonymous with *Daedrosis*, and is a distinct genus, differentiated by the complete absence of (1) hind angles of thorax, (2) shoulders, the narrowing of both segments in this region causing the "pedunculation" stated by Macleay. Besides the original *L. mastersi*, my *Daedrosis apiformis* and *D. hirsuta* must be transferred to *Leptogastrus*, and the following new species added, while the species identified by me as *Daedrosis monticola* Blackb. is described below as *D. antennalis*. *Daedrosis interrupta* mihi must be transferred to *Adelium*.

In regard to the *Daedrosis* synonymy above, there is little doubt that the fine distinctions made by Bates for "*ambigua*" disappear in the examination of a long series, the Blue Mountains forms being generally darker and larger. The small forms taken on the coast, that I had identified as *pygmaea*, happened to be more pilose, but Mr. Blair considers that they are not specifically distinct from the type of *crenato-striata*. *Daedrosis* now, therefore, contains two species, the

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*See note, infra, on *L. truncata*.

†Trans. Roy. Soc. S. Aus., xxxviii., 1914, p. 388.

genotype and *D. antennalis*, easily distinguished. *Macroperus* has the pronounced toothed humeri as in *Daedrosis*, together with the unusual development of the apical antennal joint; but I do not think these genera should be merged. *Leptogastrus*, *Licinoma* and *Brycopia* are now tabulated below.

Table of *Leptogastrus*

1—5 Elytral intervals raised (sub-costate).
2—4 Colour bronze.
3 Pronotum coarsely punctate .. .. *mastersi* Macl.
4 Pronotum finely punctate .. .. *occidentalis*, n.sp.
5 Colour blue .. .. *cyaneus*, n.sp
6—8 Elytral intervals flat.
7 2nd and 4th elytral intervals impunctate .. .. *hirsutus* Cart.
8 All elytral intervals coarsely punctate .. .. *apiformis* Cart.

LEPTOGASTRUS CYANEUS, n.sp.

Narrowly elongate-ovate, body pedunculate, upper surface nitid dark blue, thinly clad with dark upright hair; antennae, oral organs, legs, underside, lateral margins of pronotum and humeral region castaneous. *Head* and pronotum rugose-punctate, the punctures coarse and sub-confluent, the ridges with a longitudinal tendency. *Head* rather flat on vertex, epistomal suture straight, eyes large and transverse, antennae moniliform, elongate and very robust, 3rd joint clearly longer than the 4th; from 4th to 10th increasing in size, 7th-10th spherical, 11th twice as long as 10th, widely ovate. *Prothorax* sub-cordate, considerably wider at apex than at base, anterior angles forming a sharp triangular tooth pointing a little outwards; sides with a slightly uneven outline (scarcely crenate), with a small sinuation before the hind angles and a wider one at anterior; the posterior angles finely dentate, the point directed outwards; extreme lateral border sharp, narrowly horizontal within, the latter with a row of large impressed punctures. *Elytra* sub-cylindric, shoulders widely rounded, sides parallel, apex rather bluntly rounded; punctate-sulcate, the *sulci* deep, closely placed and lined with densely packed, rather large punctures, the intervals sharp, except the sutural—this wide and smooth—with three or four large setae, equally spaced. Flanks of prosternum coarsely punctate, abdomen wanting, legs long, posterior tarsi having claw joint as long as the rest combined. *Dimensions*: 7 × 2¼ mm.

Hab.—Queensland. (Blackburn collection.)

A single specimen (the type) in the South Australian Museum, is clearly distinguished from its congeners by colour, besides the sharply angulate prothorax and subcylindric elytra.

LEPTOGASTRUS OCCIDENTALIS, n.sp.

Elongate, sub-pedunculate, head and pronotum dark, elytra violet bronze, antennae, palpi, tibiae and tarsi red, upper surface moderately clothed with long upright hair. *Head* finely and evenly punctate, part between forehead and epistoma depressed, antennal ridge prominent; antennae long, the joints obconic and gradually widening outwards, apical joint less enlarged than usual. *Prothorax* subcordate, subtruncate at apex and base, sides arcuately widening from the base the greatest width in front of middle, all angles obtuse, the posterior widely so, surface finely punctate, with some larger setiferous punctures irregularly placed, the medial sulcus distinct and terminated behind in a wide depression. *Elytra* subcylindric, about as wide as prothorax and more than twice as long, shoulders rounded, sides parallel for the greater part; striate-sulcate, the intervals sharply raised and subcrenulate, the punctures in sulci large and apparently only partly separated by cancellate ridge; the 3rd, 5th, and 7th intervals containing setae: underside with sparsely scattered setiferous punctures, these more close on the last abdominal segment, each bearing longish white hairs. Posterior tarsi with first joint shorter than claw-joint. *Dimensions*: ♂, $5\frac{1}{2} \times 1\frac{1}{2}$ mm. ♀, $7 \times 1\frac{3}{4}$ mm.

Hab.—Parkerville, Western Australia. (J. Clark.)

Three specimens (2 ♂, 1 ♀) sent by Mr. Lea from the South Australian Museum, are the only ones of the genus yet recorded from Western Australia. It is nearest, though not very near, to *L. mastersi* Macl., having *much* more finely punctured prothorax, subcancellate elytra, and quite different antennae.

Types in the South Australian Museum.

DAEDROSIS ANTENNALIS, n.sp.

Subcylindric, dark bronze, nitid; underside and legs nitid black, palpi and tarsi red; antennae opaque brown (basal joints bronze). *Head* sparsely and coarsely punctate, epistomal suture straight; forehead rather flat, antennae moniliform, 3rd joint slightly longer than 4th, 7th-10th very gradually increasing in size, 11th ovate-acuminate, as long as the preceding three joints combined. *Prothorax* feebly emarginate in front, convex in the middle, anterior angles bluntly obtuse; slightly wider at apex than at base, sides lightly rounded, a little irregular in outline (subcrenate), posterior angles obtuse; disc evenly, finely and closely punctate, without any sign of medial line, an elongate fovea on basal margin near each hind angle. *Scutellum* very small. *Elytra* wider than prothorax at base and more than twice as long, humeri produced as usual, sides very lightly widened behind middle; striate-punctate, the striae deep, the punctures therein smaller and less evident than in *crenato-striata* Bates, the intervals flatter and more nitid—the 3rd and 5th slightly wider than the rest, but all sharply convex at apex. Prosternum sparsely, its epimera and the elytral epipleurae coarsely punctate; abdomen smooth; post tarsi with 1st joint shorter than claw joint. *Dimensions*: $8-10 \times 3-3\frac{3}{4}$ mm.

Hab.—Mount Irvine (Blue Mountains), New South Wales. (H. J. Carter.)

Five examples, of which one has been sent to the British Museum, belong to a species I have long had in my cabinet as *D. monticola* Blackb. The true *monticola*, however, turns out to be a *Licinoma*, and is the species I described as *L. puncto-latera*, which must now be known as *L. monticola* Blackb., leaving my species without a name till now. *D. antennalis* is clearly separated from *D. crenato-striata* Bates (= *ambigua* Bates) by the following differences: (1) apical joint of antennae very large (in Bates's species this joint is about as long as the two preceding); (2) Prothorax much more finely punctate, the sides more rounded and sub-entire, its hind angles obtuse; (3) Elytral intervals flatter and smoother. I have not been able to find any external sexual characters.

Types in Coll. Carter.

LICINOMA AFRA, n.sp. (Text-fig 8).

Elongate-oblong, brilliant brassy bronze above; antennae, legs and underside castaneous. *Head* with deep wedge-shaped depression behind epistoma, the latter wide and convex; finely and evenly punctate, antennae with 3rd joint as long as 4th-5th combined, 5th-10th sub-cupuliform, successively and rather strongly widened, 11th ovate, considerably larger than 10th. *Prothorax* feebly emarginate at apex, anterior angles rounded, sides widely and evenly rounded, posterior angles obtuse, base sub-truncate, lateral border very narrow, the sub-vertical area between disc and margin showing a rugose punctate surface; disc very nitid, covered with fine, shallow, sub-punctate impressions with a few, irregular, larger, shallow impressions (in general one on each side of middle), medial line sometimes feebly indicated near base (in one example fine and distinct). *Scutellum* small, round and nitid. *Elytra* rather wide and flat, clearly wider at base than prothorax, shoulders rather squarely rounded, sides slightly widening behind middle, disc sulcate-punctate, the punctures chiefly hidden in the deep narrow sulci, but (in good light) seen to be close and regular; intervals very nitid, rather flat and wide on centre, becoming convex and narrow at sides and apex, the 3rd and 5th wider than their neighbours; underside very nitid and glabrous, epipleurae finely punctate; protibiae lightly curved, post-tarsi with 1st joint longer than claw-joint. *Dimensions*: 8–11½ × 3½—4½ mm.

Hab.—Dorrigo, New South Wales. (W. Heron).

Five examples (2 ♂). *L. violacea* Macl. is clearly distinct by its subangular sides of prothorax and uniform elytral intervals.

Types in Coll. Carter.

Var. *comboynensis* Cart.—with sides of prothorax less widened and the posterior angles blunted.

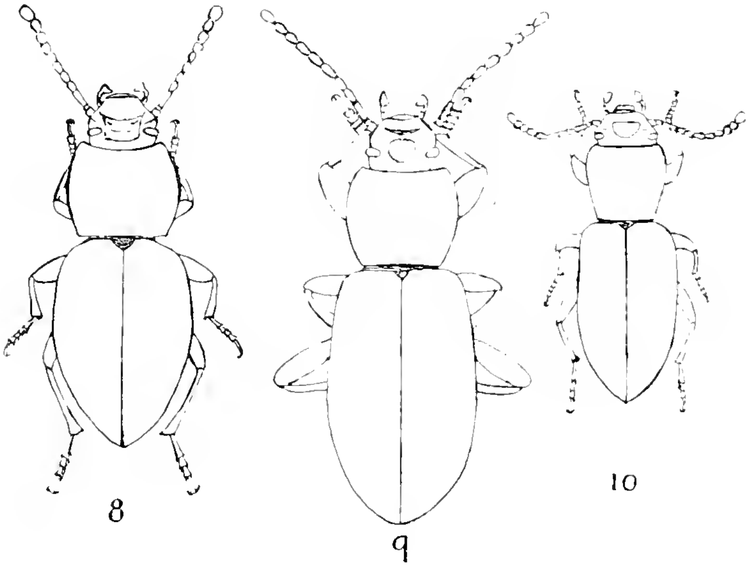
Three examples in Mr. Lea's collection may possibly deserve specific rank Two of these are labelled "(Comboyne, N.S.W. H. Muldoon)," the third, N.S.W. These three are of the same colour as *aerea* and *angusticollis* Cart. and intermediate in form between them; but *angusticollis* has a quite smooth (impunctate) pronotum and the elytra sulcate, without seriate punctures.

LICINOMA APASIOIDES, n.sp. (Text-fig. 9.)

Elongate-ovate, nitid black, glabrous, antennae reddish brown, tarsi red. *Head* with deep, irregular impression on forehead, suture arcuate; strongly punctate within the impression, eyes large, antennal joints oval, 3rd half as long again as 4th, 11th ovate-acuminate longer than 10th. *Prothorax* truncate at apex and base, narrowest at the latter, anterior angles rounded, sides rather widely rounded, widest before middle, thence more sharply narrowed to the defined obtuse posterior angles, lateral margin narrow; base with a pseudo-margin defined by a sulcus interrupted at middle; disc minutely and lightly punctate; medial line indicated in front and behind by a faint depression, an elongate fovea near lateral margin and (in two examples) four discal foveae, symmetrically placed. *Scutellum* triangular. *Elytra* clearly wider than prothorax at base, ovate, shoulders rather widely rounded; punctate-sulcate, the sulci deep, the punctures therein close and rather coarse, those near suture crenulating interior side of sulci; intervals strongly convex at sides and apex, somewhat flattened on disc, and impunctate; underside smooth, apical segment (only) finely punctate; tibiae straight. *Dimensions*: 12½ × 4½ mm.

Hab.—Forrest, Victoria. (Mr. H. W. Davey.)

Four examples (I think males from their wide anterior tarsi) sent me some years ago, were put aside as *L. nitida* Pasc. The recent identification of these shows this to be a distinct species, nearest, but not very close, to *L. monticola* Blackb., but differing in its larger size, more rounded prothorax, with more sharply defined hind angles, clearly punctate elytral sulci, etc. It forms a link with



Text-fig. 8. *Licinoma aerea.* Text-fig. 9. *L. apasioides.* Text-fig. 10. *L. meridiana.*

Apasis, and there are few characters which separate these genera, beyond the more developed humeri and the square posterior inter-coxal process of *Apasis*.

Type in Coll. Carter.

LICINOMA MERIDIANA, n.sp. (Text-fig. 10.)

Elongate-ovate, nitid black; antennae, tibiae and tarsi red. *Head* with rectangular frontal depression, coarsely punctate; antennae sub-moniliform, 3rd joint half as long again as 4th, apical three joints successively enlarged, 11th elongate-ovate, twice as long as 10th. *Prothorax* sub-rhomboidal, narrow, longer than wide, apex nearly straight, with the anterior angles very slightly protruding and sub-acute, sides feebly arcuate and narrowing to base, posterior angles obtuse, base truncate, disc rather strongly and regularly punctate; medial sulcus sharply defined throughout, with a fovea on each side of sulcus near middle (in one example), the narrow raised border separated from disc by a fine sulcus containing a row of punctures *Scutellum* small. *Elytra* wider than prothorax at base, and about twice as long; subcylindric, shoulders rounded; punctate-striate, the intervals flat, impunctate on disc, convex at sides and apex, of even width, the 3rd with a seta near apical declivity, and one on the 5th about half-way, abdomen nitid, hind tarsi with 1st joint shorter than claw-joint. *Dimensions*: 8 × 2½ mm.

Hab. Mt. Lofty Ranges, South Australia (Mr. R. J. Burton, A. H. Elston; South Australian and British Museums.)

Many specimens examined, in which I cannot see any sexual distinction. The nearly straight sides of prothorax, the feebly prominent anterior angles, the definitely channelled pronotum, distinguish this species from all its congeners. The South Australian Museum examples were erroneously labelled *L. nitida*.

VAR. with femora red (in Coll. Elston).

Type in Coll. Carter.

LICINOMA TRUNCATA, n.sp.

Subcylindric, dark bronze, nitid; underside and legs castaneous, tarsi pale red, antennae opaque reddish brown. *Head* and pronotum rather closely but unevenly pitted with coarse punctures; epistomal suture straight and deeply impressed; antennae moniliform, 3rd joint a little longer than 4th, last joint much larger than 10th. *Prothorax* rather convex in the middle, in front; apex and base truncate (as seen from above), slightly longer than wide, clearly wider at apex than at base; sides moderately arched, with greatest width before the middle; margins irregular in outline (scarcely crenate), posterior angles obtuse and blunt, medial line rather widely but interruptedly impressed; some irregular foveate impressions on each side. *Scutellum* very small. *Elytra* convex, of about the same width as the prothorax, humeri not produced (as seen from above); crenate-sulcate, the punctures in sulci close and forming crenulations at the sides of intervals; these slightly flattened on centre and finely punctured, the 3rd and 5th showing setae (four on the 3rd and one on 5th). Prosternum and epipleurae coarsely punctate, the last segment of abdomen finely punctate, the rest smooth; post tarsi with first joint shorter than the claw joint; hind intercoxal process narrow and subtruncate. *Dimensions*: 10 × 4 mm.

Hab.—Victoria (Blackburn Coll. and DuBoulay).

Two specimens are in the South Australian Museum, of which one—wanting the abdomen—bears Blackburn's No. 4473 and the name "*ambigua* Bates" in his handwriting (besides Victoria)—a manifestly incorrect identification. The other, the type, is labelled "Victoria Du Boulay Aug. , 89". This puzzling species is very like *Daedrosis*, but is without the toothed humeri; the prothorax has the sides entire, and rounded.

Type in South Australian Museum.

Table of *Licinoma*.

1—28 Elytra seriate punctate.
2—23 Elytral intervals of uniform width.
3—11 Elytral intervals flat.
4—8 Elytral intervals clearly punctate.
5 Prothorax transverse, sides well rounded .. .. *nitida* Pasc.; *victoriae* Blackb.
6—8 Prothorax as long as wide, sides nearly straight.
7 Elytral intervals nodulose .. .. *nodulosa* Champ.
8 Elytral intervals not nodulose .. .. *tasmanica* Champ.
9—11 Elytral intervals impunctate
10 Legs dark .. .. *nitidissima* Lea.
11 Legs testaceous .. .. *pallipes* Blackb.
12—23 Elytral intervals convex.
13—22 Prothorax transverse.
14—18 Prothorax widest at middle.
15 Prothorax sub-circular, highly polished (sublaevigate) .. .. *cyclocollis* Cart.
16—18 Hind angles of prothorax clearly defined, disc clearly punctate.
17 Elytral intervals narrow and punctate .. .. *elata* Pasc.; *violacea* Macl.
18 Elytral intervals wide and striolate only .. .. *gilesi* Cart.
19—21 Prothorax widest before middle, not channelled in middle

20 Hind angles rounded .. .. *monticola* Blackb., *puncta-latera* Cart.
21 Hind angles defined .. .. *apasioides*, n.sp.
22 Prothorax widest before middle, channelled in middle .. .. .. *truncata*, n.sp.
23 Prothorax longer than wide, clearly channelled .. .. *meridiana*, n.sp.
24–29 Elytral intervals not of uniform width.†
25–27 Elytral intervals flat.
26 Elytral intervals impunctate and non-setose .. .. *silvicola* Blackb.
27 Elytral intervals punctate (3rd and 5th setose) .. .. .. *commoda* Pasc.
28 Elytral intervals convex (sulci feebly punctate) .. .. *aerea*, n.sp.
29 Elytra sulcate .. .. *angusticollis* Cart.

* Impunctate does not refer to the presence of occasional setae found in *pallipes* and others.

† The 3rd and 5th intervals sometimes considerably wider than the rest; only distinct and constant examples so included.

BRYCOPIA COMATA, n.sp.

Oval, black nitid, strongly pilose, antennae and tarsi red. *Head* and pronotum densely rugose, punctate and clothed with long upright hairs; eyes large and prominent, antennae unusually long and slender, 3rd joint cylindric, nearly as long as 4th-5th combined, 4th-10th oval, 8th-10th increasing in size, 11th elongate-oval, twice as long as 10th. *Prothorax* truncate at base and apex, sides crenulate, angulately widened and widest at middle, thence obliquely narrowed each way, base and apex of about same width, all angles obtuse (anterior wider than posterior), disc without medial line or basal foveae. *Scutellum* triangular. *Elytra* wider than prothorax at base, and two and a-half times as long; punctate-striate, the striae wide, the punctures therein coarse, crenulating the sides of interstices; these convex, cross-wrinkled, each bearing a row of setae; underside strongly punctate. Legs hairy like the body. *Dimensions*: 6 × 3 (vix) mm.

Hab.—Murray River, South Australia (A. H. Elston).

A single specimen, sex uncertain, was generously given me by Mr. Elston, and shows a species distinct from all others by the combination of black colour, very hairy surface and legs, and subangulate-sided thorax.

Type in Coll. Carter.

BRYCOPIA GLOBICOLLIS, n.sp. (Text-fig. 11).

Ovate, brownish bronze, antennae and legs red, tarsi and palpi testaceous, whole upper surface rather thinly clothed with pale upright hairs. *Head* with a few scattered punctures, epistomal suture straight, deep and shortly produced backwards at its extremities; antennae stout, moniliform, joints 2, 3 and 4 subequal, thence gradually widening; 11th wider than and twice as long as 10th, ovate. *Prothorax* very convex, subcircular, truncate at apex and base, sides entire, widely and evenly rounded, widest at middle; anterior angles widely rounded, posterior widely obtuse; disc coarsely and unevenly punctured, with a few smooth rugosities; without foveae or medial line. *Scutellum* very small and round. *Elytra* ovate, two and a-half times longer than prothorax and at the shoulders slightly wider than it; humeri obliquely rounded; striate-punctate, the intervals flattish, but more convex at sides and apex, 3rd and 5th intervals wider than the rest, intervals unequally setose, the sutural interval smooth, 2nd with about two setae, 3rd and 5th with 6-8 setae, 4th nearly smooth; sides of prosternum and epipleurae sparsely and coarsely punctate, abdomen smooth. *Dimensions*: 6½ × 2½ mm.

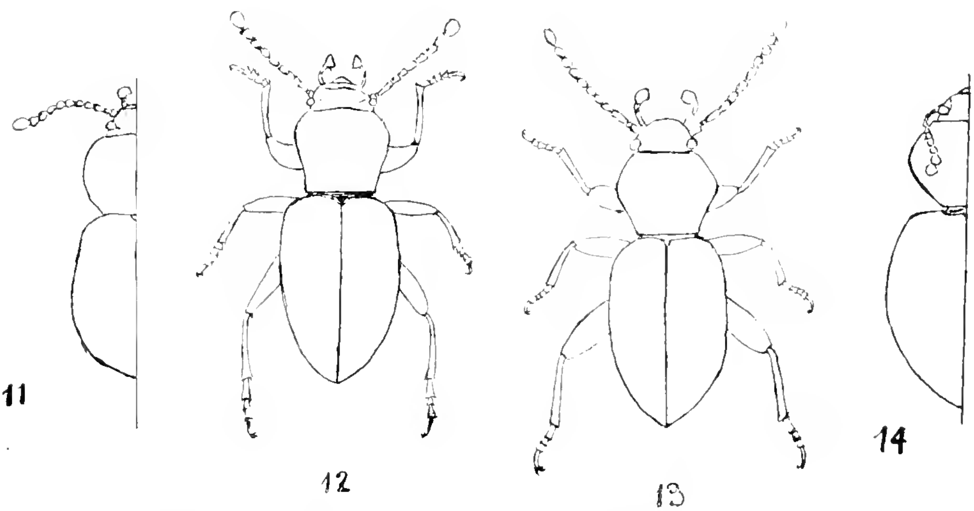
Hab. Launceston, Tasmania (A. M. Lea).

Five specimens on a card sent by Mr. Lea show a species near *B. pilosella* Pasc. and *B. crenaticollis* Cart., but clearly separated from both by the almost circular prothorax, the sides of which are nowhere crenated; the antennae are also more robust than in either of these. The prothorax of *globicollis* in the middle is nearly as wide as the elytra, whereas in the two species mentioned the prothorax is decidedly narrower than the elytra. The elytral intervals are less strongly punctured than in *B. pilosella* and are without the transverse wrinkles shown in Pascoe's species, which, moreover, has its intervals of equal width.

Types in South Australian Museum.

BRYCOPIA LEAI, n.sp. (Text-fig. 12).

Shortly ovate, rather flat, dark bronze, nitid, almost glabrous, antennae, palpi and legs pale red, tarsi testaceous. *Head* and pronotum thickly and strongly punctate, antennae with joints 4-8 shortly obconic, 9 and 10 sub-triangular, 11 ovoid. *Prothorax* sub-cordate, apex nearly straight (from above), base feebly bisinuate, anterior angles obtuse, sides arcuately widening to half-way, thence angulately narrowing in a concave curve to the acutely produced posterior angles; disc with medial line partly indicated by a short smooth space, a large shallow fovea on each side of this, a triangular impression near hind angle and a few



Text-fig.11. *Brycopia globicollis.*
Text-fig.12. *B. leai.*
Text-fig.13. *B. hexagona.*
Text-fig.14. *B. obtusa.*

larger punctures interspersed amongst the others. *Scutellum* triangular and small. *Elytra* considerably wider than prothorax at base, and about twice as long, shoulders rounded, sides sub-parallel for the greater part; punctate striate, seriate punctures large, round and regular, not at all hidden in the fine striae, intervals quite flat and dotted with distinct but smaller punctures than those in striae, the 3rd and 5th each with about 5 large setae, a few fine pale hairs discernible; flanks of meso- and meta-sternum with sparse punctures, last segment of abdomen closely punctured, rest of underside smooth or nearly so. *Dimensions*: 7 × 3 mm.

Hab.—Launceston, Tasmania.

I took a single specimen in January, 1918, and from its close likeness in form —especially of prothorax—to *Dinoria picta* Pasc., I thought it was *Dinoria coelioides* Pasc. It is perhaps nearest to *B. femorata* Cart. in sculpture.

Type (unique) in Coll. Carter.

BRYCOPIA HEXAGONA, n.sp. (Text-fig. 13).

In form and colour near the former (*leai*), but clearly differentiated from it as follows:—*Head* and *pronotum* much less strongly punctured; antennae coarser and moniliform, joints 6-10 almost round. *Prothorax* with sides less rounded in front, the lateral angulation more strongly emphasized, posterior angles rectangular and less prominent, disc without the central foveae. *Elytra* with much larger seriate punctures, coarser and deeper striae—the intervals thus appearing from a side view, sub-convex—intervals almost smooth, except for the few setiferous punctures on the 3rd and 5th intervals. Underside smooth, except for the minute punctures of the apical segment of abdomen, and a row of large punctures on front part of epipleurae. *Dimensions*: $7\frac{1}{2} \times 3$ mm.

Hab.—Near summit of Mount Wellington, Hobart (A. M. Lea).

A specimen was given to me by Mr. Lea some time ago as *Dinoria* sp., from a short series in his collection.

Type in Coll. Carter.

BRYCOPIA OBTUSA, n.sp. (Text-fig. 14).

Widely oval, dark bronze, glabrous; antennae piceous, tarsi reddish. *Head* wide, coarsely punctate, clypeal suture deeply impressed, eyes large and prominent, antennae moniliform, not extending to base of prothorax, joint 3 little longer than 4, 8th-11th enlarging gradually, 11th sub-spherical. *Prothorax*, base and apex truncate, of nearly equal width, sides widely rounded, widest at middle, thence rather straightly narrowed to base; all angles widely obtuse, sides without obvious foliation, narrowly margined throughout, disc irregularly and rather finely punctate; medial line indicated at base only by a very short sulcus; two transverse foveate impressions, one on each side behind the middle. *Scutellum* small and bead-like. *Elytra* wider than prothorax at base, widely oval, humeri rounded, punctate-sulcate, seriate punctures large, set in deep, well-marked sulci; intervals a little convex—strongly so at sides and apex, 1st (sutural) narrow, rest of uniform width and impunctate. *Sternum* finely, epipleurae coarsely punctate, abdomen smooth; posterior tarsi with 1st joint longer than claw-joint. *Dimensions*: $7 \times 3\frac{1}{2}$ mm.

Hab.—Lizard Island, Queensland.

A specimen, sex uncertain, amongst some *Adeliinae* sent from the British Museum, shows a species near *B. cheesmani* in its wide form, but differs widely in sculpture and shape of prothorax, especially in its sub-convex, smooth interstices of elytra. The pronotum is punctured somewhat as in *Adelium calosomoides* Kirby.

Type in British Museum.

Table of *Brycopia*.

1—9	Sides of prothorax crenulate.
2—6	Upper surface pilose (not including occasional setae).
3—5	Colour bronze.
4	Sides of prothorax rounded (not sinuate behind) . . . . . . *pilosella* Pasc.
5	Sides of prothorax sinuate behind (pilose clothing sparse) . . . . *minuta* Lea.
6	Colour black, sides of prothorax angulately widened . . . . . . *comata*, n.sp.

7–9 Upper surface glabrous.

8 Elytra with pale border—form flat. .. .. *(Dinoria) picta* Pasc.

9 Elytra concolorous—form very convex. .. .. *crenaticollis* Cart.

10—39 Sides of prothorax entire.

11 Upper surface pilose. .. .. *globicollis*, n.sp.

12—39 Upper surface glabrous.

13 Elytral intervals tuberculose. .. .. *tuberculifera* Champ.

14—30 Elytral intervals flat.

15—23 Sides of prothorax sinuate behind.

16 3rd and 5th elytral intervals wider than rest .. .. *taylori* Cart.

17—23 Elytral intervals of uniform width.

18 Pronotum finely punctate. .. .. *dubia* Macl.

19—23 Pronotum coarsely punctate.

20—22 Each elytral interval with a single line of punctures.

21 Form convex, seriate punctures small. .. .. *angulata* Cart.

22 Form depressed, seriate punctures large. .. .. *hexagona*, n.sp.

23 Elytral intervals thickly punctate. .. .. *leai*, n.sp.

24—30 Sides of prothorax rounded (not sinuate behind).

25 Form wide, pronotum coarsely punctate. .. .. *cheesmani* Cart.

26—30 Form narrower, pronotum finely punctate

27 Form depressed, each elytron with 4 to 6 foveate impressions *femorata* Cart.

28—30 Form convex, elytra not as in 27.

29 Size larger, sides of prothorax nearly straight behind. *(Dinoria) coelioides* Pasc.

30 Size small, sides of prothorax evenly rounded. .. .. *minor* Cart.

31—39 Elytral intervals convex.

32—34 3rd and 5th intervals wider than rest.

33 Form depressed, elytral intervals coarsely punctate .. .. *punctatissima* Cart.

34 Form convex, elytral intervals finely punctate. .. .. *globulosa* Cart.

35—39 Elytral intervals of uniform width.

36—38 Elytral intervals smooth.

37 Sides of prothorax sinuate behind. .. .. *monilicornis* Macl.

38 Sides of prothorax not sinuate behind. .. .. *obtusa*, n.sp.

39 Elytral intervals punctate. .. .. *longipes* Macl.

Adelium politum, n.sp.

Oval, black, nitid, glabrous; antennae and palpi fuscous, tarsi red. *Head* wide and, like the pronotum, mirror smooth, with a straight, deep, post-epistomal furrow, eyes very transverse, antennae with joint 3 little longer than 4; 4th-8th moniliform, 7th-11th successively widened, 9th-10th widely triangular, 11th larger than 10th, bluntly oval. *Prothorax* transverse, moderately convex, sub-truncate at apex and base, anterior angles rounded, sides evenly and rather widely rounded, posterior angles obtuse, sides not foliate, narrowly margined throughout; an elongate fovea near hind angle, another near lateral margin, otherwise without medial line or puncture. *Scutellum* widely triangular. *Elytra* wider than prothorax at base and nearly three times as long, oval, striate-punctate, the striae deep and clearly cut, the seriate punctures sub-obsolete—a few very small punctures barely visible in one or two striae near base; intervals smooth, flat on disc, convex on sides and apex. Tarsal joints short, the posterior tarsi with first joint about as long as the claw-joint. Underside smooth. *Dimensions*: 9 × 3½ mm.

Hab.—Mount Victoria, New South Wales (H. J. Carter).

I took this specimen in January; it is clearly of the *brevicorne regulare* type differing in its glassy smooth pronotum and its scarcely punctate elytra.

Type in Coll. Carter.

SEIROTRANA MINOR, n.sp.

Ovate, bronze, apical joints of antennae opaque brown. *Head* rather coarsely rugose punctate, depressed on each side within the epistoma; antennal joints short, stout and sub-triangular, 3rd about 1½ times longer than 4th, 11th ovate, and much larger than preceding. *Prothorax* 2 × 3½ mm., transverse and rather flat, arcuate-emarginate at apex, anterior angles acute, widest at middle, sides well rounded, sinuate behind, posterior angles rectangular, not dentate, base feebly sinuate (slightly advanced in middle) apical and lateral border narrow, the latter with slight tendency to crenulation; disc densely and finely rugose-punctate, medial line indicated by depression near base. *Scutellum* widely oval and punctate. *Elytra* considerably wider than prothorax at base and nearly thrice as long, ovate and moderately convex; striate-punctate, the striae containing rows of close regular punctures; intervals microscopically punctate, the 3rd, 5th, 7th, and 9th with shiny, raised, elongate catenulations, the other intervals on apical half with minute round nodules; sutural intervals flat; epipleurae and flanks of prosternum coarsely punctate, apical segment of abdomen finely punctate, other segments strigose. *Dimensions*: 9—10 × 4—4½ mm.

Hab.—Bunya Mountains, S. Queensland; VAR. A: Tenterfield, N.S.W. (11 × 4½ mm.) (H. J. Carter.)

Three specimens taken near the foot of Mount Mowbullan (Bunya Mountains) show the smallest species of the genus, structurally nearest to *S. proxima* Pasc. and *S. vicina* Cart., but with much finer elytral seriate punctures and more elongate and less strongly raised nodules. In Var. A. the lateral crenulation of prothorax is a little more, and the hind sinuation a little less marked than in the examples from Bunya Mts., but it is, I consider, conspecific with them.

Types in Coll. Carter.

ECTYCHE SEMI-BULLATA, n.sp.

Oblong-oval, subnitid black, legs piceous, antennae and tarsi castaneous, upper surface thinly clad with long upright black hair. *Head* and pronotum finely and densely rugose-punctate, epistomal suture arcuate, antennae submoniliform, 3rd joint scarcely longer than 4th, successively increasing in size from the 6th onwards, 9th and 10th sub-spherical, 11th oval. *Prothorax* convex, transverse, subtruncate at apex, sides widely and evenly rounded, anterior angles obsolete, posterior sharply rectangular, preceded by an abrupt sinuation on sides and followed by a sub-obsolete sinuation at base. *Elytra* oval, humeri squarely rounded, at shoulders about as wide as prothorax at widest; apex bluntly rounded; striate-punctate; the round, closely-packed punctures placed in fine striae; the 3rd, 5th, and 7th intervals each with about 6 large tubercles and a few much smaller tubercles on the sutural interval. Epipleurae coarsely and closely, abdomen sparsely punctate, glabrous. *Dimensions*: 4.5-5 × 2 mm.

Hab.—Geraldton, Western Australia (W. D. Dodd).

Two specimens sent from the South Australian Museum show a species easily differentiated by its sculpture from its allies. The only other species having tuberculate elytra is *E. tuberculipennis* Bates, in which small tubercles are evenly placed on all the intervals, besides many other differences. I have specmens of the latter taken by Mr. H. W. Brown at Lake Austin, W.A. I have not been able to make out any sexual distinction.

Types in the South Australian Museum.

OMOLIPUS PUNCTATO-SULCATUS, n.sp.

Moderately elongate, sub-nitid. Head, pronotum, underside and legs black, elytra dark blue (almost black), antennae and tarsi reddish brown. *Head* minutely punctate in front, smooth on vertex. *Pronotum* moderately convex, apex produced in midde, base truncate, sides but slightly rounded anteriorly and a little sinuate behind; lateral border visible from above; disc smooth. *Elytra* elongate-ovate, shoulders rather sharply rectangular and a little advanced; sides feebly enlarged behind middle, lateral border narrowly horizontal; punctate-sulcate with 8 well-marked sulci (besides the extreme lateral one), and without the usual indication of a short scutellary row of punctures; the intervals convex, punctures in sulci large, regular, crenulating the sides of intervals. Underside nearly smooth, some minute punctures on sternum and apical segments of abdomen.

Dimensions: 7—9 × 3—4 mm.

Hab.—Batchelor and Stapleton, N. Territory (Mr. G. F. Hill).

Three examples (1 ♂, 2 ♀) sent by Mr. Hill (of the Institute of Tropical Medicine, Townsville) show a species near *coeruleus* Cart. in form and sculpture, but in colour something between *O. gnesioides* Pasc. and *O. cyaneipennis* Champ., the elytra being of a blue-black shade sometimes seen in *gnesioides*, while the pronotum is smoother but less nitid than in that species. In most other species there is a short scutellary row of punctures (in *O. gnesioides* about 2 or 3), or a short sulcus as in *O. coeruleus*; the absence of this in *punctato-sulcatus* is a distinctive character.

Types in Coll Carter.

Besides the synonymy noted above the following should be recorded:—

(i.) *Chalcopterus smaragdulus* F. = *C. cairnsi* Blackb.

(ii.) *C. cupreus* F. = *C. rusticus* Blackb.

(iii.) *C. setosus* Blackb. = *C. cupriventris* Cart. (var.)

(iv.) *Argnaon championi* Blackb. = *Catopherus corpulentus* Cart.

(v) *Sirrhas limbatus* Champ. = *Notolea limbata* Cart.

Of *C. cupreus* F. (a long-standing mystery), Mr. Blair writes "is brassy becoming purple and finely narrowly bluish behind, the latter" [*rusticus*] "purple becoming bluish behind. The sculpture seems to be identical."

Of (iii.) Mr. Blair writes, "I think—are colour forms of the same." Apparently the metallic underside is not constant.

In (iv.) and (v.) the genera *Catopherus* and *Notolea* must be sunk. In the former case I failed to diagnose Blackburn's species; in the latter I had not seen Mr. Champion's paper dealing with this very unusual *Lagriid*.

ON THE MALE GENITALIA OF SOME ROBBER-FLIES BELONGING TO THE SUBFAMILY *ASILINAE*. [DIPTERA.]

By G. H. Hardy.

(With twelve Text-figures.)

A study of the male genital forceps of Australian Robberflies belonging to the subgenus *Asilus* has been undertaken for the purpose of establishing a satisfactory method of identifying the described species. A further species with extraordinarily developed male genitalia is described as new.

This opportunity is taken to publish a figure of the male genitalia of *Promachus doddi* Ricardo, which belongs to a genus containing several closely allied species.

Genus Promachus Loew.

Obs.—This genus is very scantily represented in the various collections in Australia, and the specimens available for study do not readily conform to the descriptions already published. There are six names representing six supposedly distinct species and the only named specimen in the collections under revision is *P. doddi* Ricardo, which was identified by Miss Ricardo.

Text-fig. 1. The male genitalia of *Promachus doddi* Ricardo, seen dorsally. (x 14).

PROMACHUS DODDI Ricardo. (Text-fig. 1).

Promachus doddi, Ricardo, Ann. Mag. Nat. Hist., (8), xi., 1913, p. 415.

Description.—A male specimen identified by Miss Ricardo has the genitalia quite distinct from that of other species examined in the collections under revision. It contains a pair of widely separated upper forceps, each branch of which is conspicuously kidney-shaped. Seen dorsally, in the centre there are two flat, partly overlapping appendages which are undoubtedly the lamellae. Further parts of the genital organs, usually covered by the forceps, are exposed in this species. The upper forceps apically have a number of long thick bristles, and there are three short bristles on the inner side, directed towards the median line but not meeting. The whole surface is covered with hairs which become stronger apically and merge into bristles.

Obs.—In Mr. F. H. Taylor's collection there are two specimens of this species and one, from which the above description is taken, was identified by Miss Ricardo. Two other species in the same collection are unidentified.

Genus ASILUS Linnaeus.

Obs.—White has given a key to the genera of the subfamily *Asilinae*,[1] and in it the forceps of the male genitalia of the genus *Asilus* are stated to be globular. This character is typical of only a few Australian species and the remainder have male genitalia of remarkably diverse forms. The description "large, brightly coloured species" will also only apply to a few as a number are sombre coloured, and they range in size down to species no bigger than some belonging to the group *Neoitamus*.

The material upon which the following study is based consists of the collections in the Australian and Macleay Museums, the writer's collection which contains species from Western Australia, Tasmania and New South Wales, the specimens from Queensland collected by Mr. F. H. Taylor, and finally a very valuable collection made by Dr. E. W. Ferguson containing species that occur around Sydney and identified by comparison with specimens in the British Museum.

Asilus regius Jaennicke, and *Asilus aureus* White have not been recognised in the above collections.

Characters.—The genus *Asilus* contains two subgenera in Australia. The subgenus *Neoaratus* is represented by one species, *N. hercules* Wiedemann, and is distinguished by the male having the costal border of the wings inflated, and, in addition, each branch of the upper forceps of the male genitalia is bifid. The subgenus *Asilus* contains species without the costal inflation, and the upper forceps of the male genitalia are of various shapes, with or without a process, but not bifid in the known species.

Key to the species of subgenus *Asilus*

1. The forceps of the male genitalia set wide apart and exposing other parts of the genital organs .. .. 2.
   The forceps of the male genitalia concealing the other parts of the genital organs .. .. 3.
2. The branches of the upper forceps containing an apical process on which is situated a branching appendix. .. .. *genitalis*, n.sp

[1] Proc. Roy. Soc. Tas., 1917, p. 88.

The branches of the upper forceps containing an apical process without an appendix .. .. *rubrithorax*.

3. The upper forceps attenuated apically .. .. 4.
The upper forceps not attenuated apically .. .. 6.

4. The attenuated portion of each branch of the upper forceps distinctly forms a process .. .. *ferrugineiventris*.
The attenuated portion of the upper forceps forms a continuation of the basal portion and does not form a process. .. .. 5.

5. The upper forceps constricted subapically .. .. *pelago*.
The upper forceps not constricted subapically but tapering more or less uniformly to the apex. .. .. *malleolus*, *inglorius* and *rufiventris*.

6. The upper forceps ending in a minute projection and each branch of the upper and lower forceps containing three subapical bristles on the ventral side. *blasio*.
The upper forceps more or less rounded and without bristles. *murinus*, *sydneyensis* and *alcetas*.

ASILUS GENITALIS, n.sp. (Text-fig. 2.)

Description.—♂. The head is covered with light yellowish tomentum; the moustache of the same colour contains bristly hairs in the centre; the beard, the bristles and hairs of the occiput are also the same colour; there are a few, reddish, short hairs on the tubercle containing the ocelli. The palpi are deep reddish-yellow, with similarly coloured hairs which, apically, are bristle-like. The antennae are missing in the holotype and partly damaged in one paratype, but in the second paratype they are reddish-yellow, with similarly coloured hairs on the two basal joints. The proboscis is also reddish-yellow but is strongly stained black on the apical half; the hairs are light yellowish.

The thorax has a mixed yellowish and reddish-yellow ground colour, and contains two black median stripes, and an interrupted lateral stripe on each side. Dorsally, the bristles and hairs on the pronotum are yellowish, and on the remainder of the thorax black. The dorsal thoracic bristles consist of two presutural and one anterior to these, three superalar, four postalar and three or four dorsocentral. The scutellum is similar in ground colour to that of the thorax and contains four, black, marginal bristles, but in one of the paratypes there are six reddish bristles on the apical margin. Ventrally the thorax is whitish with very sparse whitish hairs. The metapleural bristles are strong and yellow, and the hypopleural bristles are weak and whitish.

The abdomen, dorsally, is reddish-yellow with similarly coloured pubescence and whitish, bristly, lateral hairs. Ventrally, the abdomen is unicoloured with the under side of the thorax.

The genital organs are very large and the forceps are set wide apart exposing other parts which are hidden in most species of the genus. The lower half of each branch of the upper forceps is produced apically into a very long process which curves upwards, and, near the base of this, there is a short appendix which branches towards the median line and is directed downwards. The lower forceps are short, and the apical prong can be seen diverted so that it points towards the base. The lamella is broad and short, and issues from a two-pronged appendage, the apices of which can be seen between the process and the basal portion of the upper forceps.

The legs have their coxae whitish with yellow hairs and bristles. The pulvilli are yellow and the claws are reddish basally and black apically; the

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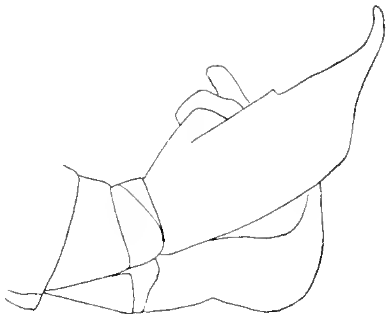

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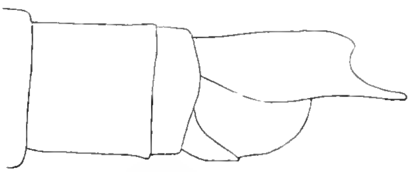

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Text-fig. 2. The male genitalia of *Asilus genitalis*, n.sp., seen laterally. (x 6).
Text-fig. 3. The male genitalia of *Asilus rubrithorax* Macquart, seen laterally. (x 6).
Text-fig. 4. The male genitalia of *Asilus ferrugineiventris* Macquart, seen laterally. (x 14).

remainder of the legs are reddish yellow with similarly coloured bristles. The anterior femora are without spines; the intermediate femora have two rows of spines on the anterior side, one ventral row, one subapical and two median spines on the posterior side; the posterior femora have two rows of bristles on the anterior side, one ventral row and a number of subapical spines.

The wings are hyaline with a slight yellowish tinge.

The female is unknown.

Length, 36 mm.

Hab.—Queensland. Two specimens are without labels; the specimen in the Macleay Museum is from Cairns.

Type.—The holotype male, in the Australian Museum, was presented by Mr. F. H. Taylor. A paratype is in Mr. Taylor's collection and a second paratype is in the Macleay Museum.

ASILUS RUBRITHORAX Macquart. (Text-fig. 3.)

Asilus rubrithorax, Macquart, Dipt. Exot., i. (2), 1838, p. 143; Walker, List Dipt. Brit. Mus., vii., suppl. 3, 1855, pp. 729 and 735; Ricardo, Ann. Mag. Nat. Hist., (8) xi., 1913, p. 441.

Description.—Two specimens, identified from the description only, are somewhat similar in appearance to *Asilus murinus* Macquart, larger in build and distinctly different in the male genitalia.

♂. The head is light yellowish; the moustache consists of some black hairs, below which there are much longer bristly white hairs. The hair on the vertex and a little of the hair on the occiput is black; the hair on the remainder of the head, including the beard, is light yellowish or white. The antennae are black, containing black hairs on the two basal segments. The palpi are black with black hairs and the proboscis is black.

The thorax has a pair of black median stripes and between them there is a slightly obscure yellowish line; on each side a lateral stripe, interrupted anteriorly, is separated from the median stripe by a bright yellow stripe; the lateral border is bright yellow merging into the light greyish on the postalar callus.

The thoracic bristles consist of a row of three presutural with one anterior to these, three or four superalar, three or four postalar and about six dorso-central. The scutellum is greyish, with about four, black, marginal bristles and black pubescence. Ventrally the thorax is light yellowish, with the hairs and bristles, including the metapleural and hypopleural, yellow or white.

The abdomen, dorsally, is yellowish brown in colour and obscurely black along the median line forming a broad obsolete stripe. The pubescence is mostly black but yellowish laterally, with yellowish hairs and bristles.

The forceps of the genitalia are black and large, set wide apart, and expose the other parts of the genital organs; each branch of the upper forceps contains a process issuing from the upper half at the apex and curves upwards; the whole surface is covered with black pubescence and some conspicuous white pubescence; the lower forceps are black, with long whitish hairs which become bristly at the apex; the black lamella is conspicuous and broad.

The legs have their coxae unicoloured with the under side of the thorax, and contain long whitish hairs and bristles; the femora are red with a black stripe on the anterior side; the tibiae are red with black at the apices; the tarsi are black; the claws are red at the base and black at the apex; the pulvilli are yellow. The pubescence is mostly yellowish on the femora and tibiae, and black on the tarsi. There are some long, black, bristly hairs on the anterior femora which are spineless; the intermediate femora contain two rows of spines on the anterior side, one ventral row and one row on the posterior side; the posterior femora contain two rows of spines on the anterior side and a few subapical spines.

Length of male, 30 mm.

Hab.—New South Wales: Hampton, near Rydal—one male specimen collected by Dr. R. J. Tillyard during January, 1918. There is also a male specimen in the Macleay Museum, with the genitalia distorted, from Walcha; the label indicates the month "November," but the year of capture is not specified.

Asilus ferrugineiventris Macquart. (Text-fig. 4.)

Asilus ferrugineiventris, Macquart, Dipt. Exot., suppl. 4, 1850, p. 92, Pl. ix, fig. 1.
Asilus hyagnis, Walker, Ins. Saund. Dipt., 1851, p. 139; Walker, List Dipt. Brit. Mus., vii., suppl. 3, 1855, pp. 730 and 739; Ricardo, Ann. Mag. Nat. Hist., (8), xi., 1913, p. 445.

Synonymy.—The description of *A. ferrugineiventris* Macquart conforms to specimens of *A. hyagnis* Walker in all essential points.

Status.—Although the synonymy is given here with the writer's convictions, the identity of the species with *A. hyagnis* Walker is accepted upon the evidence that Mr. Taylor sent to Miss Ricardo some specimens from a long series collected in Queensland and these were identified as *A. hyagnis* Walker. In consequence, the specimens retained were labelled as such and were subsequently examined by the writer. The retained specimens belong to only one species and a male was selected for inclusion in the collection of the Australian Museum. A second specimen, taken near Sydney, was found to agree with the Queensland specimens and also with the descriptions.

Description.—A straight process issues from the apex of each branch of the upper forceps of the genitalia at the lower half.

Hab.—New South Wales, Queensland and two female specimens in the Macleay Museum from King George Sound, Western Australia.

ASILUS PELAGO Walker. (Text-fig. 5.)

Asilus pelago, Walker, List. Dipt. Brit. Mus., ii., 1849, p. 419; and vii., suppl. 3, 1855, pp. 729, 731, and 735; Schiner, Verh. z.-b. Ges. Wien, xvii., 1867, p. 400; Ricardo, Ann. Mag. Nat. Hist., (8), xi., 1913, p. 443.

Description.—The attenuated portion of the upper forceps of the male genitalia is short, slightly constricted subapically, and broadly rounded at the apex; it is conspicuously deflected from the considerably arched basai portion; the whole area is covered with a vestiture of short bristly appearance.

Hab.—Western Australia: one male and one female from Perth; South Australia: two males and four females in the Macleay Museum probably belong here, but neither male specimen has the genitalia in sufficiently good condition for positive determination.

ASILUS MALLEOLUS Walker. (Text-fig. 6.)

Asilus malleolus, Walker, List Dipt. Brit. Mus., ii., 1849, p. 418; and vii., suppl. 3, 1855, pp. 729, 732 and 736.

Asilus discutiens, Walker, Ins. Saund. Dipt., 1851, p. 135; Walker, List Dipt. Brit. Mus. vii., suppl. 3, 1855, pp. 729 and 736; Ricardo, Ann. Mag. Nat. Hist., (8), xi., 1913, p. 445; White, Proc. Roy. Soc. Tas., 1916, p. 182.

Asilus unilineatus, Macquart, MS. name.

Synonymy.—The above synonymy is accepted on the authority of Miss Ricardo. *A. malleolus* Walker takes precedence over *A. discutiens* Walker, under which name the species has been well known hitherto.

Description.—The upper forceps of the male genitalia are attenuated and curve downwards; on the dorsal surface of the genitalia there is a hump which partly conceals the lamella.

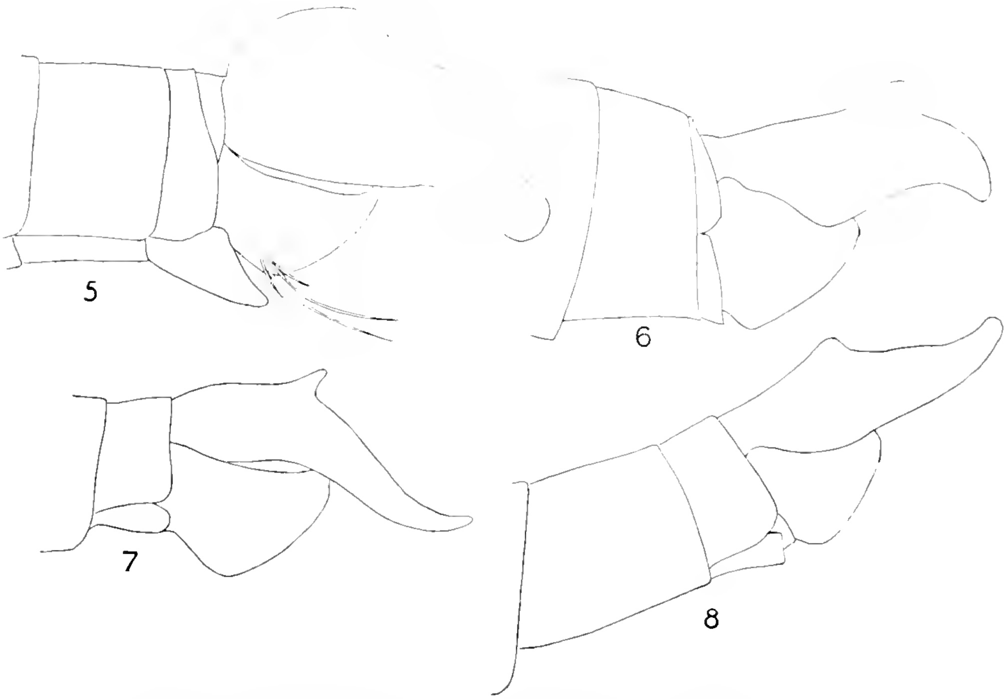
Hab.—New South Wales. Miss Ricardo reports the species from "Van Dieman's Land" which locality is usually taken to be Tasmania; there is, however, a "Van Dieman" marked on some old maps in the north of Australia, and this may be the locality of the many species recorded from Tasmania but only known from the northern half of Australia.

ASILUS INGLORIUS Macleay. (Text-fig. 7.)

Asilus inglorius, Macleay, in King's Narr. Surv. Austr., ii., 1837, p. 467; Wiedemann, Auss. Zweifl. Ins., ii., 1830, p. 644; Walker, List Dipt. Brit. Mus., ii., 1849, p. 423; and vii., suppl. 3, 1855, pp. 730, 734 and 738; Schiner, Verh. z.-b. Ges. Wien, xvi., 1866, p. 690; Schiner, Reise Novara, Dipt., 1868, p. 183; Ricardo, Ann. Mag. Nat. Hist., (8), xi., 1913, p. 439.

Asilus amycla, Walker, List Dipt. Brit. Mus., ii., 1849, p. 423 (♀); and vii., suppl. 3, 1855, pp. 730, 734 and 741.

Asilus centho, Walker, *Ibid.*, ii., 1849, p. 431 (♀); and vii., suppl. 3, 1855, pp. 730, 733 and 740.



Text-fig.5. The male genitalia of *Asilus pelago* Walker, seen laterally. (x 14).
Text-fig.6. The male genitalia of *Asilus malleolus* Walker, seen laterally. (x 14).
Text-fig.7. The male genitalia of *Asilus inglorius* Macleay, seen laterally. (x 14).
Text-fig.8. The male genitalia of *Asilus rufiventris* Macquart, seen laterally. (x 14).

Asilus planus, Walker, *Ibid.*, vii., suppl. 3, 1855, pp. 730 and 741 (♀).
Asilus sericeiventris, Macquart, MS. name.

Synonymy.—The above synonymy is given on the authority of Miss Ricardo, who accepts Schiner's authority for the identification of *Asilus inglorius* Macleay.

The species referred here is the only known form to which Macleay's description can be applied.

Description.—The upper forceps of the male genitalia are long, slender and attenuated apically; the attenuated portion is deflected basally and then curves back to the horizontal line at the apex. A hump at half the length on the dorsal surface partly conceals the lamella.

Hab.—Queensland, New South Wales, Victoria, South Australia and Western Australia. These States are represented by specimens in the Australian and Macleay Museums.

ASILUS RUFIVENTRIS Macquart. (Text-fig. 8.)

Asilus rufiventris, Macquart, Dipt. Exot., i., (2), 1838, p. 144; Walker, List Dipt. Brit. Mus., vii., suppl. 3, 1855, pp. 730 and 739; Ricardo, Ann. Mag. Nat. Hist., (8), xi., 1913, p. 442.
Asilus alligans, Walker, *Ibid.*, vii., suppl. 3, 1855, pp. 730, 734 and 740.

Synonymy.—The description of *A. alligans* Walker conforms to *A. rufiventris* Macquart, and therefore the name is placed here as a synonym of that species. Miss Ricardo states that the type is lost.

Description.—Each branch of the upper forceps of the male genitalia has an attenuated apex which curves upwards apically; a hump on the dorsal surface of the genitalia, at half the length, partly conceals the lamella.

Hab.—Queensland, New South Wales, Victoria and South Australia.

ASILUS BLASIO Walker. (Text-fig. 9.)

Asilus blasio, Walker, List Dipt. Brit. Mus., ii., 1849, p. 441; and vii., suppl. 3, 1855, pp. 730, 731 and 738; Ricardo, Ann. Mag. Nat. Hist., (8), xi., 1913, p. 444.

Status.—The species was described from Western Australia, but Miss Ricardo redescribed it from a Victorian specimen as the type is very old and worn. It is possible that the specimen described by Miss Ricardo is closely allied to, but distinct from, Walker's species. A series from New South Wales is also referable here and is used for the study of the genitalia. A male specimen from Perth, Western Australia, differs in the genitalia by having the dorsal digitate process missing; the specimen has its genitalia broken on one side but the other side appears to be complete, as a line of fracture cannot be traced; nevertheless, it is advisable to keep these specimens under one specific name until the differences in the male genitalia can be confirmed with new material from Western Australia.

Description.—The upper forceps of the male genitalia are more or less elliptical in shape. Each branch of the upper and lower forceps contains a minute projection at the extreme apex, and three conspicuous subapical bristles on the ventral side. On the dorsal edge of the upper forceps there is a digitate process situated at about three-quarters the length, which, however, is missing in the specimen from Western Australia; this specimen is also very much brighter than those from New South Wales.

Hab.—Western Australia: Perth, one male specimen; New South Wales: Blue Mountains, Blackheath, a series of each sex collected during November, 1919; Victoria: Dandenong Ranges (Ricardo).

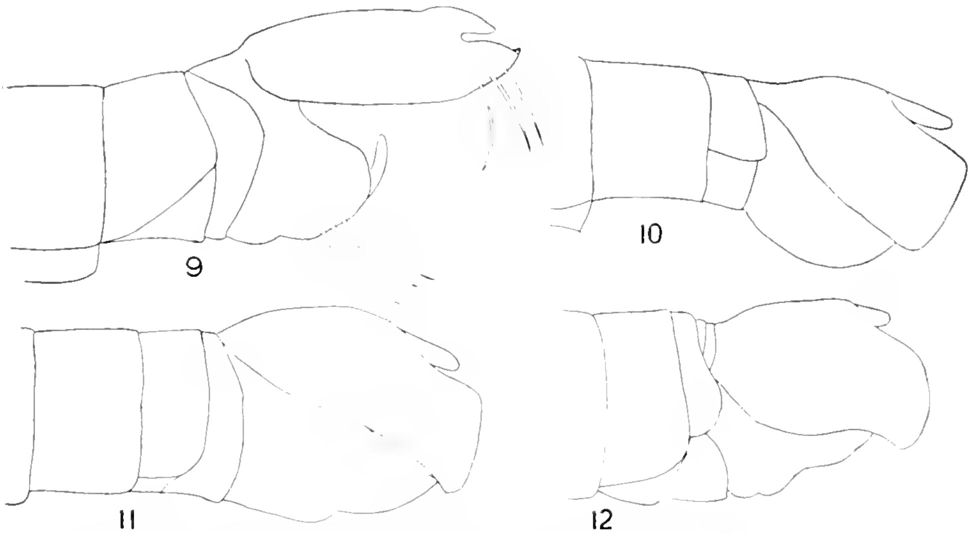
ASILUS MURINUS Macquart. (Text-fig. 10.)

Asilus murinus, Macquart, Dipt. Exot., i., (2), 1838, p. 144; Walker, List Dipt. Brit. Mus., vii., suppl. 3, 1855, pp. 729 and 736; Ricardo, Ann. Mag. Nat. Hist., (8), xi., 1913, p. 440.

Asilus murinus, var. Macquart, *ibid.*, suppl. 2, 1847, p. 45.

Description.—The shape of the male genitalia is more or less globular, a little smaller in proportion to but scarcely differing from that of *A. sydneyensis* Macquart. The Tasmanian *A. alcetas* Walker also contains similar shaped genitalia and, moreover, there does not appear to be any structural difference between the three species.

A. murinus Macquart is a dingy coloured species, whilst *A. sydneyensis* Macquart is brighter and has a reddish tinge on the abdomen; they are both from New South Wales. *A. alcetas* Walker from Tasmania, is similar to *A. murinus* Macquart, and much smaller in size.



Text-fig.9. The male genitalia of *Asilus blasio* Walker, seen laterally. (x 14).
Text-fig.10. The male genitalia of *Asilus murinus* Macquart, seen laterally. (x 14).
Text-fig.11. The male genitalia of *Asilus sydneyensis* Macquart, seen laterally. (x 14).
Text-fig.12. The male genitalia of *Asilus alcetas* Walker, seen laterally. (x 14).

ASILUS SYDNEYENSIS Macquart. (Text-fig. 11.)

Asilus nigritarsis, Macquart, Hist. Nat. Dipt., i., 1834, p. 304 (preoccupied); Walker, List Dipt. Brit. Mus., vii., suppl. 3, 1855, pp. 729 and 736; v.d. Wulp, Cat. Dipt. S.Af., 1896, p. 93.

Asilus sydneensis Macquart, Dipt. Exot., i., (2), 1838, p. 144; Walker, *ibid*, ii., 1849, p. 425; and vii., suppl. 3, 1855, pp. 730 and 739.

Itamus sydneyensis, Schiner, Novara Reise, Dipt., 1868, p. 189.

Neoitamus sydneyensis, Kertesz., Cat. Dipt., iv., 1909, p. 294.

Asilus sydneyensis, Ricardo, Ann. Mag. Nat. Hist., (8), xi., 1913, p. 442; White, Proc. Roy. Soc. Tas., 1916, p. 182.

Asilus jacksonii, Macquart, Dipt. Exot., i., (2), 1838, p. 145; Walker, *ibid.*, ii., 1849, p. 451; and vii., suppl. 3, 1855, pp. 730, 733 and 740.

Asilus tasmaniae Macquart, Dipt. Exot., i., (2), 1838, p. 145; Walker, *ibid.*, vii., suppl. 3, 1855, pp. 729 and 735.

Aratus? tasmaniae, v.d. Wulp., Term. Fuz., xxi (1), 1898, p. 237.

Asilus amythaon, Walker, *ibid.*, ii., 1849, p. 423.

Asilus maso, Walker. *ibid.*, ii., 1849, p. 424.

Synonymy.—The name *Asilus nigritarsis* was used by Wiedemann in 1821 for *Dasypogon* (now *Mallophora*) *nigritarsis* Fabricius from America. The synonymy is given on the authority of Schiner and Miss Ricardo.

Description.—The shape of the male genitalia is more or less globular and similar to but larger than that of *A. murinus* Macquart, under which species further particulars will be found.

Hab.—New South Wales. In the collections under revision the specimens with locality labels are invariably from New South Wales. The Tasmanian records are evidently incorrect.

ASILUS ALCETAS Walker. (Text-fig. 12.)

Asilus alcetas, Walker, List Dipt. Brit. Mus., ii., 1849, p. 425; and vii., suppl. 3. 1855, pp. 729, 732, and 736.

Itamus alcetas, Schiner, Verh. z.-b. Ges. Wien., xvii., 1867, p. 408.

Neoitamus alcetas, Kertesz, Cat. Dipt., iv., 1909, p. 290.

Asilus alcetas, Ricardo, Ann. Mag. Nat. Hist., (8), xi., 1913, p. 447; White, Proc. Roy. Soc. Tas., 1916, p. 181.

Asilus trachalus, Walker, Ins. Saund. Dipt. 1851, p. 143; Walker, List Dipt. Brit. Mus., vii., suppl. 3, 1855, pp. 730 and 738.

Synonymy.—The synonymy is given on the authority of Miss Ricardo, who states that the species referred by Schiner to the genus *Itamus*, now *Neoitamus*, must be an altogether different species from the type. Although this is probably correct, there is not sufficient information in the description to allow Schiner's species to be identified with any known species of *Neoitamus* and, moreover, *Asilus alcetas* Walker has a very striking resemblance to *Neoitamus*.

Description.—The shape of the male genitalia is more or less globular and similar to that of *A. murinus* Macquart, under which further particulars are given.

Hab.—Tasmania: Mount Arthur, one male and one female collected by Mr. F. M. Littler, to whom the writer is indebted for these specimens now in the collection of the Australian Museum. This is the only species of the genus definitely known from the State.

NOTES FROM THE BOTANIC GARDENS, SYDNEY.

By A. A. Hamilton, Botanical Assistant.

Scirpus supinus L.

Centennial Park (A. A. Hamilton, 2, 1916.)—a new habitat for a species apparently rare in this State. The only specific locality recorded for this plant in New South Wales is Nepean River (Coll. R.Br.).* Australian forms of this species are represented in the National Herbarium, Sydney, by specimens from the British Museum under *Isolepis supina* R.Br. (Coll. Banks and Solander, New Holland, 1770) and Lake Albert, Victoria, a locality given by Bentham, *loc. cit.* There is also an example without collector's name, locality, or date. The specimens now recorded agree with those collected by Banks and Solander in all the important characters, differing only in the length of the involucral bract, which does not exceed the measurement (2 inches) given by Bentham. In some of the Banks-Solander specimens—which were probably collected at the Endeavour River—it attains a length of 15 cm. The Victorian specimens are diminutive, 6—8 cm. high, with slightly flexuose stems. An examination of the exotic herbarium material disclosed considerable variation in the length of the involucral bract. It appears to be an exceptionally variable species, as, according to the descriptions given in the works consulted, it is found to vary greatly in such important characters as the shape of the fruits, number of style branches, and the presence or absence of rudimentary sepals or petals; and is usually quoted as an exception in the section in which it has, for convenience, been placed. Examples with biconvex fruits and 2-style branches, and others with triangular fruits and 3-style branches were noted throughout the series. In several European specimens the lamina of the leaf sheath is occasionally produced to a length of 3—5 cm.

Schoenus Moorei Benth.

Moore and Betche† placed *S. Moorei* systematically in a group with smooth fruits. This is misleading, as an examination of the fruits throughout a series of specimens from various localities shows them to be prominently transversely rugose. The character of smooth as opposed to rugose or tuberculate fruits is an important factor in the determination of members of this genus, but in this particular species Bentham‡ has omitted to mention this feature, though he refers to both the shape and ribbing of the fruit.

*Fl. Austr., vii., 1878, 330.

†H'book Fl. N.S.Wales, 1893, p.458.

‡*L.c.*, p.367.

LEPIDOSPERMA QUADRANGULATA, n.sp.

South Brothers, John's River (J. L. Boorman, 6, 1915); Port Macquarie (J. L. Boorman, 11, 1915).

Stipes 1 m. altus, 2 mm. latus, foliis latioribus, 75 cm. longis, stipes foliaque eodum modo quadrangulata. Panicula 2 ad 5 cm. longa. Bractea paniculae inferior 1—5 ad 3 cm. longa. Nux obovoidea triangularis, costis prominentibus Squamae angustae setaceae.

Stem about 1 m. high, under 2 mm. broad, finely striate, smooth, 4-angled, the edges slightly produced and rounded. Leaves 4-angled, broader and flatter than the stem, from 50 to 75 cm. long, the rounded edges of the angles prominent, forming a shallow channel more conspicuous on the broad side of the leaf. Panicle from 2 to 5 cm. long, compound, dense, ovoid-oblong to pyramidal, branches few, erect. Bracts of the inflorescence striate, the lowest 1½ to above 3 cm. long, the lamina occupying about half its length, the upper ones gradually smaller. Spikelets clustered, sessile, crowded on the panicle branches, 5—6 mm. long. Barren flowers 1—2 below the perfect one. Flowering glumes acuminate, 3—4 outer ones shorter and broader. Nut obovoid, 3-angled, the ribs prominent, pale when young, but gradually becoming mottled with brown. Hypogynous scales narrow, frequently tapering into a seta.

Its nearest affinity is *L. Neesii* Kunth., from which it is easily separated by the quadrangular leaves and stem, though in some forms of *L. Neesii* the stems show a degree of angularity. Quadrangular stems and leaves are represented in the genus by *L. tetraquetrum* Nees, an exceptional species placed by Bentham* in his otherwise flat-leaved series *Floribundae*, a position to which it is entitled by its inflorescence, an elongated panicle of 6—12 inches. The much reduced compact panicle of *L. quadrangulata* is that of Bentham's series *Tereticaules*, though it differs in the shape of stem and leaf from the other members of the group, which have—as the series distinction indicates—cylindrical stems and leaves.

GREVILLEA PUNICEA R.Br. var. CRASSIFOLIA, n.var.

Gosford (J. Purser, 9, 1899); Penang Ranges, Gosford (J. H. Maiden, 6, 1903); Road to Wiseman's Ferry, Gosford (A. A. Hamilton, 1, 1916).

Leaves crass, rigid, flattened, from ovate to rotundate, ½ to 2 cm. long, the intramarginal vein prominent and slightly tuberculate. A variety differing from the typical Port Jackson form in the size and rotundity of the leaves, and the conspicuous intra-marginal vein which gives the reflexed leaf margin a spreading rather than the typical recurved habit. This variety appears to be confined to the neighbourhood of Gosford.

HAKEA SALIGNA R.Br. var. ANGUSTIFOLIA, n.var.

Woronora River, Heathcote (A. A. Hamilton, 10, 1915). Growing among boulders in the river bed.

A compact shrub 2 m. high. Leaves narrow, ½ to 1 dec. long, 3—5 mm. broad, rigid, almost veinless. Fruit carpels small, 2 cm. long, 1—1¼ cm. broad, nearly smooth, the beak straight or barely produced, approaching the fruit of *H. microcarpa* R.Br. An example from Lawson (A. A. Hamilton, 9, 1914) of

*Fl. Austr., vii., p.385.

H. saligna, a spreading tree 6 m. high, has leaves from ½ to 1½ dec. long and 1 to nearly 3 cm. broad, distinctly veined, and fruit carpels 3½ cm. long, 2 cm. broad, covered with large prominent tubercles, the beak recurved. Specimens in the National Herbarium forming connecting links are from Cockle and Cowan Creeks (W. F. Blakely, 3, 1915), "tall slender shrubs 15—20 ft." (Collector's note), with narrow acuminate leaves, the venation indistinct, and comparatively large, prominently tuberculate fruits; Nowra (J. L. Boorman, 1, 1915), "a small tree 12—14 feet" (Collector's note) with short acute leaves, midway in width between the Lawson and Heathcote specimens, and small fruits with an elongated beak, the tubercles less prominent than in the examples from Lawson. Bentham's description of *H. saligna** may be interpreted to include all the forms here reviewed, but the morphological differences between the typical specimens from Lawson, and those from Heathcote appear to be sufficiently pronounced to warrant a varietal distinction. The figure presented by Mr. Maiden† is probably the nearest approach to the type available.

PULTENAEA FERRUGINEA Rudge.

Trans. Linn. Soc., xi., 300, t. 23.

Rudge's species is upheld by De Candolle,‡ who quotes Sieber's n. 420, but is reduced to a variety (*latifolia*) of *P. villosa* Willd. by Bentham.§ The latter also mentions Sieber's n. 420. He bases his varietal distinction on the smaller, very pubescent leaves, from narrow cuneate to broadly obovate, together with the larger flowers of the variety. We have in the National Herbarium a series of specimens collected in the neighbourhood of Glenbrook, which agree with Rudge's figure, and conform to his description, viz., Lapstone Hill (J. H. Maiden and R. H. Cambage, 10, 1904); Glenbrook (W. F. Blakely, 10, 1913; A. A. Hamilton, 11, 1914); Blue Mountains, without specific locality (E. Betche, 12, 1882). *P. villosa* has a wide range and as a consequence shows considerable variation, but none of the numerous specimens in the National Herbarium collection which were examined approach, either in habit or foliage, the form under review. The pendulous branchlets and narrow concave leaves of the typical *P. villosa* are replaced by an erect branching habit and leaves—as in Rudge's figure—rotund, slightly emarginate, and much larger than those of *P. villosa typica.* The hairs on the leaves of the typical *P. villosa* are short, erect, and bulbous at the base, and the flowers entirely yellow. In *P. ferruginea* the leaf hairs are long, weak, and appressed, and the carina of the flower is rust-coloured. Rudge gives some prominence to certain dots (sub-lente punctata) on the leaves of his species, including details in the plate showing both surfaces of a leaf to demonstrate this character. These dots are also discernible in a greater or lesser degree throughout the series of specimens of *P. villosa* examined. It will be seen that we have a difference in the habit of the plant, size and shape of leaves, size and colour of flowers, and a distinct vestiture separating these plants. When, after the passing of a century, examples are found in the neighbourhood in which Sieber (upon whose n. 420 the species is founded) is known to have collected, which are the counterpart of those figured by Rudge, it would appear that the characterization is

*Fl. Austr., v., 512.
†For. Flora N.S.W., v., p.109. Pl.171.
‡Prod. Syst. Veg., ii., 111.
§Fl. Austr., ii., 134.

sufficiently stable to warrant the retention of the specific rank and nomenclature as proposed by him.

PROSTANTHERA DENSA, n.sp.

Cronulla (A. A. Hamilton, 9, 1911; E. Cheel, 7, 1918.)

Frutex compactus subarboribus florens 5—9 dec., altus. Folia sucida, breviter petiolata, cordata ad ovata-lanceolata, costa hirsuta prominente precursa, 5 mm. ad 1 cm. longa, apnd extremitates ramorum crebra, nonnumquam fasciculata. Semina metallica ritentia. *P. marifolia* R.Br. affinis.

A compact erect undershrub 5—9 dec. high with terete hirsute branches. Leaves succulent, very shortly petiolate, from cordate to ovate-lanceolate with revolute margins, scabrous hispid above, somewhat paler underneath with a prominent hirsute midvein, 5 mm. to 1 cm. long, densely crowded at the tips of the branches, occasionally fasciculate. Flowers axillary on very short pedicels with linear hirsute bracts 3 mm. long, the floral leaves similar to those of the stem. Calyx hirsute, 5 mm. long, the lips entire and nearly equal. Corolla more than twice as long as the calyx, sprinkled on the outside with short hairs, the broad throat bearded inside with long white hairs. Anthers with one appendage about twice as long as the cell, the other short and adnate. Seeds with a metallic lustre

Its position in the genus is under Bentham's series *Convexae* following, in specific sequence *P. marifolia* R.Br., with which it is connected by a series of specimens from Helensburgh (A. A. Hamilton, 10, 1913) taken from a shrub of 9—12 dec. with an upright spreading habit. The typical *P. marifolia* of the Port Jackson district is a scrambling undershrub of 3—5 dec.

The plants were found growing in profusion on the ocean slope of the rocky headland (Hawkesbury Series) at Cronulla, and the crass foliage is doubtless a response to the halophytic conditions prevailing in this station, as plants growing in the vicinity of tidal waters frequently develop a succulent habit. The species is confined to a limited area between the ocean beach at Cronulla and the northern entrance to Port Hacking.

PROSTANTHERA RHOMBEA R.Br.

Port Macquarie (E. R. Brown, 2, 1897); Douglas Park (A. A. Hamilton, 12, 1915). Two new specific localities extending the range of this somewhat rare species. Previously recorded from the Blue Mountains and Illawarra.

PROSTANTHERA SAXICOLA R.Br. var. MONTANA, n.var.

Katoomba; Narrow Neck (A. A. Hamilton, 1, 1903). Larger in all its parts than the typical *P. saxicola*, the flowers and young shoots more thickly clothed with hairs, the setaceous bracts minute and only occasionally developed. This variety approaches a form of *P. Behriana* Schlecht, but differs from that species in the length of the calyx lips (longer in *P. Behriana*), the minutes bracts, and the bristly tomentum. (The bracts are conspicuous in *P. Behriana*, and the tomentum of a fine texture.) It is usually found in scattered patches on sheltered hillsides, on the higher elevations of the Blue Mountains. Specimens in the National Herbarium are from Mt. Victoria (R. T. Baker, 12, 1890); Blue Mountains (E. Betche, 12, 1902); Blackheath (J. H. Maiden, 1, 1904). A specimen from Milton, near top of Pigeon House, n. 775 (R. H. Cambage, 12, 1902) is also referred to this variety.

PROSTANTHERA DEBILIS F. v. M.

New for New South Wales. Recorded from the Grampian Mountains, Victoria.* Examples in the National Herbarium are from Gulgong (J. H. Maiden, 4, 1901), Warrumbungle Ranges (W. Forsyth, 10, 1901), Molong (J. L. Boorman, 11, 1906), Capertee (J. L. Boorman, 12, 1915). An interesting range for a species hitherto regarded as exclusively Victorian. The New South Wales forms of *P. debilis* approach very closely specimens in the National Herbarium from New England (the type locality) of *P. saxicola* R.Br. var. *major*, differing chiefly in the distant canaliculate leaves, and the dense hoary tomentum on the calyces and young shoots. The leaves of *P. saxicola* var. *major* are flat and crowded and the calyces and young shoots sparsely tomentose.

*Frag. Phyto. Austr., F.v.M., viii., 1874, p. 147.

ORDINARY MONTHLY MEETING.

28th July, 1920.

Mr. J. J. Fletcher, M.A., B.Sc., President, in the Chair.

Dr. Arthur Hamilton Tebbutt, 185 Macquarie-street, Sydney, was elected an Ordinary Member of the Society.

The President announced that a Pan-Pacific Science Congress was to be held at Honolulu, commencing on 2nd August, and that a number of Australian representatives had left to attend, including Mr. E. C. Andrews, Assistant-Professor L. A. Cotton, Messrs. C. Hedley, and C. A. Sussmilch, from Sydney, Professor Wood-Jones from the University of Adelaide, and Professor H. C. Richards, from the University of Queensland.

The Donations and Exchanges received since the previous Monthly Meeting (30th June, 1920), amounting to 31 Volumes, 56 Parts or Nos., 10 Bulletins, and 2 Reports, received from 39 Societies and Institutions, and two private donors, were laid upon the table.

NOTES AND EXHIBITS.

Dr. E. W. Ferguson exhibited specimens of the imago and larvae of a muscid fly belonging to an undetermined genus. The imago was bred from a pupa taken in the nest of a Leatherhead by Messrs. W. G. and R. C. Harvey, of Mackay, Queensland. The larvae live on the nestling birds, and when mature conceal themselves in the nest and pupate. Out of twenty pupae obtained by Messrs. Harvey, only one hatched out, the others being parasitised by a chalcid wasp, a pair of which were also exhibited. Mr. P. H. Gilbert, of Lakemba, Sydney, has found what appears to be the same species on nestling birds (New Holland Honeyeater).

Mr. E. Cheel exhibited some very interesting specimens of a rare lichen collected on Mount Kosciusko by Miss A. V. Duthie.

The only specimens previously collected, so far as can be ascertained at present, are in a solitary collection by Rev. F. R. M. Wilson, found on earthy rock on Mount Hotham, Victoria, in January, 1890. The specimen is labelled *Dufourea madreporiformis* (Wulf.) Ach. (Wilson No. 1157, in National Herbarium, Sydney). It seems to have close affinities with *Dactylina artica* (Hook.) Nyl., and further investigation is needed to settle the generic position, as no apothecia are present in either the Mount Hotham or Mount Kosciusko specimens. Unfortunately there are no specimens of the above-mentioned genera (recorded from Arctic Regions) available for comparison.

THE *ATRYPIDAE* OF NEW SOUTH WALES, WITH REFERENCES TO THOSE RECORDED FROM OTHER STATES OF AUSTRALIA.

By John Mitchell, late Principal of the Newcastle Technical College and School of Mines, N. S. Wales, and W. S. Dun, Palaeontologist, Dept. of Mines, Sydney.

(With Plates xiv.-xvi.; Text-figures 1-5.)

One reason for the present paper is to make some additions to our present knowledge of the *Atrypidae* found in the Palaeozoic rocks of New South Wales, with a view to facilitate their correlation with those of similar age in other countries in which such rocks have been chronologically classified. The value of the *Atrypa* group for this purpose is hardly surpassed by any other group of brachiopods and because of this, and that a supply of good material has become available to work upon, the task of systematically dealing with members of the group represented in the Middle Palaeozoic rocks of this State is now undertaken. Besides the foregoing reasons, another inducement to deal with the group was the discovery, some time ago, of a number of remarkable brachiopods belonging to the *Atrypidae,* but not placeable in any of the existing genera of the family.

Up to the present the following species of *Atrypa* have been recorded from New South Wales,—*Atrypa reticularis* Linn., *A. desquamata* Sowerby, *A. plicatella* de Koninck, and *A. marginalis* Dalman. To these species we are able to add *Atrypa pulchra,* n.sp., *A. erectirostris,* n.sp., and *A. duntroonensis,* n.sp.

If the doubtful *A. plicatella* be omitted, New South Wales would be represented by six species of *Atrypa,* and this is quite a good contribution, for nowhere are the species of *Atrypa* found to be very numerous, as is the case with some other genera of brachiopods. In addition to these true Atrypas we find it necessary to add a new genus to the group, for the reception of some brachiopods collected from Molong, Yass and Bowning districts. From external features, these remarkable fossils were considered to belong to *Meristina,* but the discovery of specimens exhibiting internal structures proves that their true position is with the *Atrypidae.*

For this new genus we have decided upon the name *Atrypoidea,* and in it we have placed the following species:—*Atrypoidea australis,* n.sp., and *A. angusta,* n.sp.

Atrypa reticularis Linnaeus.

(Pl. xv., figs. 1-7; Pl. xvi., figs. 6, 19, 20.)

It is unnecessary to supply the synonymy or the description of this world widely distributed and stratigraphically persistent brachiopod. Its history for this State is a brief one.

The first record of its occurrence was made by the late J. W. Salter in a letter to the late Rev. W. B. Clarke, dated 28th Nov., 1858, wherein he states that he had identified this species in a collection of fossils from New South Wales which had been sent to the Woodwardian Museum of Cambridge University by Clarke in 1844 for description.*

In 1877 its presence is noted by Prof. de Koninck† from Kempsey, and the banks of the Murrumbidgee [Devonian]. With regard to the Kempsey locality there is considerable doubt, the formations in that area being of Upper Palaeozoic age. In 1888 the species was reported from the Bowning Beds.‡ In 1880 R. Etheridge, Jr., recorded *A. reticularis* from Bombala, and the variety *aspera* from Collins Flat.§

Normal specimens of this fossil from the Bowning-Yass Beds, exclusive of their foliated margins, appear to be rather smaller than the European species. The dimensions of one of the largest specimens from these beds are—length and width, 20 mm., depth 11 mm. Judging from the figures of *A. reticularis* in Davidson's British Brachiopoda, it would appear that adult British species usually exceed an inch in length and width, and are more gibbous than our forms. The pedicle valves of our specimens too seem less convex in the umbonal region, and more concave laterally and anteriorly. Some specimens from Wellington Caves, N.S.W., have been obtained of relatively large size, their length and width exceeding 43 mm. without the fringe, with a thickness of 26 mm. In these specimens the radial ribs are coarse, and the marginal sinus in front deep and tongue-like, but, except for their unusual size, their external and internal features, as far as they are revealed, are quite typical of the normal *A. reticularis.*

In the upper beds of the Bowning Series, a form occurs, possessing features which would place it about midway between *A. aspera* and *A. reticularis*, and although these features are unvarying in all the specimens of it that have come under our notice, we deem it undesirable to separate it from the type form at present. *Vide* Pl. xvi., fig. 13.

The stratigraphical range of the species in the Bowning Series extends practically from base to summit; but it is most abundant in the lower beds of the series especially in those of Hatton's Corner and the limestones of Limestone Creek, Silverdale. Its associates in these beds are *Barrandella linguifera* var. *wilkinsoni* Eth., *Rhizophyllum interpunctatum* de Koninck, *Encrinurus mitchelli* Foerste, *Bronteus jenkinsi* E. and M., etc.

Loc. and horizon.—Hatton's Corner, Yass River, Parish of Yass, County Murray; Limestone Creek Parish of Derrengullen, County King; Bowning Creek, etc., Parish of Bowning, County Harden. Upper Silurian—Wenlock or Barrande's étage E of Bohemia; and in the upper part of the Bowning Series probably passing into Devonian.

ATRYPA ERECTIROSTRIS, n.sp. (Pl. xv., figs. 10, 11; Pl. xvi., figs. 17, 18.)

Shell subdiscoidal when the fringe is attached in mature specimens; radial striae numerous, fine, strongly arcuate laterally and dichotomous at more or less frequent intervals. Pedicle valve moderately convex at the umbonal region, concave laterally, and at front margin only mildly sinuate, umbo inconspicuous, beak erect, high, acutely-pointed, laterally supported by strong divergent umbonal ridges. Aperture circular, the under half enclosed by the deltidial plates, false area conspicuous, hinge line wide, undulating; cardinal angles high and rounded.

*Sed. Form. N.S. Wales, 1878, p.155.

†Mem. Geol. Surv. N.S.W., Pal. No. 6, 1898, pp. 77-78.

‡Mitchell, Proc. Aust. Assoc. Adv. Sci., i., 1887 (1888), p.293.

§Jour. Proc. Roy. Soc. N.S.Wales, xiv., 1880, p.216.

Brachial valve very convex to gibbous in large specimens, laterally strongly turned up. The spiralia are of the true *Atrypa* type and, with cones, consist of ten or more spirals with their apices directed towards the outward centre of the brachial valve; apices of the cones are apart, but opposing sides compressed. *Dimensions*: The largest of specimens has a length and width of one and a-half inches without the marginal fringe, and a depth of three quarters of an inch. This specimen, with the fringe, would have had a width of not less than two and a quarter inches.

Obs.—The valves in young specimens are very mildly and about equally convex, and the umbo, cardinal ridges and beak form an isosceles triangle, the base of which is from one cardinal angle to the other, but with age the brachial valve becomes more and more convex until, when full growth has been reached, it is strongly so, or gibbous. This form resembles both *A. reticularis* and *A. desquamata*, but differs from each of them in the fineness of its surface ornamentation and the strong curve of the radial striae which is directed laterally. From *A. reticularis* it differs in the high, erect, pointed beak of the pedicle valve, the more exposed deltidium and false area, exceedingly fine concentric growth lines, and much greater dimensions when compared with normal representatives of the species. In the proportions of the length to width, and also in contour it agrees with *A. reticularis*. It resembles *A. desquamata* in having a high pedicle valve beak, exposed circular foramen and deltidial plates, prominent umbonal ridges and false area, also in the features of the brachial cones, but with some of these resemblances it is merely a matter of degree, because the beak of the present species is very much higher and erect, more acutely pointed and practically without incurvation. The umbonal ridges are less divergent, higher, and with the beak form a triangle with an acute apical angle, quite different from the triangle formed by these ridges in *A. desquamata*. Then there are the differences already referred to—the much finer superficial ornamentation of the shells of the local form, and the strong curving of the radial striae laterally and towards the cardinal angles. The hinge line of *A. desquamata* is mildly arcuate, that of the other undulating. Plainly our species resembles in several particulars both *A. reticularis* and *A. desquamata*, and the latter in more than it does the former.

Considering the tendency to variation among the *Atrypa* group some might be disposed to recognise *A. erectirostris* as a variant of *A. desquamata*, but it is to be noted that, though the differences between the two forms in some instances appear only to be of degree, yet they are permanently established; for, though the normal form of *A. desquamata* is found in association with the one here described, there is no evidence of gradation of the one form into the other, and this affords an additional reason for a separation of the two types.

Loc. and horizon.—Cave Flat, near the junction of the Goodradigbee with the Murrumbidgee River, an area that is now submerged by the waters impounded within the Barren Jack (Burrinjuck) dam, where it occurs plentifully in a stratum of limited thickness, associated with *Spirifer yassensis* and many other *Spirifers* not yet determined, *Rhynchonella*, *Atrypa desquamata*, *Cyrtina*, etc. Parish of Woolgarlo, County of Harden. Probably lower Middle Devonian.

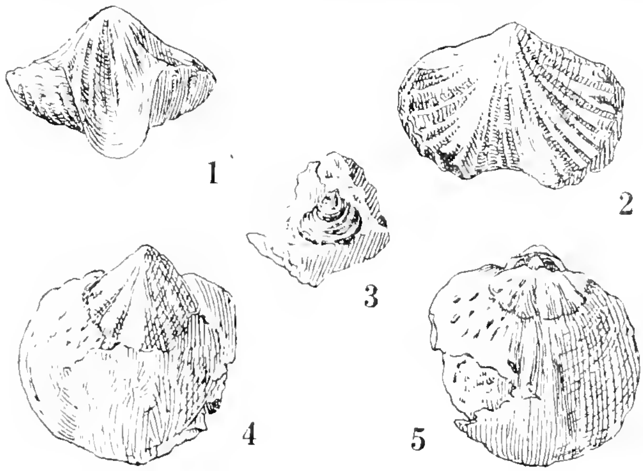
ATRYPA MARGINALIS Dalman. (Pl. xv., figs. 14-16; Pl. xvi., figs. 1-5; Text-figs. 1-5.)

The following is Davidson's description of this species*:

"*Spec. Char.* Transversely subpentagonal or almost elliptical; hinge line nearly straight; lateral margins rounded, very slightly so in front, beak of ventral

*Mon. Brit. Dev. and Sil. Brachiopoda, vol. iii., Sect. Sil. Brach., pp. 133-4.

valve small, straight, moderately incurved with a circular foramen under its extremity, and distinctly separated from the umbone or hinge-line of dorsal valve by a deltidium in two pieces, almost surrounding the aperture. Dorsal valve moderately convex and trilobed; mesial fold extremely narrow at first and suddenly widening, slightly elevated, flattened along the middle, and sharply separated from the lateral portions of the valve by a deepened groove. The fold is also often bent upwards close to the frontal edge. Ventral valve almost flat or very



Text-figs.1–5. *Atrypa marginalis* Dalm. Enlarged drawings to show the surface ornamentation, muscular scars and, in one, greater portion of a spiral.

slightly convex near the beak with a rather deep and sharply defined sinus, margined on either side by a prominent ridge, while the lateral portions of the valve are gently concave and vertically turned up at the extremity; lateral margins undulating; front margin abruptly raised, straight along the middle; surface of both valves ornamented with numerous small bifurcating ridges or ribs." The above description applies to the Australian representatives so fully as to make it unnecessary to give them a separate one.

In North America this species occurs associated with *A. reticularis* in Silurian rocks (Niagara Formation),* and is there said by the authors quoted to have been short lived, just as it appears to have been, as far as evidence yet available goes to show, in Australia.

The discovery of this very remarkable *Atrypa* in Australia is of considerable interest to paleontologists, adding, as it does, another instance of the remarkable powers for world wide distribution possessed by certain types of brachiopoda. It would appear too, that this species originated in the British Isles and lived there through a longer geological period than elsewhere. In this State it occurs plentifully in the lowest zone of the Lower Trilobite Beds of the Bowning Series on the East and West sides of the Bowning Syncline. Its vertical range here seems to be very limited. It is not improbable that it occurs also in the Orange district, for the fossil described by one of us† under the name of *Camarotechia*

*Hall and Clarke, Pal. N.Y., vol. iii., Brachiopoda, pt. ii., p.173.

†Dun, Rec. Geol. Surv. N.S.W., viii., pt. 3, 1907, p.127, Pl. xl., figs.3, 3b.

sussmilchi may be identical with this species. In England it seems to range from Lower to middle Upper Silurian. In our Bowning rocks it is found associated with *Encrinurus silverdalensis* E. & M., *E. mitchelli* Foerste and below beds containing *Odontopleura bowningensis* E. & M., *O. parvissima*, E. & M., *Ceratocephala vogdesi* E. & M., and these rocks are not younger than those of Wenlock age. The occurrence of this small *Atrypa* at such a distance from places where previously found will no doubt be of much interest to geologists, and may help to indicate the route along which Palaeozoic marine faunas were distributed from Europe to Australia or *vice versa.*

The first record of its presence in Australian rocks appears to have been made by one of us.*

Loc. and horizon.—Silverdale, Parish of Derrengullen, County King; and one mile south of Bowning Public School, Parish of Bowning, County Harden. Lower Trilobite Beds, Bowning Series.

ATRYPA PULCHRA, n.sp. (Pl. xiv., fig. 19; Pl. xvi., figs. 14-16.)

Shell subdiscoidal or rarely oval, biconvex, radial and concentric striae very fine, and form a beautiful cancellate pattern; marginal fringe very narrow, and mildly recurved, hinge line arcuate, front margin very mildly sinuate. Pedicle valve about as convex as the brachial valve, from the umbo for two thirds of its length medially decidedly ridged, and opposed to this in the brachial valve is a shallow sulcus; beak moderately prominent, mildly incurved, foramen conspicuous and circular. Brachial valve evenly and moderately to fairly strongly convex in adult specimens; sulcus faint and vanishes as it reaches the middle of the valve. *Dimensions* of an adult specimen—length and width, 15.4 mm., depth, 9.4 mm

Obs.—This species differs from the *A. reticularis* in (1) its small size, (2) exceedingly fine ornamentation, (3) approximately equal biconvexity of the valves, (4) greater prominence of the beak of the pedicle valve and of its foramen, (5) its uniformly subcircular outline, (6) very narrow marginal fringe.

We have no specimen showing internal structure, but from external evidence we assume it to closely resemble that of *A. reticularis* in this particular. The specimens of this species used for the present description were obtained chiefly from the upper of the limestone beds of Limestone Creek, Silverdale, immediately below the Lower Trilobite Beds of the Bowning Series, and were associated with numerous corals representing the genera *Favosites*, *Heliolites*, *Cyathophyllum* and *Tryplasma* and with *A. reticularis*, etc. The vertical range of this fossil is apparently limited.

Loc. and horizon.—Limestone Creek, Silverdale, near Bowning, Parish of Derrengullen, County King. Probably Wenlock.

ATRYPA DUNTROONENSIS, n.sp. (Pl. xvi., figs. 8-12.)

Shell almost equally biconvex oval, radial ribs subsharply ridged, not prominent, dichotomise two or three times, concentric striae fine and very numerous and undulating towards the front. Pedicle valve moderately convex throughout, slightly upturned at the margins, umbo and beak not prominent, the latter depressed. Brachial valve slightly more tumid than the other, muscle scars inconspicuous, the margin in front very slightly sinuate. *Dimensions*: Length, 19.7, width, 17, depth 11 mm. These dimensions are for mature specimens.

*Mitchell, Proc. Aust. Assocn. Adv. Sc., i., 1887 (1888), p.293.

Obs.—Among specimens forwarded by the late Rev. W. B. Clarke to the late Rev. Sedgwick in 1844* from Duntroon, N.S.W., Salter reported having recognised *Atrypa reticularis* Linn. We are of the opinion that the shell now under review is specifically identical with the one referred to by Salter. It certainly bears some resemblance to the normal *A. reticularis,* and on first inspection we were inclined to make it a variety of the normal form but on closer study of it, determined to give it specific rank. From *A. reticularis* it differs in having the valves almost equally convex, little or no foliated margin, very fine wavy and numerous concentric striae, no defined sulcus in either valve, slightly sinuate margins, and the length invariably greater than the width. In some respects this species resembles *A.* (?) *headii* Billings var. *anglica.* Found associated with *Encrinurus duntroonensis* E. and M. and *Trinucleus clarkei* Mitchell.

Loc. and horizon.—Near Duntroon homestead, Parish of Canberra, County Murray.

ATRYPA DESQUAMATA Sowerby. (Pl. xv., figs. 12, 13.)

This species was recorded by de Koninck from New South Wales, but no particulars of locality were given.

Specimens of the species have been collected from the black cave limestone beds of Cave Flat, and Goodravale, Parish of Woolgarlo, County Harden, and the Tarago District, by officers of the Department of Mines, Sydney, and one of us, and it will be noticed, on reference to our figures given of a specimen of the local form, that it agrees with the European types.

ATRYPA PLICATELLA de Koninck.

This species was said to have been found in a black limestone in Yass district.†

No subsequent reference seems to have been made regarding the occurrence of this species in New South Wales rocks. Judging by the figures and description we are not disposed to accept de Koninck's determination. Externally it bears little if any resemblance to an Atrypid.

ATRYPOIDEA, n.g.

Gen. chars.—Shells strongly biconvex and at maturity some forms ovoid to globular, not conspicuously inequivalve, surface smooth, but sometimes very faintly showing concentric growth lines. Beaks not prominent, hinge line straight and moderately long; cardinal angles high and rounded. *Pedicle valve* less convex than the brachial, with or without a faint sulcus, beak of the pedicle valve relatively small, depressed and incurved. Foramen apical and circular in mature specimens. Anterior margin moderately to very intensely sinuate. The deltidial plates and teeth have not been observed. Muscle scars appear to be large and moderately defined. *Brachial valve* very convex, no defined median fold except in cases of mature specimens in which, towards the front, a short fold is sometimes developed, but sometimes bearing a very faint medial sulcus. No cardinal area, beak incurved and concealed. Crura unknown. Brachidia or spirals form cones, consisting of about ten volutions in specimens reaching two thirds maturity. The apices of the cones are directed towards the centre of the brachial valve cavity, but in one or two cases they had a droop anteriorly which may have arisen from accidental causes.

**Op. cit.*

†de Koninck, Mem. Geol. Surv. N.S.W., Pal. No. 6, 1898, p.78, Pl. iii., figs. 4 and 4a.

Obs.—The features which separate this genus from *Atrypa* are the great biconvexity and smoothness of the valves, absence of marginal fringe and radial striae or ribs.

Genotype. *Atrypoidea australis.*

ATRYPOIDEA AUSTRALIS n.gen. et sp. (Pl. xiv., figs. 1-18; Pl. xv., figs. 8, 9; Pl. xvi., figs. 7, 13.)

Shells intensely biconvex to subglobular in mature specimens. In young specimens mildly convex beak, as maturity is approached the convexity and front sinus of the valves rapidly develop, and at no stage of growth is the difference in the convexity of the two valves of this species very pronounced, though that of the brachial valve is the greater; cardinal angles rounded, hinge line wide, straight or only gently arcuate. Pedicle valve has, in some large specimens, a faint medial fold extending from the umbo to the front and, on each side of this fold, a very shallow faint sulcus; opposed to this in the brachial valve is a faint sulcus bounded by an exceedingly faintly defined fold, but this feature does not appear to be constant, for, in some forms, the plainness of the surface is uninterrupted and in others a feeble sulcus takes the place of the fold; front sinus wide and deep in mature specimens, its intensity gradually developing with age, very immature shells having none. Brachial valve very convex and at no stage of growth showing a decided fold, beak small and concealed. *Dimensions* of a mature individual (Pl. xiv., figs. 5 and 6): Length, 28, width, 28, thickness, 22 mm. The proportions of these measurements remain very constant for sizes of shells from half to full maturity.

Obs.—A specimen of this species was described by one of us* under the name of *Meristina australis*. This determination and description was based upon superficial features only, which indeed very closely resembled those of the *Meristina* group. That there were good reasons for this determination is shown by the fact that specimens of this new group, showing only external features, were submitted to British palaeontologists and they referred them to *Meristina tumida*. More recently, specimens of the group with spirals preserved enable us now to place it in or near its proper phylogenetic position, and that it belongs to *Atrypidae*, we believe, cannot be disputed, though certainly a few features of its internal structure remain to be revealed, but we do not expect the revelation of them will materially alter the views we have arrived at with respect to its classification. Externally the group shows some features not seen in *Atrypa*, yet on the other hand has others that are truly Atrypoid, as, for instance, the straight hinge line, absence of cardinal area, high rounded cardinal angles, depressed incurved beak of the pedicle valve, and very strongly convex brachial valve. They are certainly extraordinary Atrypids and up to the present are known to occur only in the limestones of Molong and the impure limy shales of the Bowning Series, and the specimens in these different districts are, for the most part, alike specifically. Those belonging to the present species from Molong are uniformly of much larger size than the Bowning-Yass (Hatton's Corner) representatives. This variation may have arisen from more favourable conditions for their development having prevailed in the Molong area than at Bowning. In the former the sea was clear, and free from the muddy sediment present in the latter. Besides the relative smallness of the Hatton's Corner members of the species, they

*Dun, Records Geol. Surv. N.S.W., vii., 1904, p.318.

also appear to have a slightly less conspicuous umbo and beak than those from Molong; also the strong tongue-like anterior sinus would seem to have developed at an earlier stage of growth in those from Hatton's Corner than in the others. Further, in one specimen of this species from Molong, the brachidia show a rather strong droop apically, but this would appear to be accidental, for others from Molong show the apices of the spiralia to be directed almost towards the centre of the brachial valve, and this agrees with the Hatton's Corner types.

Loc. and horizon.—Near Molong, Parish of Boney, County Wellington; Hatton's Corner, Parish of Yass, County Murray; Gurnett's Selection, three miles west of Bowning, Parish of Bowning, County Harden. Upper Silurian.

ATRYPOIDEA ANGUSTA, n.sp. (Pl. xiv., figs. 20-29.)

Shell intensely biconvex, subquadrate, smooth; length greater than width, valve margins intensely sinuate, front sinus very deep. Hinge line mildly arcuate; umbonal ridges low and spreading. Pedicle valve transversely and longitudinally strongly convex, just below the umbonal region the inflation is so great that it gives the shell quite a hunchback aspect; towards the front a very faint sulcus is developed, the sides of it being slightly more depressed than the medial portion, indenting lip tongue-like and long. Umbo of moderate size, beak strongly incurved and depressed, aperture small. Brachial valve very much arched transversely, highest in front of its centre, and developing into a strong fold on the anterior third. *Dimensions*: Length, 23.4, width, 22, thickness, 18.7 mm., for the largest specimens from Bowning and Molong; but the specimens from Hatton's Corner so far collected, are much smaller, the largest from here measuring—length, 19, width, 17.2, thickness, 14 mm., respectively, and an immature specimen from Molong had the same dimensions. The relative proportions of these measurements are fairly constant for the specimens from all three localities.

Obs.—The internal structure of the species has been observed in the Bowning form only and agrees in the spiralia with the genotype. From the foregoing species the present differs in being much more biconvex, having a less conspicuous umbo, more strongly incurved and depressed beak, narrower hinge line, greater length than width, a greater relative thickness, much stronger sinuosity of the lateral and front margins.

It may be noted that very immature shells of this species cannot be distinguished from similar ones of *A. australis*, or at least we have not been able to do so up to the present.

Loc. and horizon.—The same as for the preceding species.

References to records of Atrypa *from other States of Australia.*

QUEENSLAND.

Atrypa reticularis Linnaeus.—The occurrence of this species has been recorded from the Fanning River, Burdekin Downs, by the late R. Etheridge Jun.* and by Foord.† In 1892, R. Etheridge repeated his previous records.‡

Through the courtesy of Mr. B. Dunstan, Chief Government Geologist of Queensland, we have been enabled to inspect the original specimen referred to

*Proc. R. Phys. Soc. Edinb., v., 1880, p.270.

†Geol. Mag., vii., (3), 1890, p.100.

‡Geol. Pal. Qld. and N.Guinea, 1892, p.65, Pl. 4, f. 4.

this species by the late Mr. R. Etheridge, Jun., and after a very critical examination of it, conclude that it is not *A. reticularis,* but an immature *A. desquamata.* Our reasons for this conclusion are the prominent beak, the exposure in the specimen of an area, and the strong curvature of the lateral ribs towards the cardinal angles. In addition, the alleged *A. reticularis* is represented in the Museum of the Geological Survey, Brisbane, only by the single specimen which served Mr. Etheridge Jr. for his determination. This of itself is a very suggestive fact, for *A. reticularis* was a very gregarious brachiopod and wherever it occurs, does so, almost without exception, in numbers. It is also worthy of remark, that this fossil occurs in association with numerous individuals of *Atrypa desquamata;* a circumstance which supports the contention that it is an immature specimen of the latter species.

Atrypa desquamata J. de C. Sowerby.—The occurrence of this brachiopod is also recorded by Mr. Etheridge Jun.§ It is found plentifully in the middle Devonian Rocks outcropping in the valley of the Fanning, Burdekin and Broken Rivers in the Burdekin Downs District, and the specimens collected from this locality agree very fully with the original types. In New South Wales, to my knowledge, *A. reticularis* has never been found in association with *A. desquamata.* May this not be the case also in Queensland? In England, the two species are found commingled in Middle Devonian Rocks.

VICTORIA.

F. Chapman* has recorded the occurrence of *A. reticularis* var. *decurrens* from the Yeringian of Yering and Loyola; *A. aspera* Schloth. from Loyola and the Middle Devonian of Bindi; and *A. fimbriata* from Lilydale. The latter form he compared with *A. hystrix* and *A. spinosa* J. Hall from the Chemung and Hamilton Groups of N. America. In general these forms have extra-Australian Devonian affinities.

Mr. Chapman observes with reference to the occurrence of *A. reticularis* that he finds it to be very common in the limestone beds and much less common in the shales of the Yeringian beds of Victoria. In the Bowning-Yass beds of New South Wales, the same thing is noticeable, and it appears that this preference for clear sea floors on the part of this remarkable brachiopod is manifest in every part of the world where it is found. With reference to his *A. aspera,* recorded from the Yeringian beds and which he says had been recorded from the Silurian and Devonian of Victoria previously by McCoy, it must be observed that the latter regarded it as a variety of *A. reticularis.* We have some doubts as to the correctness of this determination, though it must be admitted that the concentric lamellae exhibited by Mr. Chapman's species closely resemble those of the original type. Whether Mr. Chapman's conclusion is right or not, it must not be overlooked that many palaeontologists recognise *A. aspera* only as a variety of *A. reticularis.*

Atrypa reticularis var. *decurrens,* to us, seems a slightly abnormal *A. reticularis.* Some similar specimens have been noticed by one of us from the Bowning Beds. *A. fimbriata* Chapman is a very interesting species and as Mr. Chapman points out is very like *A. hystrix* J. Hall. Nothing similar has yet been collected from New South Wales. Mr. Chapman† has also recorded *A. reticularis* from O'Keefe's Gully, Aberfeldy River, and *Atrypa* sp. from Tyer's River.

§*Loc. cit.*

*Proc. Roy. Soc. Vict., xxvi., (N.S.), Pt. i., 1913, pp.107-109.

†Rec. Geol. Survey Vic., ii., Pt. i., 1907, pp.68, 71.

WESTERN AUSTRALIA.

A. H. Foord‡ records *Atrypa reticularis* from Mt. Piene, Kimberley District, associated with *Rhynchonella pleurodon* and *Rhynchonella cuboides*, in the Stromatoporoid horizon which Nicholson considered to be Upper Devonian. To our knowledge, no specimen of this species from a similar horizon in Eastern Australia has yet been collected.

EXPLANATION OF PLATES XIV.-XVI.

Plate xiv.

(All figures natural size.)

Atrypoidea australis, Mitchell and Dun.

Figs. 1—4. Ventral, profile and dorsal views of two perfect young specimens. Molong. Coll. Mitchell.

Figs. 5—7. Front, profile and ventral view of a mature specimen. Molong. ing. Coll. Mitchell.

Fig. 8. Front view of a nearly mature specimen. Molong Coll. Mitchell.

Figs. 9—11. Front, profile and ventral views of the largest specimen from Bowning. Coll. Mitchell.

Fig. 12. Ventral view of specimen shown in figure 8. Molong. Coll. Mitchell.

Figs. 13—18. Specimens from Hatton's Corner, Yass River. Fig. 13 shows the largest shell from that locality; fig. 18, a small, square-shouldered form with inconspicuous umbo. Coll. Mitchell.

Atrypa pulchra Mitchell and Dun.

Fig. 19. A perfect specimen, dorsal aspect.. Silverdale, near Bowning. Coll. Mitchell.

Atrypoidea angusta Mitchell and Dun.

Figs. 20—21. Oblique profile and front view of largest specimen from the Bowning series. This shows, in the original where the brachial valve is weathered slightly, faint outlines of one of the spirals. Gurnett's farm, three miles west of Bowning. Coll. Mitchell.

Figs. 22—26, 29. Specimens from Molong, at various stages of growth.

Figs. 27—28. Front and profile views of two specimens from Hatton's Corner, Yass River.

Plate xv.

Atrypa reticularis Linn.

Fig. 1. A beautifully weathered transverse section of a large shell, showing the spiral cones and great inflation of the brachial valve. Wellington Caves. Coll. Mining Museum, Sydney.

Fig. 2. Same specimen as fig. 3, but enlarged to show the surface ornamentation.

‡Geol. Mag., Dec. 3, vii., 1890, pp.100-1.

Figs. 3—4. Ventral and front views of normal specimen from the same locality and Collection.

Fig. 5. A very large specimen (silicified), showing, rather plainly, one spiral cone with some twenty coils and tongue-like, sinuation in front. Reduced. Wellington. Coll. Mining Museum, Sydney, N.S.W.

Figs. 6—7. Ventral views of two adult shells. Derrengullen Creek, near its junction with Limestone Creek. Coll. Mitchell.

Atrypoidea australis Mitchell and Dun.

Figs. 8—9. Dorsal and ventral views, enlarged. Coll. Mining Museum, Sydney.

Atrypa erectirostris Mitchell and Dun.

Figs. 10—11. Dorsal and ventral views of two specimens, slightly reduced. Cave Flat. Coll. Mitchell.

Atrypa desquamata Sowerby.

Figs. 12—13. Front and dorsal views of a specimen from Cave Flat, near the junction of the Goodradigbee and Murrumbidgee Rivers. Coll. Mining Museum, Sydney, N.S.W.

Atrypa marginalis Dalm.

Figs. 14—16. Ventral, dorsal and front views of three nearly adult specimens. Limestone Creek, Silverdale near Bowning. Coll. Mitchell.

Plate xvi.

Atrypa marginalis Dalm.

Figs. 1—5. Photos of specimens of different stages of growth, slightly enlarged. Coll. Mitchell.

Fig. 6. A small specimen with concentric ornamentation, like *A. Aspera* Schloth. Coll. Mitchell.

Atrypoidea australis Mitchell and Dun.

Figs. 7 and 13. A sketch and photo of a specimen from which the brachial is removed and the spiral cones exposed. Fig. 13 (enlarged 2).

Atrypa duntroonensis Mitchell and Dun.

Figs. 8—11. Four different specimens, dorsal and ventral views.

Fig. 12. Same specimen as Fig. 9, enlarged (x 2).

Atrypa pulchra Mitchell and Dun.

Fig. 14. Dorsal view, slightly enlarged.

Figs. 15 and 16. Ventral and dorsal views of mature specimens (x 2). Fig. 16 same as fig. 14. Limestone Creek. Coll. Mitchell.

Atrypa erectirostris Mitchell and Dun.

Fig. 17. A young specimen—shows the high, erect umbo, acutely pointed beak, steeply sloping umbonal ridges, and radial striae. (x 2.)

Fig. 18. An immature specimen in which the dorsal valve has been weathered away and exposed the spirals. The apex of the beak has been weathered off. (x 2.) Coll. Mitchell.

Atrypa reticularis Linn.

Figs. 19 and 20. Two specimens with the marginal fringes partly preserved.

NOTE ON CERTAIN VARIATIONS OF THE SPOROCYST IN A SPECIES OF *SAPROLEGNIA*.*

By Marjorie I. Collins, B.Sc., Linnean Macleay Fellow of the Society in Botany.

(With eleven Text-figures.)

Introduction.

During the summer of 1919, a quantity of *Saprolegnia* was made available to the writer by the accidental drowning of a beetle, in a tank situated in the glass-house of the Botany Department, University of Adelaide. The material, with a little water from the tank, was transferred to the laboratory and kept under observation for some weeks. It was found to show variations in sporocyst formation similar to those recorded by Lechmere† for *Saprolegnia Thureti* and certain additional variations which are thought to be of sufficient interest to place on record.

Since sexual reproduction was not observed, it was impossible to identify the species under examination with any accuracy. Judging by the stout nature of the hyphae, however, it seems probable that the species is identical with that of Lechmere's work, *Saprolegnia Thureti.*

The writer's thanks are due to Professor T. G. B. Osborn, University of Adelaide, in whose Department these observations were made, for his interest in the work.

Previous Investigations.

In his investigation of certain species of *Saprolegnia* Lechmere‡ draws attention to the marked variability in the nature of sporocyst formation and discharge. In addition to the normal *Saprolegnia* type of sporocyst, he records five variations, each of which shows features which are characteristic of a distinct genus of the *Saprolegniaceae*. These variations are all concerned with the nature of discharge of the sporocysts, and sometimes result in the suppression of the first, second or of both motile phases. The following is a brief summary of the sporocyst variations observed by Lechmere:—

1. *Leptolegnia* condition, where the zoospores are arranged in a single row in a long cylindrical sporocyst. Two motile phases.

2. *Pythiopsis* condition, where the spores swarm feebly from a club-shaped sporocyst, and come to rest near the mouth of the sporocyst. No record of a second motile phase.

*The observations recorded in this paper were made while the writer held the position of Demonstrator in Botany, The University of Adelaide.

†New Phytologist, ix., 1910, p.308.

‡*Loc. cit.*

3. *Achlya* condition, where the first motile phase is merely represented by the liberation of the spores, which encyst in a mass near the mouth of the sporocyst. The second motile phase occurs later.

4. *Dictyuchus* condition, where the spores encyst within the sporocyst, regardless of the terminal opening formed for their exit. Later, the spores leave their cyst cases, enter upon the second motile phase, pass out through the terminal opening, often pushing their empty cyst cases before them. A second *Dictyuchus* condition is described* where the zoospores pass directly through the wall of the sporocyst. There is no definite statement as to how the zoospores pass through the sporocyst wall, but from Lechmere's figure 17 we can only infer that the sporocyst wall degenerates at certain places to allow the escape of the zoospores.

5. *Aplanes* condition, where all motility is suppressed, and germination is direct within the sporocyst, the germ tubes growing out through the wall of the sporocyst.

A variation of the sporocyst known as the "*Dictyuchus*-form" was recorded for the *Saprolegniaceae* prior to Lechmere's work. Hartog† refers to this form in his analysis of the genera in the *Saprolegniaceae*, as follows:—

"*Dictyuchus*-form. When the spores of *Achlya* or *Saprolegnia* fail to leave it [the sporocyst] at maturity, they encyst within, constituting this form or dictyosporange. They either swarm ultimately in the second form or germinate in situ by emission of a hypha." The "*Dictyuchus*-form" of Hartog is evidently the dictyosporocyst of Lechmere which includes the *Dictyuchus* and *Aplanes* conditions.

In the present investigation, which was made upon material growing under natural conditions as well as upon white of egg cultures, the writer observed sporocysts of the *Leptolegnia*, *Pythiopsis*, *Achlya* and *Aplanes* types similar to those described by Lechmere. In addition, certain remarkable composite sporocysts were observed which combine the characters of from two to four genera; also a new *Dictyuchus* condition which differs from either of those described by Lechmere.‡

Material was selected from the body, legs, wings and antennae of the insect in order to ascertain whether the sporocyst variations were restricted to any particular part of the host, and whether their occurrence is influenced by the amount of available nutriment. Although the general growth of the hyphae was found to be more vigorous upon the body of the insect, the abnormal sporocysts occurred freely on all parts.

Upon transferring part of the material to tap water in the laboratory, the production of sporocysts was stimulated in both old and young hyphae. Young hyphae show a preponderance of the normal *Saprolegnia* type of sporocyst in which two motile phases were observed. In old hyphae, however, the new sporocysts often form within or at the base of three or four discharged sporocysts. In these cases some of the new zoospores find difficulty of escape, and encyst during their passage through the old discharged sporocysts (Text-fig 1). Encystment within the sporocyst under these conditions is found to occur at approximately the same time as that of zoospores which succeed in escaping. Retained zoospores

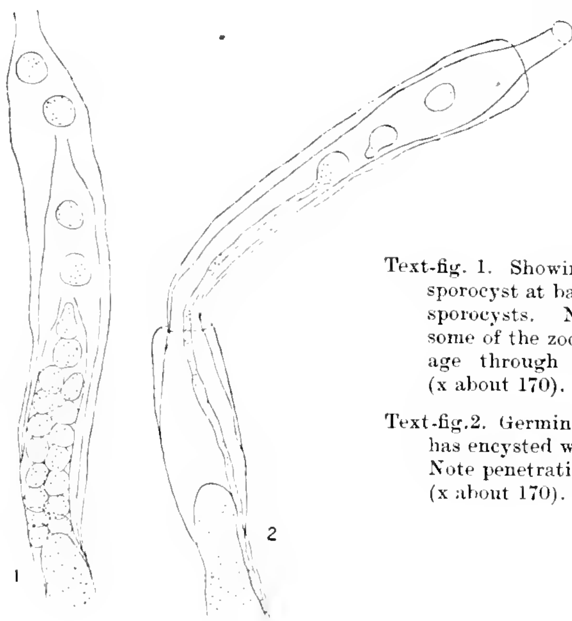
*New Phytologist, x., 1911, pp.167-203.

†Ann. Bot., xi., 1888-89, p.203.

‡New Phytologist, ix., 1910, p.308; and x., 1911, p.167.

which encyst in the above manner, do not enter upon a second motile phase, but germinate directly within the sporocyst. In some cases a germ tube from an encysted zoospore has been observed to grow back through a series of empty sporocysts and penetrate the hypha behind for some distance (Text-fig. 2). The *Aplanes* type of germination by penetration of the wall of the sporocyst, does not occur under these circumstances.

In cultures made upon white of egg, early sporocyst formation was decidedly of the *Saprolegnia* type, but after some days, all the variations recorded appeared in the culture. Owing to the rapidity of their formation, it was impos-



Text-fig. 1. Showing formation of new sporocyst at base of old discharged sporocysts. Note encystment of some of the zoospores during passage through empty sporocysts. (x about 170).

Text-fig. 2. Germination of spore which has encysted within old sporocyst. Note penetration of hypha behind. (x about 170).

sible to discover any definite sequence of formation of sporocyst types. It was found, however, that normal sporocysts occur more abundantly in the young culture, though they continue to be formed to a slight degree, after the abnormal forms have made their appearance. *Leptolegnia, Pythiopsis* and *Achlya* conditions were found to be more rare than *Dictyuchus* and *Aplanes* conditions.

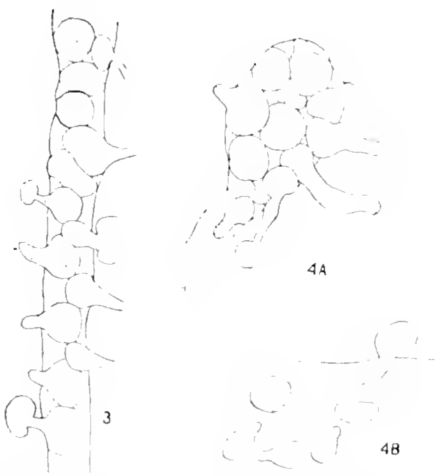
The most noticeable feature of the material was the prevalence, under both natural and cultural conditions, of two forms of sporocyst unrecorded by previous investigators. The first of these is certainly a *Dictyuchus* condition, though it differs in salient features from either of the *Dictyuchus* conditions described by Lechmere. In reference to the formation of the *Dictyuchus* condition on a white of egg culture, Lechmere says:—

"The numerous resting sporocysts present on the mycelium commenced to develop into sporocysts. In by far the greater number of cases observed, the spores encysted within the sporocyst before its discharge, in spite of the fact that a tubular process was developed on the sporocyst before the spores encysted."*

*New Phytologist, ix., 1910, p.316, Pl. 2, figs. 30, 31.

Also, "The zoospores were observed leaving their cyst walls and escaping through the tubular process, pushing before them the empty cyst cases which were in the tube."† Lechmere only observed this condition during the development of resting sporocysts in white of egg cultures. It is interesting to note that here the second motile phase commences within the sporocyst. A further *Dictyuchus* condition is recorded by Lechmere in his second paper.‡ He says of these sporocysts: "they are always derived from gemmae, and in shape they are broad and short. The empty spore cases form a dense network within the sporocyst, the wall of which is very thin and is apparently directly penetrated by the zoospores on their escape from their encysted condition."

The *Dictyuchus* condition observed by the writer, resembles the second of Lechmere's *Dictyuchus* forms in the fact that the second motile phase occurs outside the sporocyst, the first being suppressed. The sporocysts are found to be either short and club-shaped, or long and cylindrical; they are never observed to arise from resting sporocysts and occur freely under natural as well as cultural conditions. The encysted spores send out a protuberance which penetrates the sporocyst wall and projects for a distance of varying length (Text-fig. 3). The protoplast then shrinks from the cyst wall, streams out through the cyst tube, the



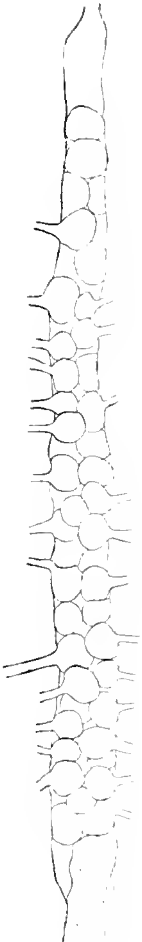
Text-fig.3. Portion of young *Dictyuchus* sporocyst. Note germination of encysted spores and passing of protoplast through cyst tube. (x 230).

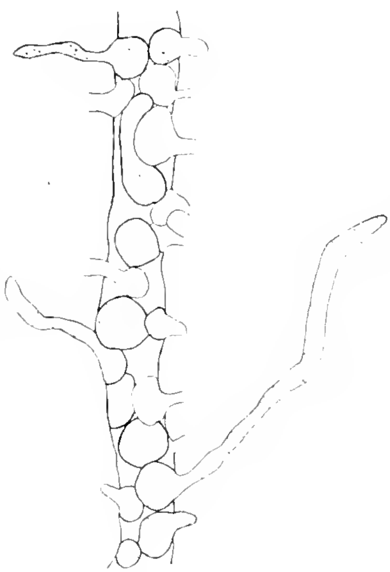
Text-figs. 4*b*. & 4*a*. Club-shaped *Dictyuchus* sporocyst showing liberation af ciliated zoospore and the coming to rest and second encystment of the latter. (x 230).

tip of which degenerates. A ciliated zoospore is liberated which remains attached to the cyst tube for about five minutes, maintaining a rocking motion. It then swims away and comes to rest close to the sporocyst after a period of from 3–5 minutes (Text-figs. 4*b* and 4*a*). This motility is noticeably feeble in comparison with the vigorous motility in Lechmere's first *Dictyuchus* condition where the zoospores push their empty cyst cases before them when leaving the sporo-

†*Id.*, ix., 1910, p.317.
‡*Id.*, x., 1911, p.186, fig. 17

cyst. Direct germination follows this second encystment. This mode of discharge, through cyst-tubes which penetrate the wall of the sporocyst, is similar to the mode of discharge described and figured by Lotsy for the genus *Dictyuchus.*§





6.

7.

5.

Text-fig.5. *Dictyuchus* type of sporocyst incompletely discharged. Note projecting cyst tubes from empty cyst cases. (x about 170).

Text-fig.6. Portion of a cylindrical sporocyst showing combination of *Dictyuchus* and *Aplanes* conditions. (x 230).

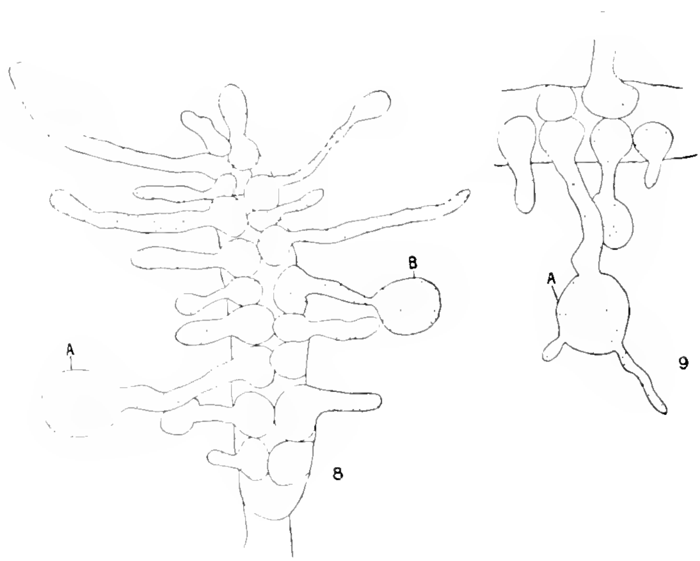
Text-fig.7. Composite sporocyst showing predominance of "*Dictyu-Aplanes*" condition. Note *Achlya* type of branching with lateral sporocysts of normal *Saprolegnia* form. In the latter, complete discharge has led to encystment and germination within the sporocyst. (x about 170).

The partly or wholly discharged sporocysts with their empty cyst cases and projecting cyst tubes with abruptly broken tips, present a peculiar and striking appearance (Text-fig. 5). In some instances there is evidence of a primary attempt at discharge of the sporocyst in the normal *Saprolegnia* manner through a terminal opening (Text-fig. 5).

§Lotsy, Pflanzensystematik, i., 1907, p.164, fig. 95.

In the opinion of the writer the above is the true *Dictyuchus* condition, that described by Leclnere being a transitional stage to this condition.

In addition to a true *Dictyuchus* and a true *Aplanes* condition, an interesting transition often occurs which combines the features of both these types. In certain sporocysts a number of encysted spores germinate directly, producing long narrow tubes resembling young hyphae, which penetrate the sporocyst wall. Other encysted spores, within the same sporocyst, after producing a cyst tube, cease to germinate and enter upon a *Dictyuchus* condition, the second motile phase taking place with the liberation of a zoospore from a broken cyst tube (Text-fig. 6). This type of sporocyst is a combination of that where all motility is suppressed (*Aplanes*) with one in which the second motile phase is present, although noticeably feeble and short in duration. It is interesting to note that transitional forms occur, between the true *Dictyuchus* condition, through composite sporocysts where either the *Dictyuchus* or *Aplanes* condition is predominant, to the pure *Aplanes* form. It is suggested that this composite sporocyst should be known as the "*Dictyu-Aplanes*" condition.



Text-fig.8. Club-shaped sporocyst of the *Aplanes* form. Swollen structures at "a" and "b" are formed by the streaming of the protoplasm towards the tip of the germ tube. (x 230).

Text-fig.9. Shows formation of two germ tubes in terminal swelling after streaming of protoplasm has ceased. (x 230).

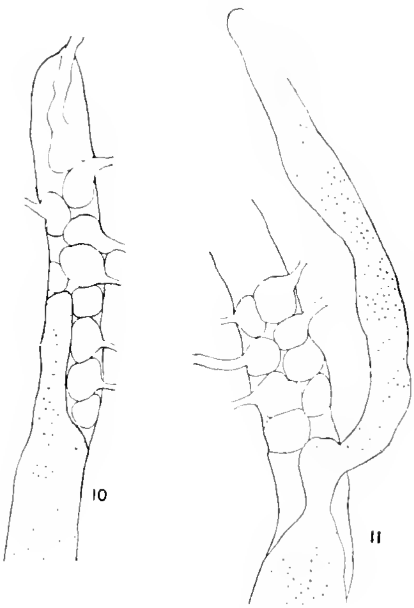
Rare examples of composite sporocysts are found, in which the features of *Achlya*, *Saprolegnia*, *Dictyuchus* and *Aplanes* are combined. In Text-fig. 7 the *Achlya* type of branching is shown. The main sporocyst is of the "*Dictyu-Aplanes*" form, while the two basal sporocysts are normal *Saprolegnia* sporocysts incompletely discharged.

An interesting feature often occurs in the *Aplanes* type of sporocyst, in what may be regarded as an attempt at escape of the protoplast during germination. After some of the germ-tubes have reached a certain length, a streaming movement is observed from the body of the germinating spore. Part of the protoplasm streams to the tip of the tube, where a large swollen structure is formed (Text-fig. 8). This swollen structure never ruptures the tip of the germ-tube, but appears to function as an encysted spore from which one or two germ-tubes may ultimately develop (Text-fig. 9).

From these observations it seems conceivable that the *Aplanes* condition has arisen from the *Dictyuchus* condition by the delay of protoplasmic activity until the length of the germ-tube renders escape ineffective.

Formation of New Sporocysts.

Owing to the prevalence of *Dictyuchus*, *Aplanes*, and "*Dictyu-Aplanes*" forms in which the original sporocyst remains blocked either by empty cyst cases or by



Text-fig.10. Short *Dictyuchus* sporocyst showing penetration of hypha at base in attempt to form new sporocyst. (x 230).

Text-fig.11. Base of old *Dictyuchus* sporocyst showing lateral divergence of hypha to form new sporocyst. (x 230).

germinating spores, the formation of a new sporocyst almost invariably takes place by the lateral outgrowth of the hypha from the base of the sporocyst. The hypha grows forward until further progress is blocked, lateral divergences then taking place (Text-figs. 10 and 11). In this manner a pseudo-*Achlya* condition is obtained.

Summary.

1. Certain species of *Saprolegnia* are known to show variations in sporocyst formation and discharge, when grown under cultural conditions.
2. In the present investigation certain variations are recorded for an undetermined species of *Saprolegnia* growing under natural as well as cultural conditions. *Leptolegnia, Pythiopsis* and *Achlya* conditions occurred rarely, while *Dictyuchus* and *Aplanes* conditions were found frequently. These variations occurred in both club-shaped and cylindrical sporocysts, but were not observed arising from resting sporocysts.
3. The *Dictyuchus* condition described here differs from either of those described by Lechmere and is held to be the true *Dictyuchus* condition.
4. Composite sporocysts were observed, the most important of which combine the features of *Dictyuchus* and *Aplanes*. The name "*Dictyu-Aplanes*" is suggested for these sporocysts.
5. Evidence is given in favour of the suggestion that the *Aplanes* condition has arisen from the *Dictyuchus* condition, by failure of the protoplast to escape from the germ-tube during its early growth.
6. New sporocysts are frequently formed as lateral, basal branches of old sporocysts, owing to the blocking of the latter with empty cyst cases and germinating spores.

All Text-figures were made at table level, with Zeiss camera lucida and tube at 160 mm., Leitz objectives 3 and 6 and oculars 2 and 4.

THE GEOLOGY AND PETROLOGY OF THE GREAT SERPENTINE BELT OF NEW SOUTH WALES.

PART IX.—THE GEOLOGY, PALAEONTOLOGY AND PETROGRAPHY OF THE CURRABUBULA DISTRICT, WITH NOTES ON ADJACENT REGIONS.

BY PROFESSOR W. N. BENSON, B.A., D.Sc., F.G.S., W. S. DUN, AND W. R. BROWNE, B.Sc.

Section A.—GENERAL GEOLOGY.

By W. N. BENSON, B.A., D.Sc., F.G.S. Professor of Geology, The University of Otago, N.Z.; formerly Linnean Macleay Fellow of the Society in Geology.

(Plates xvii.-xviii*a*; Text-figures 1-9.)

CONTENTS.

INTRODUCTION AND ACKNOWLEDGMENTS.

It has been the endeavour in previous parts of this series to present in each part a fairly detailed account of some area or problem investigated in the Great Serpentine Belt. The preliminary survey of the whole belt, described in Parts i. and vi. (1-2),* and other studies (3) have indicated the significance of the Carboniferous crust-movements and vulcanicity in the general tectonic and petrologic evolution of the Serpentine Belt, and it is therefore desirable that there should be made a detailed investigation of the Carboniferous history of the Serpentine Belt, in addition to the Devonian history to which attention has chiefly been directed hitherto. For this reason the Currabubula district was selected as most suitable for study, being easy of access, and lying midway between the Burindi and Rocky Creek regions already examined (though but rapidly), and the more fully-known extensive development of Carboniferous rocks in the region north of Newcastle. Some four weeks were spent by the writer in surveying in 1915, but he was unable to visit the region again until January, 1917, when, accompanied by Browne, he spent a week in completing the mapping of about

* The figures in brackets refer to the bibliography at the end of the paper.

seventy-five square miles and visiting some outlying districts. Removal to New Zealand prevented the writer from continuing in further detail the mapping thus rapidly outlined. Meantime, the investigations by Mr. Sussmilch and others showed the widespread nature of the fluvioglacial phenomena in Carboniferous rocks discovered in 1914 by Professor David, and of this work an exceedingly important statement has just appeared (4). A two days' visit to Currabubula paid by Browne in September, 1919, resulted in the discovery of the glacial phenomena in this district also, an observation confirmed immediately afterwards by Professor David. The writer paid further brief visits in December, 1919, and January, 1920, and noted the extension of these glacial beds, and, in more detail, the stratigraphical succession. While, therefore, we are now able to give a general account of the geology of this district, it is obvious that much remains to be done in the detailed study of all the formations, and in particular it must be pointed out that the boundaries of the subdivisions of the sedimentary series and the estimates of their thickness are only rough approximations, and no attempt has been made to differentiate between the numerous igneous formations, sills, dykes, breccias, etc., grouped together as the roughly outlined Warragundi complex. The improbability of opportunity for further detailed work in this region seems to justify the publication of results of our studies up to the present time.

For the purpose of linking this study to those made in the regions about the head of the Manilla River (2), the available data concerning the intervening region have also been summarised.

The writer's thanks are due in the first place to his collaborators, Mr. W. R. Browne and Mr. W. S. Dun, to Professor David for helpful discussion in the field and in the laboratory, to Professor Lawson for his interesting palaeobotanical notes, and to Mr. F. Chapman, A.L.S., for descriptions of oolitic limestones, *Chaetetes* and Bryozoa. Mr. Porter, of Tamworth, first directed our attention to the occurrence of fossils at Currabubula, and Mrs. Scott to the south-eastern corner of the Parish of Babbinboon, from which locality she has made a large collection available for our study. To the hospitality of her parents, Mr. and Mrs. Mackay, of Allanbank, the writer is indebted for the opportunity of visiting this most interesting area. The hospitality of Mr. and Mrs. Doyle, of Purleywah, Werris Creek, made possible the examination of the upper parts of Werrie's Creek, and to the guidance of Mr. Hammond, of Escott Park, is due the knowledge of the Permian Rocks of this district.

General Geology of the Western Zone of the Great Serpentine Belt, especially the Somerton-Carroll District.

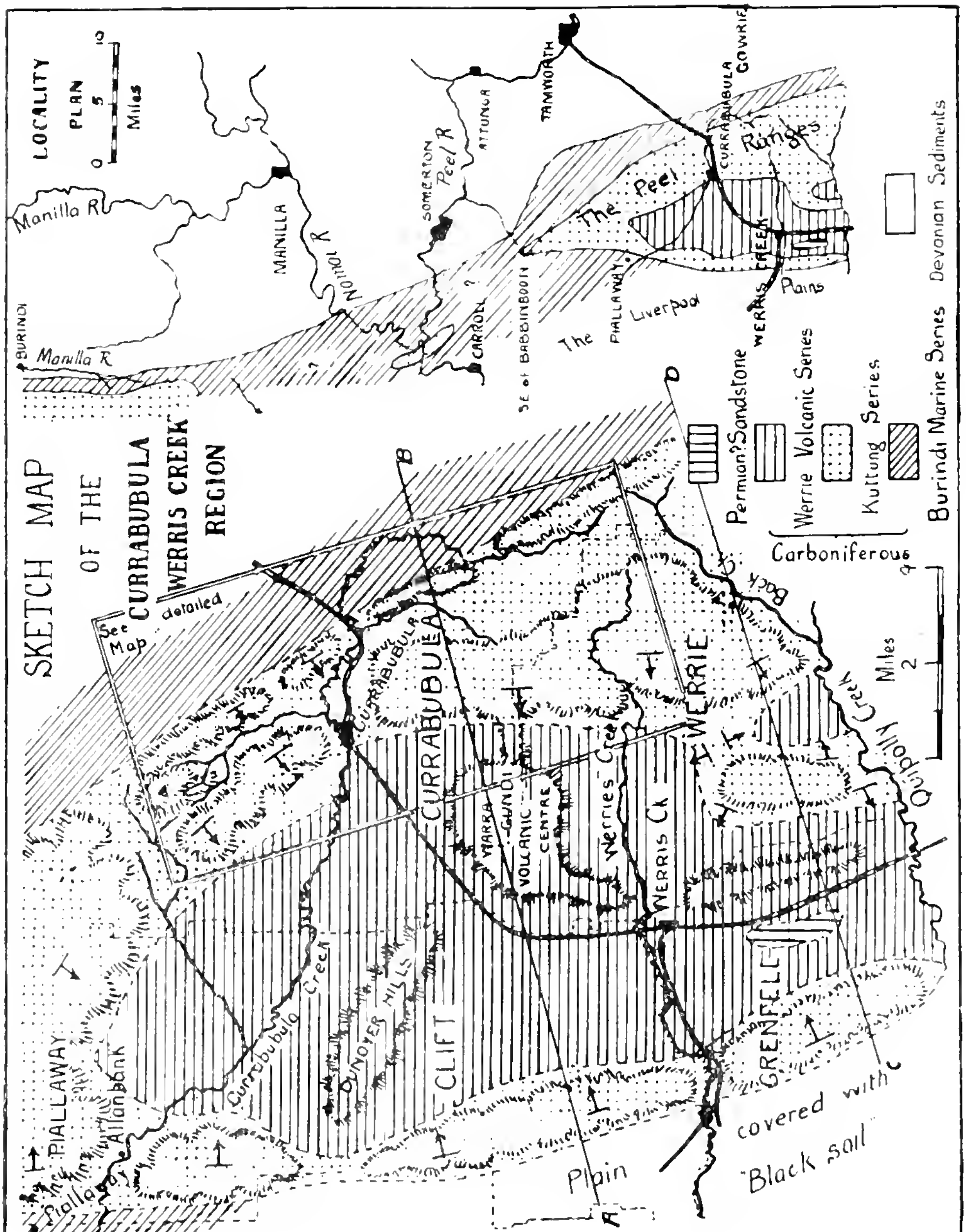
In the northern region of the Great Serpentine Belt (2) the general structure is as follows:— Immediately west of the zone of serpentine, there are strongly folded Devonian rocks, with occasionally infolded Carboniferous rocks. West from this, lie gently, sometimes steeply, folded Upper Devonian (Barraba) mudstones with tuffs, etc., passing up into Lower Carboniferous marine limestones, with occasional bands of conglomerate, limestones and tuffs, the Burindi Series, on which lie a largely conglomeratic series and beds containing Carboniferous plant fossils with abundant tuffs and volcanic rocks, to which the term Rocky Creek Series was applied, the whole forming a conformable sequence. The two Carboniferous formations are developed chiefly in a synclinal zone lying about twenty miles west of the serpentine. [*See* (1), p. 503 and Pl. xxi., fig. 4, and

(2), pp. 264-272, Pl. xx., fig. 4.] Studies in the southern region by Professor David and Mr. Sussmilch (4) have shown that there also the Carboniferous is divisible into a lower marine portion, which, as pointed out by the writer (1. p. 504), is to be correlated with the Burindi Series, and an upper portion of conglomerates, tuffs and other volcanic rocks and glacial formations. As this portion is so much more extensive and varied in the Southern district than in the Northern, the name Rocky Creek Series was clearly not sufficiently inclusive, and the term "Kuttung Series" was adopted to cover all those formations that lie between the top of the Burindi and the base of Permo-Carboniferous Beds. The term Rocky Creek Series, if it be retained, must, then, be considered as indicating a local development of the Kuttung Series, and the latter term will be employed herein in its original significance. The possibility of correlation of portions of the Kuttung Series in different localities, *e.g.*, the Rocky Creek and Wallarobba conglomerates, or the several horizons of "Varve Rock" can be determined only after much more extensive work than has yet been undertaken.

If we trace the development of the Carboniferous rocks southwards from the Gwydir, the following is the outline of the structures observed. The syncline, which seems to be broken by strike faulting, is seen to form the northern spur of the Nandewar Ranges, west of Horton River. It is intersected by Rocky Creek, and extends beyond the head of the Manilla River. It is the most marked of several parallel synclines, the axes of which undulate southward from the head of the Manilla River. The fold axis seems to have been warped upwards, and the Kuttung sediments have been removed for some miles (*see* text-fig. 1). The rocks outcropping at the surface are the underlying Burindi beds, and those near Rangira have been hastily examined by Mr. Pittman (5) who obtained therefrom specimens of *Rhynchonella* and *Cyrtoceras*. In the Parish of Tulcumbah, Mr. Porter collected oolitic limestone which has been examined by Mr. F. Chapman (*see* below). The Kuttung rocks appear again, however, where this synclinal zone crosses the Namoi River, striking S. 35° E., as noted by Pittman (6) and Andrews (7). At Keepit, the syncline is broken by a strike-fault throwing down to the west (6), and this faulted structure has also been recognised by Messrs. Cotton and Walkom (8) at Carroll Gap, two miles to the south of the river, where Burindi rocks only occur. Eight miles in a south-easterly direction from here, the low ridges rise up to form the northern extremity of the Peel Range. According to the writer's hurried observations, this range here consists of the eastern limb of the syncline of Kuttung rocks, the eastern being here the downthrown side of the fault. The underlying, richly fossiliferous Burindi rocks forming the trough and western limb of the syncline make the foothills to the Peel Range and extend for several miles on either side of it. From this point, the axis of the syncline pitches steadily to the south, and the Kuttung rocks on either limb of the syncline make up the Peel Range, which, for some distance, consists of two series of opposed, slightly divergent, dip-ridges or cuestas.

A digression must here be made to point out the great interest of the region just described, which, unless its geology is unduly obscured by the recent alluvial deposits noted by Cotton and Walkom (8), is likely to be of very great importance in the study of the Burindi rocks of this State. The first examination of the region was made by Sir T. L. Mitchell in 1831 (9, pp. 38, 39). The historic interest of the early work on this region makes full quotation desirable:

"We met with a rather singular formation of little hills formed by projecting strata, the strike extending in a direction of N. 30 W., and the dip being


SKETCH MAP
OF THE
CURRABUBULA
WERRIS CREEK
REGION
LOCALITY
PLAN
0 5 10
Miles
Manilla R
MANILLA
BURINDI
Manilla R
Namoi R
SOMERTON
Peel R
ATTUNGA
TAMWORTH
CURRABUBULA
GOWRIE
The Peel Ranges
CARROLL
SE of BABBINBOON
PIALLAWAY
WERRIS CREEK
The Liverpool Plains
Permian? Sandstone
Werrie Volcanic Series
Kuttung Series
Burindi Marine Series
Carboniferous
Devonian Sediments
See Map detailed
CURRABUBULA
WERRIE
Werries Creek
Werris Ck
WARRA-GUNDI VOLCANIC CENTRE
CLIFT
DUNOVER HILLS
Currabubula Creek
PIALLAWAY
Allanbank
The Piallaway
GRENFELL
Plain covered with "Black soil"
Back Creek
Quipolly Creek
Miles
0 2 4

Text-fig. 1.

to the east at an angle of about 30°. The rock appears to consist in some parts of a buff calcareous sandstone, calcareous tuff, and more abundantly of limestone. . . . . with disseminated portions of calcareous spar, principally due to fragments of crinoidea. At a lower part in the same rock less compact, I found a beautiful chalcedonic cast, apparently of a *terebra*" (*Loxonema?*); "the calcareous sandstone . . . . contained fragments of shells of the *littorina* or *turbo*" (*Macrocheilus filosa*). "We encamped on the 'Nammoy' or Peel river at the foot of a small hill named 'Perimbungay.' In the left bank of the river I found a conglomerate-rock consisting of waterworn fragments of serpentine and trap cemented by calcareous spar." "The range we had crossed at Turi was near us to the westward and a conical hill called 'Uriary' in the direction of Turi, was the most prominent feature to the south-east. The Peel continued its course through this range which presented a more defined and elevated outline where it continued beyond the river."

In 1852, the Rev. W. B. Clarke visited this area (10) and recognised the relationship of the marine beds with those elsewhere in the Colony. "In my report of September 6, 1852," he says, "I stated my opinon that there is a regular sequence of the various beds of this formation over the *Lepidodendron* beds of the Manilla and Goonoo Goonoo. I have now to show that the middle beds of this formation, those of the Hunter and Hawkesbury, are widely distributed in the western border of the country between New England and the interior. Sir T. L. Mitchell in 1831 found strata having the usual strike and dip of the region and bearing fossils which evidently belong to similar rocks which I have found abundant in similar remains at the base of the Carboniferous on the Paterson and Hunter, and more recently I have obtained from the same neighbourhood near the junction of the Peel and Namoi rivers other fossils which are identical with specimens coming from Wollongong in the Illawarra, where they occur in beds that pass in ascending order into the coal-bearing grits and sandstones of the Wollondilly and Hunter River basins."

About the years 1888-90, Mr. Donald Porter collected a number of fossils from here which were transferred to the Australian Museum and to the Mining Museum, and in the following year Stonier (11) remarks that at Somerton the marine beds "appear to belong to two distinct series which are unconformable, and may perhaps belong to the Upper and Lower Marine. The evidence is not conclusive, nor are the sections sufficiently clear to establish the unconformity without a detailed survey." Mr. Etheridge (12), in the same year, accepted, with some doubt, the correlation of these beds with the Upper Marine Series, a correlation which was abandoned in the following year when a more extensive study of the fossils had been made (13). No further field studies were made of this region for a long time, except the visits of Mr. Pittman (6) and Mr. Andrews (7), but large series of fossils were obtained by Messrs. Porter, Musson, Pittman and Cullen, which were in part described by Mr. Etheridge (14, 15), and have also been studied by Mr. Dun and the writer in the present paper. These have been supplemented by collections obtained from the south-eastern portion of the parish of Babbinboon by Mrs. Scott and the writer. Here, adjacent to portion 14 of the Parish, there is a low hill capped with a horizontal layer of fine-grained limestone, beneath which is a calcareous and tuffaceous mudstone with abundant fossils. The following is the list up to the present date of the fossils recognised in the region contained between Carroll, Babbinboon, Mt.

Uriari and Somerton. In a subsequent paper the localities for each will be indicated as far as possible with the present indefinite statements available. The list cannot be considered exhaustive. A distinctive feature is the abundance of *Productus muricatus*, casts of *Loxonema*, and forms of *Gosseletina*.

PLANTAE.—*Girvanella*.

PORIFERA.—Sponge spicules.

COELENTERATA.—*Zaphrentis culleni*, *Z. sumphuens*, *Z.* sp. indet., *Amygdalophyllum etheridgei*, gen. et sp. nov., *Diphyphyllum* sp. indet., ? *Lithostrotion* sp. indet., ? *Tryplasma* sp. indet., *Michelinia tenuisepta*, *Michelinia* sp. nov., *Chaetetes spinuliferus*, sp. nov.

BRYOZOA.—*Fistulipora microscopica*, sp. nov., *Cycloidotrypa australis*, gen. et sp. nov. *Hallopora fruticosa*, *Thamniscus* sp.

BRACHIOPODA.—*Orthotetes crenistria*, *Chonetes aspinosa*, *Productus hemisphaericus*, *P. muricatus*, *P. pustulosus*, *P. semireticulatus*, *P.* sp. indet., *Orthis* (*Rhipidomella*) *australis*, *Orthis* (*Schizophoria*) *resupinata*, *Rhynchonella pleurodon*, *R.* sp. indet., *Dielasma sacculum* var. *hastata*, *D. sacculum* var. *amygdala*, *D.* sp. indet., *Seminula subtilita*, *Spirifera bisulcata*, *S. davidis*, *S. duplicicostata*, *S. mosquensis*, *S. pinguis*, *S. pinguis* var. *elongata*, var. nov., *S. striata*, *S. striato-convoluta*, sp. nov., *S.* sp. indet., *Syringothyris exsuperans*, *Retzia* cf. *ulotrix*, *Actinoconchus planosulcata*.

PELECYPODA.—*Sanguinolites triradiatus*, sp. nov., *S.* sp. indet., *Edmondia* sp. indet., *Ctenodonta* sp. indet., *Nuculana* sp. indet., *Parallelodon carnei*, sp. nov., *Pteronites subpittmani*, *P. tanipteroides*, *Kochia striata*, sp. nov., *Conocardium* sp. indet., *Posidoniella?* spp. indet., *Spathella* sp. indet., *Panenka porteri*, sp. nov., *Aviculopecten* sp. indet. (cf. *A. granosus*), *A.* sp. indet., *Entolium aviculatum*, *E.* sp. indet., *Leiopteria australis*, *Sealdia* sp. indet.

GASTROPODA.—*Pleurotomaria* sp. indet., *Ptycomphalus culleni*, sp. nov., *Ptycomphalina* sp. indet., *Mourlonia ornata*, sp. nov., *M.* sp. indet., *Gosseletina australis*, *G. australis* var. *alta*, var. nov., *G. mackayi*, sp. nov., *G. scotti*, sp. nov., *Porcellia pearsi*, *Phanerotremata australis*, sp. nov., *P. australis* var. *alta*, var. nov., *Murchisonia* spp. indet., *Bellerophon* sp. cf. *hiulcus*, *B.* sp. indet., *Euomphalus carrollensis* sp. nov., *E. cera*, *E. pentangulatus*, *E.* sp. indet., *Straparollus davidis*, sp. nov., *Naticopsis brevispira*, *N. globosa*, *N. obliqua*, sp. nov., *Macrocheilus filosus*, *M.* sp., *Loxonema babbinboonensis*, *L.* cf. *lefevrei*, *L.* sp. indet., *Platyceras* sp. indet., *Conularia* sp. indet., *Hyolites* sp. indet.

SCAPHOPODA.—*Dentalium* sp. indet.

CEPHALOPODA.—*Orthoceras* sp. indet., *Trochoceras* sp. indet., *Cyrtoceras* sp. indet. (? *Gyroceras*), *Gomphoceras*.

TRILOBITA.—*Phillipsia* ? *robusta*.

As will be shown in section B of this paper, this series of fossils indicates that the Burindi beds here may be correlated with the middle portion of the Carboniferous limestone of Western Europe. It is not possible yet to indicate the thickness of the fossiliferous beds, or to state whether there is any zonal distribution of forms, but this area is strongly to be recommended as one suitable for such further studies.

In regard to the lithology of these beds, little can yet be added to the remarks made above save to call attention to the importance of the oolitic limestone bands which are so frequent a feature of Burindi rocks. Besides the occurrence in the Parish of Tulcumbah, north of Carroll, noted above, there is also a patch about a hundred yards in length on the western edge of Conditional Purchase Lease 172 in the south of the Parish of Babbinboon. Mr. Chapman in private communication states that the former rock contains stem-joints and nodal joints of a crinoid, which are like those that may be seen in the *Hexacrinidae*, though it would be hazardous to point out their exact relationship on such meagre evidence. Numerous grooved brachial ossicles occur as nuclei in the oolitic grains of this rock. This limestone is interstratified in a calcareous mudstone with abundant crinoids and some corals, dipping E 30° N. at 40°.

We now return from this long digression to trace further southwards the tectonic structures. The Burindi beds have been traced down the western side of the Peel Range to the Currabubula Creek at Piallaway, and preserve throughout an easterly dip, though with slight variation in strike and inclination, and doubtless form the western limb of the syncline, and are overlain by Kuttung rocks. South-east from Piallaway, the diverging ranges of Kuttung rocks are separated by an extensive volcanic formation, the Werrie Series, chiefly composed of basalt flows overlying the Kuttung rocks, and as the main syncline plunges more deeply to the south, these form the broad plain between Currabubula and Werris Creek townships, enclosed by the ranges of Kuttung rocks to the east and west. The eastern range is the main Peel Range and is the more continuous, though traversed by several gaps. It extends past the Currabubula, Werrie's and Quipolly Creeks and continues southwards towards the Liverpool Ranges, the component rocks having a general dip of 35° to 40° in a direction about W. 20° S. The cuesta or dip-ridge character of the ranges is most marked, especially where, as in the Currabubula District, they contain very resistant stratiform masses of andesite. The marine rocks continue in a zone dipping beneath the Peel Range and resting in turn upon the *Lepidodendron australe* beds (Barraba Series), as noted at Goonoo Goonoo by Clarke (10) and Stonier (11). Characteristic fossils have been obtained east of Currabubula (*see* later) and further south at Gowrie and particularly at Goonoo Goonoo.

The following fossils have been recorded in the last two districts: *Martinia* sp., *Nucula* sp., *Entolium aviculatum*, *Aviculopecten* sp., *Macrochilina*, *Yrania konincki*, *Orthoceras* sp.

The westerly segment of the syncline of Kuttung rocks crosses Currabubula Creek by Piallaway and continues southwards across Werrie's Creek (which occupies a narrow defile) to Quipolly Creek.

South of Werris Creek, the opening between these diverging ridges is partially closed by a little cross warping bringing up a minor anticline of Kuttung rocks and cutting off a small basin of Werrie Basalts. Between this and the western range there has been let down into the Werrie basalts a small patch of *Glossopteris*-bearing sandstone, possibly belonging to the Newcastle Series. Thus the region of Werrie basalts between Currabubula and Werris Creek forms almost an enclosed basin. Within this the low land is interrupted by the resistant mountain mass of Warragundi, a volcanic complex, from which extends a series of ridges following a bundle of dykes, running in a curve to the south-west. To the north-west the Dunover Mountains appear from a distant inspection to be also a complex of volcanic rocks, more resistant to erosion than the surrounding basalts. Here and there are minor intrusions of basalts, probably of Tertiary age, and recent alluvium occurs in some amount in the valleys.

The main structures and formations have been now outlined, but the details of stratigraphic succession of the sequence of igneous events and the complexities of structure introduced by faulting, can be partly realised from a consideration of the features of the Currabubula district.

The Geology of the Currabubula District.

Previous Investigation.

The first account of this district was given by Sir T. L. Mitchell in 1831 (1, p. 31), in the following words: "The country appeared tolerably open and level, so that we could pursue our course in one direction nearly eight miles. The most conspicuous hill on our right was named by the native "Barragundy." It was visible during the whole of our day's journey. We at length entered upon an open and grassy plain, and found in the skirts of the wood beyond it a channel containing water in abundance, and which was known to the natives as "Carrabobila."* Beyond this channel arose a peaked and picturesque range whereof the highest summit was named "Turi." Several gullies were difficult for the passage of the carts, and detained the party in its ascent, but at length we reached the top of the pass and crossed the range, which appeared to be continuous, thus separating the basin of the Peel from that of the water falling into the Liverpool Plains.** We were agreeably surprised to find that the opposite side of these hills, and the whole face of the country beyond them presented a very different appearance from that through which we had passed. A gently sloping extremity lay before us for eight miles in the direction of our proposed route. . . . . The heights which we had crossed appeared to extend from the Liverpool Range to the northward as far as could be seen; but the native told me that it soon terminated on the river 'Callala' (or Peel), whose course he said turned westward."

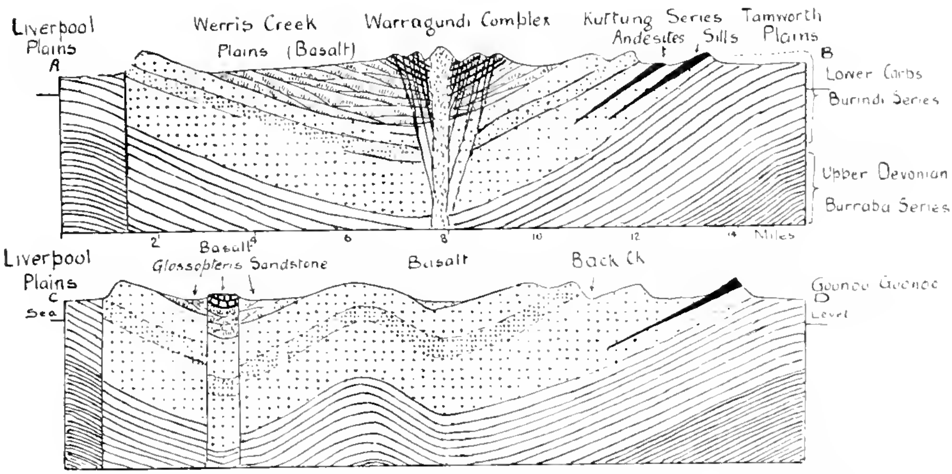
The Rev. W. B. Clarke, twenty years later, determined the height of Turi Peak as 2,952 ft., but made no reference to the geology of the region (10); Mr. Etheridge received samples of crinoidal limestone from Glen Donald, four miles east of Currabubula in 1890 (11); and in 1905 Mr. Andrews briefly referred to the topographical features (17). In 1913 Mr. Carne examined the *Glossopteris* sandstones of Werris Creek (18) and Mr. Cambage obtained *Rhacopteris* near Currabubula (19). The occurrence of *Archaeocalamites* was also reported in 1914 (20). No connected account of the geology of the region has, however, yet been given.

The Burindi Series.

The eastern portion of the Currabubula region consists of rocks of marine origin. They comprise a lower and an upper portion. The former is made up of marine mudstones of an olive-green colour showing Carboniferous fossils mostly as casts. They contain here and there small lenticles of limestone up to a few inches in thickness and a few feet in diameter, and are interbedded with tuffs of intermediate or keratophyric composition, the tuffaceous zones being also at times fossiliferous. Narrow zones of conglomerate or pebbly tuff occur, and locally larger masses of coralline (*Zaphrentis*) and crinoidal limestones. In general, these beds resemble quite clearly the Burindi rocks in the western slopes

*Mitchell adds: "Even before my men had seen this spot, the native name in their mouths was corrupted into 'Terrible Billy.'" Locally this name is now applied to the hill, officially termed "Warragundi" or "Terrible Mountain."

**Probably Mitchell's party passed through the gap north of Duri Peak.



Text-fig.2. Geological Structure of the Currabubula and Werris Creek Districts.

of New England (2) and near Dungog (4). To the west they appear to pass down into the Upper Devonian (Barraba) rocks at Goonoo Goonoo, which contain *Lepidodendron australe,* but the exact position of the zone of passage has not been determined. In the north-western portion of the area mapped, in a small gully in portion 197* there occur four narrow seams of very impure coal, the thickness being only twelve inches. They are all much veined by calcite. They recall the carbonaceous shales of Clarencetown (21) to some extent, but are not among freshwater strata. Among these marine rocks has been thrust a sill of glassy (sometimes lithoidal) andesite which forms the easternmost of the more or less continuous zones of sills in this region, reaches a thickness of about four hundred feet but pinches out south of the railway line; where thickest it forms the high cuesta called Minnarooba. Here, in its northern part in portion 199, the intrusive character of the igneous rocks is clearly indicated at its upper surface where the andesite has enclosed and indurated the fragments of mudstone. The mudstone is also somewhat indurated adjacent to the andesite in the small ridge crossed by the railway cutting in portion 35. A few fossils have been noted in portion 199, but the majority were found near the railway cutting in portions 83 85, and 35 in Mr. Donaldson's property (11). The writer's attention was called to these fossils by Mr. Donald Porter, and in collecting them he was aided by Mr. C. E. Tilley, B.Sc., and Mr. D. A. Pritchard, B.Sc. The gem of the collection, however, the *Cactocrinus*, was presented by Mr. Donaldson and found probably a short distance south of the railway line. The collection is remarkably depauperate. A pebbly or conglomeratic layer is intercalated in the mudstone here and a small lenticular mass of limestone, a few yards in length and width, occurs which is made up almost entirely of crinoidal fragments and *Zaphrentis*.

The following are the forms recognised, obviously representing the Burindi fauna:—*Cactocrinus brownei*, sp. nov., *Zaphrentis culleni*, *Zaphrentis* sp. indet., *Fenestella* sp. indet., *Chonetes hardrensis*, *Orthotetes crenistria*, *Productus longispinus*, *Orthis (Rhipidomella) australis*, *Orthis (Schizophoria) resupinata*, *Spiri-*

* Portion numbers refer to the Parish of Currabubula except where otherwise stated.

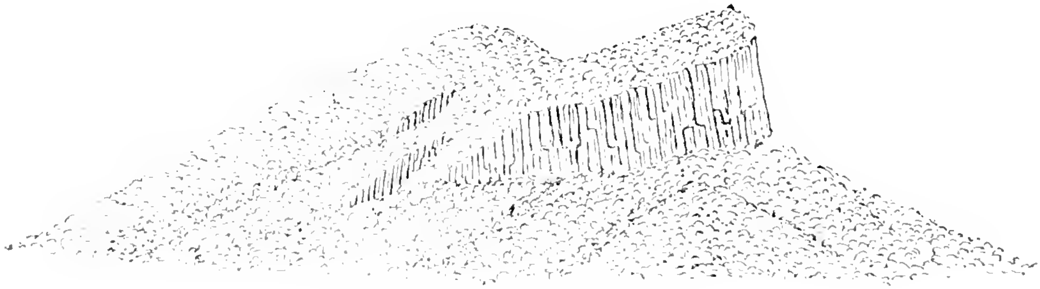
fera bisulcata, *Spirifera* sp. indet., *Spiriferina insculpta*, *Dielasma sacculum* var *hastata*, two indefinite species of *Pelecypods*, *Conularia* sp. ?, *Phillipsia* sp. ?.

The lower limit of the Burindi beds is not definite, but we may assume their thickness to be not less than twenty-five hundred feet, and the lower portion, containing marine fossils, to be about half that amount, which agrees with the estimate of their thickness in the type locality (1. p. 508). The upper moiety of the Burindi Series does not make any marked outcrop, but seems to consist of mudstone and also of very easily decomposed basic tuffs, yielding a tenacious red soil. At the base of these a stronger band of tuff was found to contain *Lepidodendron veltheimianum*. Scattered through the belt of red soil are irregular nodular masses of silica, sometimes apparently chalcedonic, at other times clearly silicified tuffs, more often replacements of some unknown material. This horizon of silicification runs throughout the region mapped, and is immediately followed by rather more felsitic tuffs.

Above this there is a zone of passage into the more keratophyric tuffs which form the base of the Kuttung Series. This zone is developed along the eastern slopes of Mts. Colla and Sugarloaf, and here Mr. Donaldson found the silicified plant remains described in the palaeontological section of this paper, and consisting of gymnospermous wood and a bundle of roots, both of an indeterminate nature.

Lower Portion of the Kuttung Series.

In the region mapped the distinction between the base of the Kuttung Series and the top of the Burindi Beds is not sharp. The former are less readily decomposed and contain one or more marked pebbly zones. This basal portion of the Kuttung Series may be traced along the scarp of the easternmost line of the westerly inclined dip-slopes of the Peel Range, which line of ridges is made up of a nearly continuous band of more or less glassy hypersthene andesite about five hundred feet in thickness. The relation of this to the adjacent Kuttung rocks is not clear, for distinctive outcrops have not been discovered (but *see* p. 304). The Kuttung Rocks are here mostly of medium grain, gritty tuffs composed chiefly of acid felspar, and are associated with occasional zones of thinly bedded olive-green mudstone and of pebbles which are apparently waterworn. No glacial striae have been found on any of these yet, but they have not been closely investigated. In Turi Creek (Portions 57 and 59) a thin flow of basalt occurs. Through this portion of the series there extends another series of stratiform masses of more or less glassy andesite. Duri Peak, for example, is a magnificent



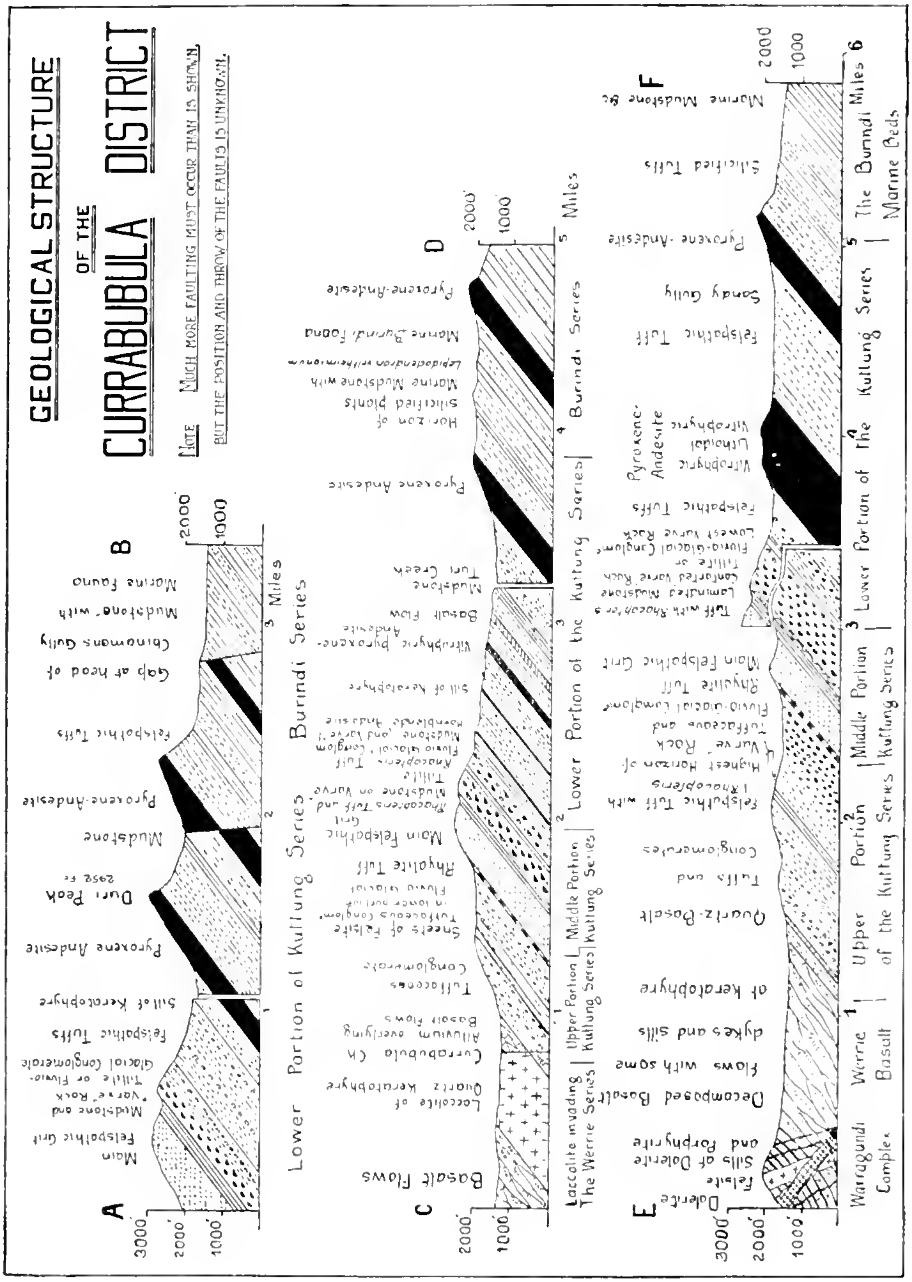
Text-fig.3. Duri Park from the east.

cuesta, formed of a sheet of igneous rock over three hundred and fifty feet in thickness, the western dip slope and almost vertical eastern scarp being very distinctive (*see* Text fig. 3.) South of this, there is a small hill in portion 116 which seems to be composed of a lenticular mass of the rock about two hundred feet in thickness. Further south, in Sandy Gully, is a larger mass composed of both vitrophyric and lithoidal andesite which together reach a thickness of nearly fifteen hundred feet, and further south again, on the margin of the map, is the great mass forming Kingsmill's Peak, the thickness of which has not yet been ascertained. It does not seem likely that these isolated masses of pyroxene andesite are repetitions by faulting of portions of the continuous median zone, though perhaps not impossible. Strike faulting occurs to some extent, but its full effects are unknown. Thus along the two lines of section north of Currabubula Creek, the apparent thicknesses of the lower portion of the Kuttung beds are respectively forty-two and forty-four hundred feet. Along the southern line of section, the apparent thickness of these beds is only thirty-four hundred feet, and there is additional evidence (*see* pp. 307-8) to suggest that the movements differed on the two sides of Currabubula Creek, that some portion of the Lower Kuttung rock was repeated by strike-faulting north of the Currabubula Creek, or was cut out by the same process south of the same creek. The truncation of the western margin of the andesite of Kingsmill's Peak suggests the latter as the more probable alternative. In either case, the exact thickness of the Lower Kuttung Series remains in doubt. No fossils have been found in this portion of the Series, unless the plants assigned to the uppermost Burindi rocks should rightly be included here.

The inclination of the beds is between 35° and 40° to the S.S.W. in the northern part of the region, but less in the southern.

Middle Portion of the Kuttung Series.

(*a*) *The Lower Glacial Beds.*—This is the most varied and interesting portion of the Kuttung rocks in the district. The succession of beds has been traced in approximate detail along four lines of traverse. In portion 223, a mile and a half to the east of Currabubula railway station, a small quarry exhibits a very fine-grained, almost porcellanous, creamy-white banded rock which has some of the characters of the "varve" rock of De Geer (22) (*see* Text-fig. 3*a*, Section iii.). Beneath and especially above it the bouldery rock is not a normal conglomerate, but in place of closely-packed, contiguous, rounded pebbles, more or less uniform in size, the pebbles present are sub-angular, very varied in size, and are set in a matrix of gritty felspathic material, in which they are often widely spaced and not contiguous, and there is little sign of stratification. The rock has thus some of the characters of boulder clay or tillite. This bouldery material, with interbedded tuff lying above the fine-grained banded rock, is about 1000 feet thick, and extends into portion 321 (Mr. Proctor's property). Above this is a second zone of fine-grained banded rock, but here the comparison with "varve" rock is even more marked. The bedding planes of this rock are often strongly contorted, and scattered through it are small or large pebbles of granite, aplite, etc.—evidently small erratics. This zone of "varve" rock has been proved to be continuous for at least five miles, and is, therefore, termed the main "varve" zone; it is about fifty feet in thickness. Lying above it are laminated, olive-green mudstones very like those in the Burindi Series, but so far these have not been found to be fos-



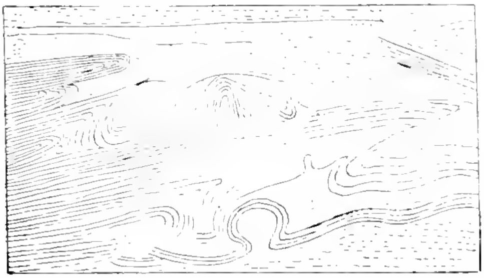
Text-fig. 3a. Geological Sections across the Currabubula District.

siliceous. These mudstones are about fifty feet thick. Upon them lie conglomerate or bouldery beds, interstratified with fine-grained tuff containing plant remains. On the steep sides of the hill in portions 320, 321, immediately south of Mr. Proctor's homestead, Mr. Browne and Mr. Waterhouse obtained from this horizon a number of fossil plant-remains, including *Rhacopteris intermedia*, *Aneimites ovata*, and reed-like impressions, possibly of *Calamites*. These beds are followed by the gritty felspathic rock which is described below as the main felspathic grit. The total thickness of the beds here described as forming the lower moiety of the Middle Portion of the Kuttung Series is about thirteen hundred feet. They are grouped together as the Lower Glacial Beds. The main "varve" zone may be traced to the south, and has been studied two miles from here, where the eastern branch of Rocky Creek approaches Sandy Gully (portion 278). The ridge separating Rocky Creek from Sandy Gully consists of a succession of banded mudstones, felspathic tuffs, narrow zones of tillite and traces of varve rock overlain by a definite zone of tillite. The main "varve" zone follows this, and can be seen in the valley of Rocky Creek below the northern sharp bend, and it is followed by the main felspathic grit (*see* Text-fig. 3*a*, Section iii., E—F). The boundaries of the glacial beds southwards from here are largely conjectural.

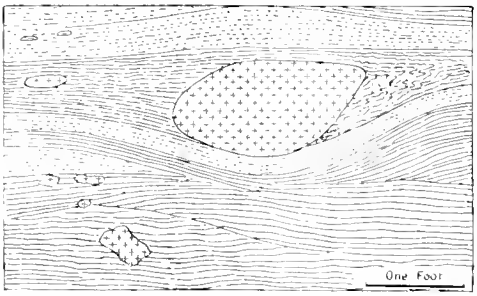
North of Currabubula Creek, still more distinct evidence of glaciation is available (*see* Text-fig. 3*a*, Section ii., C—D). Tracing the sequence of beds up from the valley of Turi Creek we find that the upper portions of the easterly facing slopes are rather too covered with shed rock to yield a clear succession to a hasty traverse. The rocks appear, however, to be felspathic grits with pebbly layers and some well stratified material, and possibly represent the lowest "varve" horizon. Above these, forming the almost vertical cliffs at the scarp edge, is a thick stratum of boulder-bearing rock which perhaps is more like a normal conglomerate than a tillite Above it, is a narrow zone of fine-grained, creamy, felspathic tuff containing abundant remains of *Rhacopteris intermedia*, *Aneimites ovata* and *Calamite*-like impressions. These were first obtained here by Mr. Cambage (19). Probably, also, the *Archaeocalamites* was obtained from this spot (20). These plant-beds are followed by a thick zone of tillite, which forms the highest part of the ridge where it is crossed by the line of section (C—D), and may be traced down the valley of Browne's Creek. Here the glacial origin of the rock is shown, not only by similarity of the structure to that of a boulder clay but by the presence of polished striated and more or less faulted pebbles collected by Professor David and Mr. Browne.* These are, however, difficult to obtain, for the matrix of the tillite is strongly cemented. Moreover, as in the Paterson-Maitland District, the striations are found almost solely on the quartzite pebbles, the boulders of granite, porphyry and aplite being generally without striation, though they are often only partially rounded. The largest boulders are of granite which may be over two feet in diameter. Above this tillite lies the main "varve zone" first discovered by Browne, and well exposed here in Browne's Creek. Here the contorted character of the rhythmically banded "varve" rock is most striking (*see* Text-fig. 4) and so also is the presence of abundant erratics of granite, some over a yard in diameter, embedded in these fine-grained sediments (*see* Text-figs. 5 and 6). The main varve zone is followed as usual by laminated

*For photographs of glaciated pebbles from Browne's Creek and Rocky Creek *see* Plate xxiv., figs.9,10 of section B of this paper, to appear in Part 3 of these Proceedings for 1920.

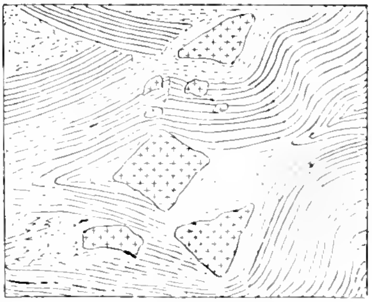
olive-green mudstones about sixty feet in thickness overlain by a thin tuffaceous conglomerate containing *Rhacopteris intermedia* and *R. roemeri?* (probably the equivalent of the *Rhacopteris* beds by Proctor's homestead). These are followed by the Main Felspathic Grit. The main "varve" zone and the olive-green mudstones are weak structures compared with the tillites below and the grits above, and their extension for some miles to the north is indicated by the manner in which the heads of creeks open out into strike valleys following the base of the Main Felspathic Grit In the three preceding traverses across steep slopes only broad subdivisions of the Lower Glacial Series have been traced. The exposures in Currabubula Creek, where it passes through the township, indicate that in reality the succession of beds is more complex. The section from the point where the Creek is crossed by the Duri Road to that where it is joined by Anstey's Creek



Text-fig.4. Contorted "varve-rock" in Browne's Creek.



Text-fig.5. A rounded granite boulder in "varve-rock," Browne's Creek.



Text-fig.6. Subangular granite boulders in contorted "varve-rock," Browne's Creek.

merits detailed study. Commencing the section is a thick band of conglomerate followed by banded mudstone 40 ft., tillite 10 ft. (including a granite-erratic three feet in diameter), well bedded felspathic tuff 30 ft., tillite 10 ft., contorted "varve"-like felspathic tuff 50 ft., tillite 30 ft., followed by thick conglomerate extending to the bend where Rocky Creek enters. Here the section is broken by a zone of crushing probably denoting a fault. There follows banded contorted "varve" rock 60 ft containing many small erratics; this must be considered to be the main "varve" zone. It is overlain by laminated olive-green mudstones, and these again by the Main Felspathic Grit which extends beyond the point where Anstey's Creek enters the main stream. The grit contains intercalated bands of conglomerate.

(*b*) *The Main Felspathic Grit* which thus immediately overlies the lower glacial beds is the most uniform portion of the Kuttung Series in this district. It is a strongly cemented grit chiefly composed of fragmental grains of orthoclase and quartz with a little albite *et cetera.* Here and there it contains interstratified pebble-bands, passing into definite layers of conglomerate, and also occasionally thin bands of mudstone. Its great resistance to erosion is seen from the persistency with which it forms the highest ridges throughout the whole of the district. It probably forms "Rocky Peak," between Quipolly and Werrie's Creeks, and then north of it rises to form Soma, and the point immediately north of it (both of which are higher than Duri Peak); it also forms the ridges east of Rocky Creek, and those lying just west of the watershed between Currabubula and Turi Creek. No fossils have yet been found in this formation, which is approximately a thousand feet thick. It evidently resulted from prolonged explosive eruptions which culminated in the production of a little rhyolitic tuff, possibly in some parts rhyolitic flow-breccia, about fifty feet thick. This last has been traced down the eastern side of Rocky Creek, and along the western foothills of the ridges north of Currabubula.

The Upper Portion of the Kuttung Series.

The beds following this are again more or less glacial in character. North of Currabubula Creek, a little basic tuff and a flow of basalt only a yard wide intervene between the rhyolitic tuff and the tillite, but these are absent from the development in Rocky Creek where also some faulting appears to have obscured the succession. The tillite has the same general characters as that in the Lower glacial beds, and contains striated pebbles of quartzite (*see* footnote on p. 297) among many more or less rounded boulders of granite, porphyry, and aplite. It becomes more conglomeratic in character in its higher portions, and is interstratified with a large amount of felspathic tuff. About fifteen hundred feet above the top of the Main Felspathic Grit there is a narrow zone of fine-grained, white felspathic tuffs, which may be traced up the face of and the spur to the south of the hill immediately to the south-east of Currabubula. Traces of *Rhacopteris* have been observed in this, and associated with it are contorted banded tuffs somewhat resembling "varve" rock. Altogether these are rather more than fifty feet thick. Two miles from Currabubula Station, in portion 274, where the western branch of Rocky Creek crosses what is probably this horizon, coarse tillite is seen containing several narrow layers of "varve" rock up to a foot in width.

The Kuttung Rocks West of Werris Creek.

The Kuttung rocks, which make the western limb of the syncline, form the hills to the north and south of Werris Creek Gap. They have not yet been investigated in detail, but appear to be similar to the upper portion of the Kuttung Series near Currabubula. Intercalated in these is a mass of andesite thirty feet thick, which closely resembles the rock termed the Martin's Creek andesite in the Paterson District, which there has been shown to be a flow. Immediately to the west of these hills extend the Liverpool Plains which, near the Werris Creek Gap, are covered by black soil, probably derived from the Werrie basalts. It is possible that the western face of these hills is parallel to a line of strike-fault bringing up the Burindi beds beneath the cover of black soil. The width of the range does not seem sufficient to permit of the development here of the full thickness of the Kuttung Series (*see* Text-fig. 2).

General Remarks Concerning the Kuttung Series.

Summarising the above facts we find that the Kuttung Series in this region is made up of the following members:—

	Approximate Thickness.
Upper Portion:	
Tuffs and conglomerates	1600 feet.
Rhacopteris tuffs and varve beds	50
Upper Tillites, conglomerates and tuffs	1500
Middle Portion:	
Rhyolite Tuff	50
Main Felspathic Grit	1000
Lower Glacial Beds	1300
Lower Portion:	
Felspathic tuffs and pebble beds (say)	4000
Total	9500

The total thickness of the Kuttung Series in this district is thus comparable with the thickness of 7000 feet measured in the same series in the Paterson area by Professor David and Mr. Sussmilch (4). It would, however, be quite premature to attempt any detailed correlation. A striking point of distinction is the comparative rarity of actual flows of volcanic rock in the Currabubula district, contrasted with their frequent occurrence in the Paterson region.

Attention may here be directed to the writer's comment on the section exposed on Rocky Creek near Bingara (2, p. 268),—"The series is, in ascending order; Burindi tuffaceous mudstones, followed by tuffs covered by a very great thickness of coarse conglomerates with boulders of granite, porphyry and rhyolite in a tuffaceous groundmass, with interbedded layers of rhyolite and rhyolite tuff. Following this there is more tuff, and above a band, about fifty feet thick, of a hard cherty tuff, very fine grained but including small pebbles of granite, etc." [*See* also the microscopic description (23, p. 720, M.B. 16).] "Following this is a mass of coarse rhyolite tuff. Altogether the series cannot be less than two thousand feet thick, and the hill at the side exposes at least five hundred feet more."

The experience now gained leads the writer to conclude that this "hard cherty tuff," observed by him in 1911, was also a glacial rock containing small erratics, and that the section exposed on Rocky Creek is perhaps comparable with the Middle and Lower Portions of the Kuttung Series as here described.

As regards the conditions under which these sediments were deposited, it is evident that the epoch of their formation was one of continuous and energetic explosive volcanic activity, accompanied by extensive glaciation. The apparent absence of striated pavements and the rarity of the preservation of striae except on the quartzite pebbles, together with the abundance of waterworn pebbles and of "varve" rocks, seem to indicate that fluvio-glacial rather than purely glacial conditions predominated, a conclusion which accords with that of Professor David and Mr. Sussmilch (4). At the same time, the unstratified beds containing large boulders scattered through a felspathic matrix have some features like those of subglacial till. It must also be pointed out that the discrimination between glacial beds and mere conglomerates rests at present upon a rapid survey only. It will be necessary to establish and apply critically discriminative criteria before definite conclusions concerning these beds may be obtained.

The Werrie Volcanic Series.

This consists of an immense mass of basaltic rocks, which are now probably over two or three thousand feet thick near Warragundi, and must originally have been much more extensive. Invading these is an extensive series of sills and dykes described below. The lavas are chiefly very decomposed basalts, of which the petrological examination is very difficult. No fresh examples have been obtained, though the nature of the rock may be fairly well determined in a specimen from the bottom of a deep well near the head of Anstey's Creek. The rocks are very vesicular, the vesicles being either empty or filled with zeolites, calcite, chlorite, or a form of silica. Here and there there is evidence that the mass is composed of many flows of small size. In the banks of creeks the irregular outlines of the chilled margins of slaggy flows may be seen.

On the summit of a hill in portion 110, Parish of Werrie (west of the area mapped), at the highest point of the Werrie lavas so far as is yet known, slaggy and ropy lava is found deeply weathered and of red brown colour. It is not, however, a true basalt.

Warragundi, or Terrible Mountain,* and the group of hills around it probably formed the centre of the ancient volcanic activity. In all probability the original volcanoes were dissected and reduced in Permo-Carboniferous times, and covered with *Glossopteris*-bearing sandstones, of which a remnant still occurs near Werris Creek. This covering being stripped off by subsequent erosion, perhaps in comparatively recent times, renewed dissection has cut deep into the core of the old volcano. Probably there is no finer example in Australia of a dissected volcanic complex than is afforded by these hills, the detailed examination of which will form a most fascinating study. The writer has been able to spend only three days among these hills, and has therefore merely indicated on the map, Plate xvii., roughly the area in which the greatest variety of rocks is to be found, classing the whole as the Warragundi complex. A few notes, however, may be given to indicate the nature of this complex. The basaltic rocks are in one place associated with rhyolite, possibly a flow. They have been broken through by large masses of trachytic or felsitic agglomerate, the largest of which forms Warragundi itself, and adjacent to these are more basic agglomerates. In addition, there is a varied and extensive series of intrusive rocks, which form dykes, sills or sheets, or less regularly shaped masses, the rocks of which may be termed provisionally felsites or granophyres and keratophyres, porphyrites of several types, and dolerites. These are clearly related to the intrusive rocks, dykes and sheets in the Carboniferous sediments, as will appear more clearly after a consideration of the latter rocks. It will suffice at present to point out that the dykes in the sediments tend to radiate out from about Warragundi. From this centre two bundles of dykes pass outwards, the one extending to the east, forming the ridge at the head of Anstey's Creek, and extending for a considerable distance through the Kuttung rocks; the other bundle strikes to the south-west and bends round almost to a southerly direction on crossing Werrie's Creek, and being resistant to erosion the dykes have determined the presence of the crescentic

* See footnote p.292.

row of hills which lie east of the railway line. Possibly this continuous dyke-zone marks the site of fissures from which the Werrie basalts were ejected.

The consideration of the age of these rocks is deferred to a later section (p. 308), but the most probable conclusion is that they were formed in late Carboniferous or early Permo-Carboniferous times.

The Intrusive Igneous Rocks.

We have just remarked that the Werrie Series and we may now say the underlying sedimentary formations also, have been invaded by numerous, more or less concordant intrusions and dykes composed of a variety of igneous rocks. These intrusions fall into several groups:

(*a*) *Sills and sheets.* The most striking of the intrusive rocks are sills of glassy or lithoidal pyroxene andesite. Of these there are three zones, a comparatively short and intermittent eastern zone, the main continuous zone, and the western zone of intermittent but large intrusions which rise to form two of the highest peaks in the district. The resistance to erosion offered by these sills is very great, and as they are inclined at a considerable angle they usually form high, sharp-ridged cuestas.

The eastern zone commences in a low hill in the south-western corner of the Parish of Warral and thence continues intermittently southwards, rising into a well marked ridge. In portions 266 and 197 of the Parish of Currabubula, exposures of the upper surface of the sill seen in a creek, show that the andesite has invaded the mudstone, and included fragments of it, which have been converted into a dense flinty hornstone. The sill is not seen from about a mile south of the Duri road until it appears again in portion 83, after which it continues intermittently, forming a low ridge extending for a mile and a half further to the south-east. The railway cutting through this ridge reveals a complex of shattered and indurated mudstones, conglomerate, and tuffs.

The main zone of pyroxene andesite extends from the Parish of Winton on the north into the area mapped, crosses the low divide at the head of Chinaman's Gully, and rises into the strongly asymmetric hill east of Duri Peak which has a precipitous westerly-facing scarp and a long, smooth, but steep dip-slope to the east, rising until the surface of the andesite is half a mile wide. The andesite is truncated by a fault, the same which forms the southern boundary of the igneous rocks of Duri Peak, and by this fault the outcrop is displaced a quarter of a mile to the west, the down-throw being to the north. A basic dyke occupies this fault-fissure. Thence the andesite continues in a succession of dip-ridges or cuestas, broken by minor dip-faults and occasionally crossed by narrow dykes of basalt, which weather so rapidly that they have determined in several instances the positions of the valleys crossing the andesite (*see* p. 310). The most marked instance is that between Mts. Cobla and Sugarloaf. Fault-fissures also have determined transverse valleys, as in the case of Currabubula Creek. South of the latter the andesite band wedges out and is replaced by a second zone commencing to the east of this termination of the main band. The narrow strip of sediments between these two masses of pyroxene andesite consists of fragmental jaspery rock. The zone now continues across the upper part of Currabubula Creek, and rises into the high ridges forming the western boundary of the Parish of Goonoo Goonoo. It appears to continue for several miles further to the south-east.

No indubitable evidence of the intrusive nature of this main zone of pyroxene andesite has yet been found, and its classification rests chiefly on lithological similarity with the rock of the eastern zone, and the similar absence of characteristically volcanic features. The jaspery character of the brecciated rock between the two overlapping portions of this zone suggests that here is contact metamorphism which has become most marked between the separated portions of a split sill, but it is still possible that the apparent splitting and shattering may be due to a powerful strike-fault.

The third zone is the most intermittent, though containing the broadest exposures of pyroxene andesite. Of these the northernmost extends into the area mapped from the Parish of Winton, crosses the upper portion of Chinaman's Gully without producing marked relief, and becomes rather narrower until it is sharply upthrown by a fault to form the shapely ridge of Duri Peak (Text-fig. 3). In this the andesite is exposed as a cliff of prismatic rock on the north-eastern face, showing that the igneous stratum is about three hundred and fifty feet thick. The south-western face is a dip slope inclined at an angle of 40°. The southern flank of the mass is grooved by an L-shaped valley, the position of which was apparently determined by a small strike fault intersecting a dip-fault, the latter partly truncating the andesite, its plane being occupied by a basalt dyke. The remnant of the andesite extending beyond this fault is cut off by a second one a short distance to the south, which also displaced the main zone of andesite.

The portion of the pyroxene andesite included between these two faults shows most markedly a flow structure, especially on weathered surfaces, where the lines of phenocrysts of plagioclase and pyroxene stand out distinctly from the glassy matrix, which is often weathered to a bright red colour by the separation of dusty haematite.

About a mile to the south-east from here is a small mass of pitchstone (in portion 116) from which was obtained the sample which has been analysed. It forms an inconspicuous knoll.

The pyroxene andesites appear again in the valley of Sandy Creek. They are brought up to the surface by a fault (which has been traced westwards for some distance), and thence the mass swells out to a width of about half a mile, continuing for two miles to the south-east and rising to form a small group of hills about five hundred feet above the floor of the valley. Two faults cross this mass, displacing it slightly, and its southern margin is also a fault traceable for some distance westward. An interesting feature of this mass is its three-fold nature. The highest hill is seen to be craggy on the easterly and westerly aspects, the rock composing the slopes being very glassy, but in the centre of the hill there is a smooth saddle, slightly lower than the sides, and composed of lithoidal andesite. Possibly the mass is twofold in nature, the vitrophyric external segments having a lithoidal inner portion. In other parts of this region is seen a close association of lithoidal and glassy rocks of otherwise similar nature, and forming part of a simple mass. The significance of this will be a matter of interesting research. A somewhat analogous association has been found to be not uncommon in Western Scotland (24). This mass, if stratiform, must be nearly fifteen hundred feet thick.

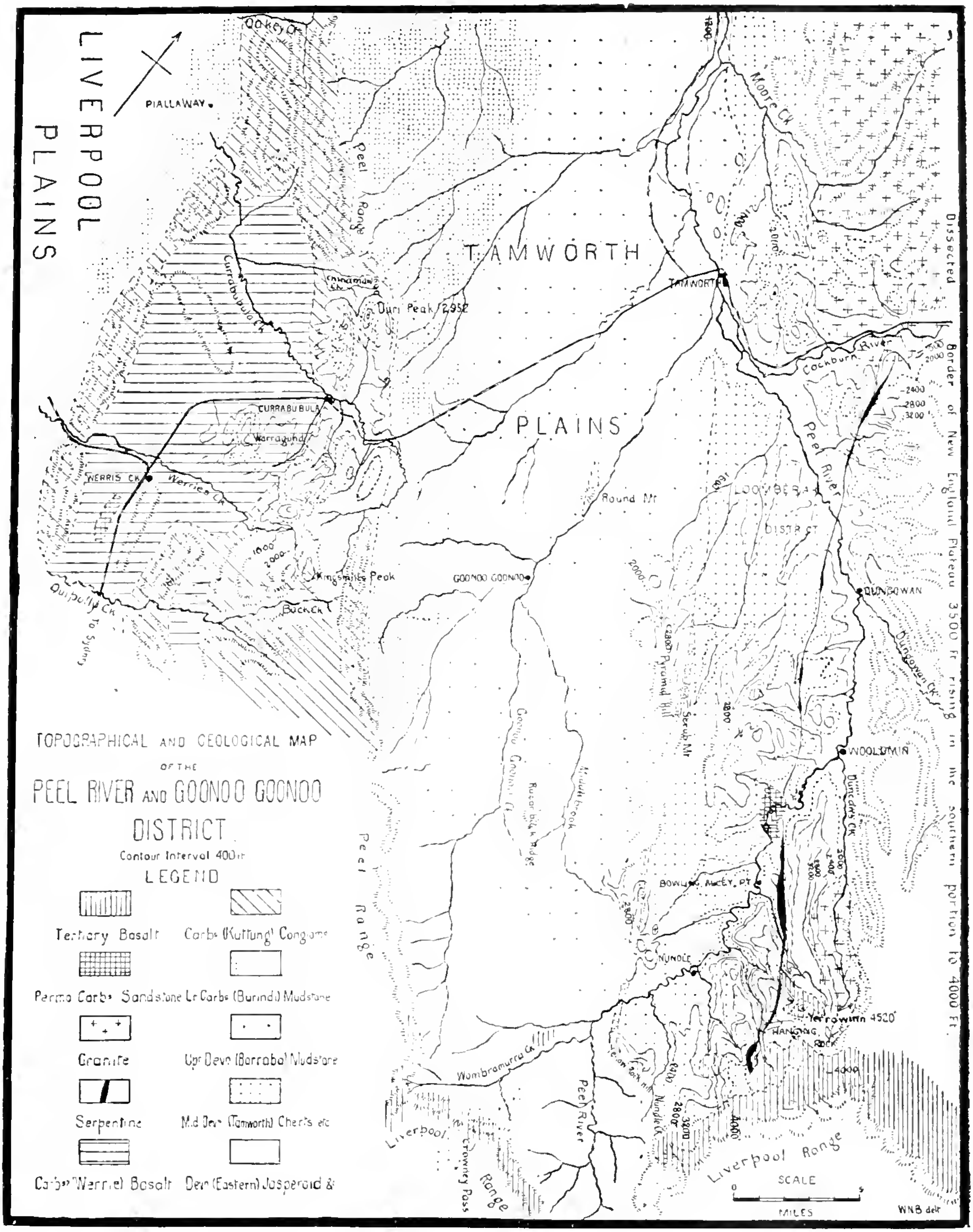
The last occurrence of pyroxene andesite remaining for description is that which forms Kingsmill's Peak at the head of Currabubula, Werrie's and Back Creeks. In this mass the width of the exposed surface of pyroxene andesite is greater than elsewhere owing to the smaller inclination of the dip-slope. The western boundary of the mass is a strongly marked fault which crosses Werrie's Creek obliquely. The eastern margin is a steep scarp. The andesite appears to be cut off to the south by a dip-fault, and does not reach Back Creek. The thickness of the sill does not apparently exceed three hundred feet at its eastern margin.

As in the case of the occurrences along the main zone of pyroxene andesite, no exposures have been found of the contact between the igneous rock and the surrounding sediments, and the classification of the four western masses as intrusive bodies again rests on their lithological resemblance to the rocks intrusive into the Burindi beds two or three thousand feet lower in the stratigraphical succession. Against this it might be urged that there is a lithological similarity no less marked between the rocks of the main and western zone of pyroxene andesite and those which in the Seaham and Clarencetown areas are considered to be flows (4). In our area the rocks are marked by concordant fluxional banding, and by an absence of any evidence of a scoriaceous or spherulitic upper surface, or of the presence of fragments of similar rock in the tuffaceous beds among which they occur. These features, together with their great thickness and continuity, are perhaps more in favour of an intrusive than an extrusive origin for the andesite.

Among the main minor sheets and sills, we may consider those of andesite, quartz basalt and dolerite, and also those of keratophyre.

A short distance below the Lower Glacial zone is a band of hornblende andesite extending along the eastward slope of the ridge north of Currabubula, and occurring again in a similar horizon in portion 88, near Proctor's, south of Currabubula Creek. It is of the type of rock known as Martin's Creek andesite in the Paterson region (4), weathers to an ochreous or buff colour, showing strongly-marked fluidal structure, and in the rare fresh specimens is a grey-blue with plentiful phenocrysts of plagioclase and hornblende. As before noted, the same type of rock may be found in the Kuttung Rocks in Werris Creek Gap. The rock of this type in the Paterson region is considered to be a flow; here it is classed doubtfully as a sill. Decisive evidence is not yet available.

Andesites and porphyrites of several other types occur forming sheets in the Warragundi hills. The quartz basalts are fine-grained, greenish-grey rocks which are generally more or less vesicular. They occur in most noteworthy amount forming two layers extending through the uppermost portion of the Kuttung rocks from Werris Creek to within two miles of Currabubula. These are not associated with basic tuffs, but seem to transgress the bedding planes of the sediments, and to be associated with dykes of the same composition. In the north-west corner of the region mapped, however, is an irregularly bounded layer of the same rock, only about a yard in width where observed, intercalated in basic tuff. This may perhaps be a flow. Some sheets of the same type of rock occur along the eastern slopes of the Warragundi hills. Sills of dolerite occur in the Werrie Volcanic Series, two very thick masses being known in the hills east of Warragundi Mountain, and thinner ones to the west, but these have not yet been studied in detail. In the tuffs and conglomerates half a mile south-south-east of Currabubula railway station, there is a sill which runs for about a quarter of a mile, increasing in width until it is 120 feet across near the northern angle of portions 271 and 287, where it is truncated by a fault. Although of teschenitic character and resembling some of the Tertiary intrusive masses, it is not neces-



Text-fig. 9. Topographical and Geological Map of the Peel River and Goonoo Goonoo District.

Tamworth Common north-westwards to Moore Creek, and is continued to the south-east in the ridges running out into the Common, where the back slope or scarp of the tilted block has been deeply dissected by streams which have worked back along the soft claystones and crush zones between the hard agglomerates and tuffs, and have even captured part of the drainage that previously flowed to the north-west.

Again in the Nundle District (*see* 28) the varying elevation of the Tertiary gravels shows that warping and faulting has occurred since their formation, perhaps during and certainly also after, the period of Tertiary volcanic activity. The following facts will indicate this, reference being made to the geological and topographical map of the Nundle District (28, Plate xxii.), the figures being based on aneroid observations. Commencing at Hanging Rock there are a number of occurrences of a "deep lead" or gravel-filled valley covered over by basalt. The floor of this valley descends nine hundred feet within a distance of three miles in a south-westerly direction, the sharp drop including one fault of two hundred feet. This steep descent is, however, only a local feature, for in an adjacent deep lead beneath the basalts of Yerrowinn, the fall is only two hundred and ten feet in a distance of two and a half miles in a north-westerly direction. In Yellow Rock Hill the slope of the base of the gravel is 140 feet in a distance of two miles to the north-east, but the slope of the base of the overlying basalt is 160 feet in the opposite direction, the gravel being 340 feet thick at the south-eastern end and 40 feet only at the other.* Moreover, the lowest point of these gravels is lower now than any possible outlet for the Tertiary stream system in which they were formed. It seems, therefore, certain that the region about Yellow Rock Hill has been depressed relatively to the surrounding regions, during later Tertiary or post-Tertiary crust movements. To this warping and faulting is probably due also the sharp decrease in the height of the Liverpool Ranges south of the head of Nundle Creek. We must therefore conclude that within the watershed of the Peel River System, late or post-Tertiary differential crust-movements, as well as differential erosion, have been significant factors in determining the present topography. This is in accord with the conclusion obtained from a study of the western slopes of New England between the Namoi and Gwydir Rivers, and in particular the "Nandewar Buttress" (2).

Probably several epochs of movement and subsequent erosion occurred, as Andrews (29*b*) has urged. Of these some evidence is afforded in the Nundle district. The study of the relation between the present contour lines and the boundaries of the Tertiary basalts there suggests that they flooded over a fairly matured peneplain, and down into comparatively youthful valleys filled to a considerable depth with gravel. Uplift of the peneplain to permit dissection, and subsequent depression, accounting for the great thickness of the gravel appears to have occurred. From the plateau of basalts and the older rocks, however, have been carved out broad mature valleys to a depth of about 300 feet, which lead into the deep canyons of the upper, but not *head* waters of some of the streams of the present cycle. Thus we realise the complexity of the history of the present topography and drainage system. If it be indeed a superimposed system, formed by the cutting down of streams through a more or less uniform Mesozoic or Permo-Carboniferous sandstone covering (now removed) on to a foundation of Upper Palaeozoic rocks of very variable hardness, it must be recognised that it has not

*Comparison should be made with the facts recorded concerning the relative levels of basalts and underlying gravels in the Nandewar Range (2, pp.276-278).

been by a single cycle of movement and erosion, but by a series of movements, regional and local, the effects of which would alone suffice to give much complexity to the present drainage system even if it were not for the complicating factor of the very variable hardness of the structures on to which they were superimposed. In the regions of harder structures some indications of the former valley system may still be preserved, but in the softest mudstones the streams have now succeeded in obliterating nearly all trace of their complex history, producing the apparently simple, and approximately consequent drainage of the Tamworth Plains.

Summary of Geological History.

The long-continued subsidence and sedimentation of Devonian times was continued into the Carboniferous Period, and an invasion of a marine fauna with strong affinities with that of Western Europe took place about the middle of Lower Carboniferous times. Volcanic eruptions occurred from time to time, producing intercalated layers of tuff, and occasional bands of conglomerate may indicate some crust movement. The presence of *Lepidodendron veltheimianum* in place of the *L. australe* of Devonian times indicates a change in the flora of adjacent lands.

Crustal upwarping became more pronounced, and explosive volcanic activity greatly increased. Hydrothermal siliceous solutions affected some of the flora (gymnosperms and some indeterminable roots) and an overwhelming predominant deposition of keratophyric tuff took place, intercalated with conglomerate bands, a little mudstone, and rarely flows of basalt. Glaciers formed on the adjacent uplands, and discharged great masses of fluvio-glacial conglomerate and till, and locally there appeared widespread lakes in which the water, charged with rock flour, deposited seasonally banded "varve" sediments, which became contorted through subsequent thrusting from stranding ice-floes, the presence of which floating in the lakes, is indicated by the occurrence of large boulders dropped among the banded clays. The plants of the period were now *Rhacopteris* and *Calamites*. Meantime explosive eruption continued with varying intensity, felspathic material, but occasionally rhyolitic, being produced, and this was interstratified with conglomerate, etc. Perhaps some basic flows occurred. There followed, however, possibly after a hiatus, a huge development of flows of basalt derived from fissures, and perhaps at the same time a great development of sills of intermediate and basic rocks in the sediments beneath the basalts. Crust warping, fracturing, and extensive differential movement (block-faulting) followed, and with or after it a great development of keratophyre and quartz keratophyre sills and dykes radiating from the volcanic centre of Warragundi. Here, too, many dykes, sheets and sills were formed in the basalts about the volcanic centre, where several large masses of breccia now filled the volcanic vents. Dykes of basalt and dolerite, extending into the older formations, formed about this time also. This great eruptive activity concluded the Carboniferous or ushered in the Permo-Carboniferous Period.

Long continued erosion followed, but at the close of this latter period, the region had become one of deposition of the Newcastle Series of *Glossopteris*-bearing sandstone. The final movements of the epoch of crustal instability which appeared in Carboniferous times, broke up the Permo-Carboniferous, or Permian sediments, and let down small blocks into the general platform of older structure, where they have been preserved from erosion. The Mesozoic Era closed with the formation of a peneplain, which in Tertiary times was uplifted by a series of comparatively small uplifts and finally by a much larger one, these acting regionally but being complicated by local warping and faulting, while basaltic eruptions occurred after the first, but before the last of these movements. Erosion acting throughout this period has produced wide valleys or plains on the softer structures, but remnants of the harder structures are still preserved in narrow ridges or wide plateaus.

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sarily to be separated from the group of Carboniferous igneous rocks. Its age is, therefore, uncertain.

Sills of keratophyre occur in the Kuttung Series and can be traced along the eastern scarp of the ridges north of Currabubula. One very interesting sill occurs immediately south of Duri Peak. It extends in the felspathic tuffs in portion 255 for about half a mile, then turns sharply and runs as a dyke up the slope to the west, cutting several bands of conglomerate (or tillite) and turns once more into a sill in the Lower Glacial Beds at a horizon more than a thousand feet higher than the part of the sill in portion 255. A little to the south of the dyke which thus connects the two portions of the sill, there is a second dyke extending downwards from the upper moiety of this twofold sill, till it reaches the Duri pyroxene andesite, which, however, it does not traverse, though it seems to be represented by an extension of the same dyke of keratophyre on the opposite eastern side of the Duri andesite. There is here evidence of the contemporaneous origin of at least one group of dykes and sills of keratophyre. South of this, similar dykes are found to extend upwards into the sills of which they were perhaps the feeding channels, and one of these appears to intersect the hornblende andesite described above.

South of Currabubula Creek they appear in the Middle and Upper portions of the Kuttung Beds, and have been noted in portions 212, the north-western corner of 229 and elsewhere. With these we may perhaps class a sheet of felsitic rock which makes a striking feature in the extreme north-west of the area mapped, occurring in a fissure which runs parallel to the Currabubula Creek fault zone.

(*b*) *Intrusions of less regular form.* The most striking of these is perhaps that which occurs in the Werrie basalts immediately west of Currabubula. Appearing beneath the alluvium of Currabubula Creek about a mile north-west of the railway station, it extends to the south-south-east and becomes 700 yards in width, and splits to the south into several thick sills which appear in the decomposed basalts exposed in the railway cuttings. The rock of which these are composed appears to be a normal keratophyre, but in the centre of this laccolitic intrusion it is a quartz keratophyre, with a peculiar interstitial development of quartz. Quartz is also found in the rock of the two following masses which invade the Kuttung rocks. The smaller lies in the lowest portion of the series in the south-eastern extremity of the region mapped, and just below the main sill of andesitic pitchstone. Though its southern extremity has not been mapped, the lenticular outline of the northern extremity suggests that the mass is probably a laccolite.

The larger mass lies in the valley of Werrie's Creek between Kingsmill's Peak and Mount Soma. It is a roughly circular area about a mile in diameter, and as it truncates sharply the planes of bedding of the grits and conglomerate on the southern flanks of Mt. Soma, it may be a small boss rather than a laccolite. Its southern margin has not been closely examined. It is invaded by a narrow dyke of pyroxenic keratophyre.

(*c*) *Dykes.* The dykes consist of a very varied assortment of rocks, quartz keratophyres, keratophyres, trachytes, latites, lamprophyre, andesites, dolerites and basalt. As yet they have not been sufficiently studied to determine their chronological relationships. In the northern portion of the map they have a general north-easterly trend, but in the southern portion they run more nearly east and west, tending thus to radiate from the volcanic centre of Warragundi.

which, however, is probably a local centre of radiation in a region of general east-north-easterly trend of dyke-fissures (Compare 25). Dykes very frequently occupy fault fissures, so that it is probable that the main fault-movements accompanied or preceded the formation of the dykes.

The more acid dykes consist of rocks closely resembling the material composing the keratophyre sills. These are most obvious in the conglomerates and felspathic grits, but have not yet been traced through into Burindi Mudstone. The longest of these dykes crosses from the hills west of the head of Anstey's Creek, and may be traced thence across the sills of quartz basalt and through the Kuttung rocks as far as the slopes overlooking Sandy Creek. The fissure which it occupies seems to be continued by the fault truncating, on the south, the pyroxene andesite in the valley. Of the basic dykes, we may note the group of outcrops, which commence in the railway cutting in portion 34, pass through the gap between Cobla and Sugarloaf, and seem to be continued in a dyke crossing Currabubula Creek in portion 140 and the main road in portion 319. The rock in these is generally decomposed, but in the above-mentioned gap is a compound dyke of decomposed basalt containing another dyke in the centre composed of fresh dolerite. Other fresh specimens of basic dykes have been found, particularly where such traverse well-cemented conglomerate. Very frequently decomposed basic dykes occur in fault fissures, and such fault-dykes traverse the sills of pyroxene andesite.

Dykes of porphyritic dolerite occur abundantly in the Warragundi complex but have not yet been studied in detail. They also occur in the arcuate line of hills that run to the south-west from that volcanic centre.

With regard to the relative age of these various dykes and sills, little can yet be stated, except that, apart from the cases in which the keratophyre dykes and sills may be contemporaneous, but older than the pyroxene andesites, the dykes are younger than the sills wherever their intersections have been observed. Perhaps here also the phase of minor intrusions was one of increasing basicity (Compare 25). Nevertheless, it must be emphasised that much detailed observation of these rocks is yet required, and that the present list of types of rock developed, and mapping of intrusions is far from being exhaustive.

The Permian (?) Glossopteris Sandstone.

These rocks were first noted by Mr. J. E. Carne (18), being pointed out to him and later to ourselves by Mr. Hammond, of Escott Park. They are not present in the area mapped in detail, but occur in Grenfell Parish, and extend along the western side of the railway line for a mile and a half, commencing two miles south of Werris Creek. Mr. Carne noted a dip to the W.S.W. at 20° on the eastern edge of the sandstone, and we observed a dip of like amount in the opposite direction on the western side. The sandstone is thus bent into sympathy with the folding of the Kuttung Beds and lies over the synclinal axis. It is probably not merely a residual mass left by erosion; its sharp, almost rectilinear boundaries are more in accord with the view that it is an infaulted outlier brought now into relief by differential erosion of the softer basalts about it. The rock consists of sandstone and a little conglomerate, quite different from that of the Kuttung rocks; indeed the sandstone is remarkably similar to that in the Newcastle Coal Measures west of Pokolbin, with which it is tentatively correlated. Like them it contains several species of *Glossopteris* with *Vertebraria* and silicified (coniferous?) wood. Mr. Carne, however, suggested that it might be correlated with the Greta Coal Measures.

Tertiary Igneous Rocks.

A few masses of rock may be referred to this epoch. More than three miles to the south-south-east of Currabubula railway station, in the centre of portion 178, there is an oval patch of basalt, the major and minor axes of which are forty and twenty feet respectively: this is probably a pipe. A second and smaller patch occurs a mile and a half east of Currabubula on the lane between portions 319 and 68. The rocks comprising these are indistinguishable in hand specimen from the normal Tertiary basalt of this State. Mr. Browne considers there is considerable similarity between the Tertiary teschenitic dolerites found in the vicinity, *e.g.*, at Goonoo Goonoo (23, p. 703) and near Murrurundi and the teschenitic dolerite occurring south of Currabubula township. This similarity is not, however, sufficient to determine that the latter is of Tertiary age.

Recent Alluvium.

No features of the Tertiary alluvium call for special comment, except the widespread character of the alluvial fans where gullies open out on to the areas of Werrie basalt. The distribution of ochreous felsitic detritus on the black soil of the plains at the north side of the Warragundi hills shows how much alluviation of piedmont plains may be produced, not by definite streams, but merely by the creeping of the soil mantle down the slopes of the hills directly leading to the plains. An extensive alluvial fan has formed at the mouth of Browne's Creek, the result of a land slide which occurred a few years ago.

Tectonics.

The general structure of the district is simple. As shown in Text-figures 1 and 2, it is a syncline, the region mapped in detail forming the eastern limb. This consists of a long sequence of sediments of Carboniferous age with a total thickness of about fourteen thousand feet, and covered by lava flows of unknown thickness. The whole dips to the west-south-west at an angle varying between 28° and 45°, but usually about 37° in the northern portion, but less steeply near Werris Creek. Complexity is brought in by the faults, of which there are two series. The dip-faults are very obvious and numerous and often have a very considerable throw. Of these the most important is that first made apparent by the discovery of the glacial beds of Browne's Creek and at Proctor's homestead, which though formerly continuous, have been displaced about half a mile. Approximate determinations show that the downthrow on the southern side of the fault at Currabubula must be about twenty-seven hundred feet. But, where (presumably) the same fault crosses the main zone of pyroxene andesite, the downthrow is on the northern side and is only a hundred feet. If we consider this fault to have therefore had a pivotal movement, the present westerly inclination of the beds on the south side of the fault should be about ten degrees greater than it is on the north, but instead there is no noticeable difference of dip. The same absence of evidence of pivotal movement where it might be expected arises in other cases as shown below. Parallel to this fault are several other features, the long dyke of hornblende andesite in the north-western portion of the area mapped, the large laccolite of keratophyre west of Currabubula, a narrow zone of crushing which crosses Currabubula Creek just below its junction with Rocky Creek, the lower course of the valley of Rocky Creek itself, and the dyke of keratophyre that extends from the "elbow" in this creek, past Proctor's homestead towards the Gap south of Cobla—these all combine to show that a broad belt of fracturing traverses the Peel Range at this place, into which were injected felsitic magmas in late Palaeozoic times, and by which, at the present time, the structures have been rendered less resistant to stream erosion. Concerning other important dip-faults, we may note that these have also very extensive throws. The fault immediately north of Duri Peak throws the andesite down nearly nine hundred feet, but, though the displacement of the andesite directly to the east has not been measured, it has clearly not been moved along the fault to the same extent as the mass composing Duri Peak. This mass again is cut off to the south by two faults with an aggregate throw of over twelve hundred feet. This, however, does affect the rocks to the east, but the southern side of the fault is the upthrow side to almost as great an amount. Two miles further south there is another fault, possibly a branch of the Currabubula Creek fault zone, and this has moved the main zone of andesite so that the southern side of the fault has been thrown up over six hundred feet.

South of Currabubula Creek the mass of andesite in the valley of Sandy Gully is brought up by a fault of at least nine hundred feet throw, which is followed immediately by another of about four hundred feet throw. Both these seem to affect the sedimentary rocks immediately to the west to some extent, but have no noticeable effect on andesite to the east, unless the first strikes through Currabubula Creek Gap also, where a fault movement of about a hundred feet has occurred. The mass of andesite in the valley of Sandy Gully is again cut by faults, the one throwing up to the south about four hundred feet, and the other with a throw of perhaps nine hundred feet completely cutting off the mass of andesite, but neither of these appears to have had any effect on the andesite of the main zone immediately to the west. This extraordinary diversity of movement along the one fault line, without an accompanying change of dip, owing to local warping, can be best explained by the presence of several strike-faults, and the assumption that the region was tilted, fractured by strike and dip-faults, and the blocks into which the crust was thus separated moved up and down to various elevations. Unfortunately direct evidence of the existence of such strike-faults is wanting save for that running west of Kingsmill's Peak. The occurrence of a belt of mudstone beside the main zone of andesite directly east of Duri Peak, and again midway between the western and main zone of andesites crossed by the section line two miles to the south, may result from the presence of such strike faulting (*Compare* Text-fig. 3*a*, Sections A—B and C—D). The sections, however, merely indicate that some of these strike-faults occur; their positions and amount of throw are as yet almost entirely conjectural.

The occurrence of dip-faults recalls the faults of the Loomberah District (26). It may be that these faults are the continuation of the same regional series perpendicular to the fold axes as are there represented. Moreover, it was shown in the paper cited, that the movements along the lines both of dip- and of strike-fault must have continued on into the close of the Permo-Carboniferous times, or have been then repeated as posthumous movement. The same appears to have been the case near Werris Creek where the Permian (?) *Glossopteris* sandstone has been let down among the Werrie basalts along faults parallel to the old strike lines.

The Age of the Werrie Volcanic Series and Its Relation to the Crust Movements.

The sequence of events shown by the sedimentary and igneous record indicates a close association between crust-movements and igneous action. An extensive upward warping of the crust is indicated by the gradual change in conditions from those when the Burindi mudstones were deposited in a sea some distance from land, to those during the formation of Kuttung times, when in the vicinity of this area appeared high land from which glaciers carried a load of granitic erratics, and streams discharged abundant more or less rounded boulders, and land plants flourished. As Professor David and Mr. Sussmilch have pointed out (4), though this movement did not produce a stratigraphical unconformity, it was one of great importance, and with it there occurred immense and prolonged explosive volcanic activity yielding the felspathic tuffs. These are clearly related to the keratophyres in the Werrie Series. It requires more detailed survey than has been possible as yet to determine whether the Werrie Series lies conformably upon the Kuttung sediments, or whether some crust movement and erosion of the Kuttung rocks preceded the outpouring of the basalts, probably through fissures radiating from volcanic centres. It is evident, however, that no great hiatus occurred. The intrusion of pyroxene andesite may have occurred sometime before the outpouring of the basalts. Crust-fracturing and extensive faulting supervened, and especially at this period would we note the formation of the Currabubula Creek zone of fractures, into which were injected felsitic magmas (keratophyres and perhaps the hornblende andesites) of much the same composition as the pre-basaltic tuffs. The magma rising in fault fissures also was thrust out into sills (*see* p. 305).

Perhaps also at this period were formed the large intrusions of quartz keratophyre on Upper Currabubula Creek, Werrie's Creek, and west of Currabubula township. The age of the porphyrites and dolerites we do not yet know, but among the latest extrusions must be placed the basalt dykes, now largely decomposed, and as these occur so frequently in the fissures of powerful faults, it is probable that crust movements were still in progress at the time of their intrusion. We have thus evidence of long, but not necessarily unbroken succession of igneous events accompanied by crust-movement.

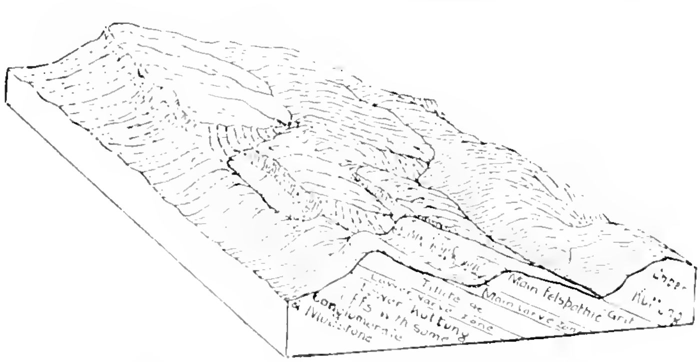
No evidence of the extension of these dykes of felsite, dolerite or basalt into the *Glossopteris* sandstone has yet been found, and therefore we conclude that the igneous activity about the Warragundi centre had ceased before their formation, though the crust movements had not then ceased. Thus, in the presence of extensive igneous activity extending from the Carboniferous period possibly into Permian time, with crustal instability of even longer duration, we find some analogy here with the sequence of events in the Hunter River District (4).

PHYSIOGRAPHY OF THE PEEL RIVER VALLEY AND ITS BORDERING RANGES.

In this section we discuss first the detailed physiography of the Currabubula district as an introduction to a general consideration of the valley of the Peel River. The special interest of the physiography of the Currabubula district lies in the vivid manner in which it illustrates the effects of differential erosion of a complex terrane. The western portion of our area is formed of the wide lowland of the Tamworth Plains; the portion west of the Werris Creek and Piallaway Gaps is similarly portion of the Liverpool Plains, both of which lowlands are (near our area) cut from the soft Burindi mudstones. The broad valleys of Turi and Sandy Creeks are cut from the soft felspathic tuffs comprising the lowest portion of the Kuttung Series, while the lowland basin between Currabubula, Werrie's and Quipolly Creeks is cut from decomposed basalts. These surfaces lie between 1200 and 1400 feet above sea level. The elevations are all of hard rock. Most striking are the "cuesta" ridges of the northern part of the eastern zone of pyroxene andesite, the main zone, Duri and Kingsmill's Peaks. Here and there for reasons not yet apparent, these hard rocks have been reduced to rounded hills, as in Sandy Creek valley or the low knoll in the valley of Duri Creek, or they have even been reduced to lowland as in the valley of Chinaman's Creek, just north of the region mapped. (Perhaps this last is an old water gap.) West of these rise the complex ridges cut from the Middle and Upper portions of the Kuttung rocks and moulded in a great degree by the resistant masses of the lower tillites and the main felspathic grit. Between this is the softer horizon of the main "varve" zone, and overlying mudstone, in which extend tributary heads of the small streams, the adjustment of streams to structures being as yet far from complete. Westward again the hills around Warragundi, made up of resistant trachytic breccia or strengthened by sills and dykes of dolerite and andesite, rise above the surrounding easily-eroded Werrie basalts. These greater elevations all rise approximately to a height of 3000 feet or rather less, or nearly two thousand feet above the general level of the lower land.

In minor topographic features, the adjustment of streams to structures is no less marked. Nearly every stream which crosses a resistant band or zone of rock follows through a belt of weakness, a line of faulting or crush brecciation, or a dyke, generally one of the very readily decomposed basic dykes, often in a fault-fissure. Attention may be called to several instances of this feature. The main transverse valley of the district, that by which Currabubula Creek passes through the Kuttung Series follows the fracture line, the existence of which is shown by the displacement of the rocks of this Series, and by other features. To the same direction are parallel the lower portion of Rocky Creek and the fault and dyke extending beyond it towards the gap in the main zone of pyroxene andesite. The main transverse valley in the district thus follows a marked and ancient zone of weakness.

Of the gaps determined by the presence of decomposed basic dykes we have already indicated that that between Mts. Cobla and Sugarloaf is the most marked. To the same cause, however, must be assigned the form of Duri Peak, a striking landmark seen from most points between Barraba and Hanging Rock (*see* Text-fig. 3). A decomposed basalt dyke crosses the ridge between the two summits, and may be traced down either side. Though only a few feet wide, it has in all probability determined the depression in the ridge between the summits



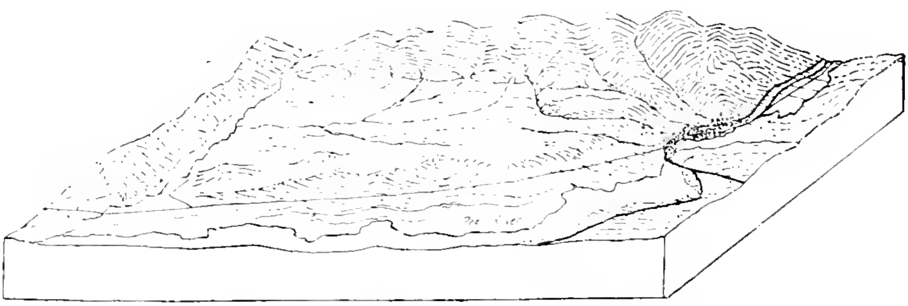
Text-fig. 7. Block diagram of Rocky Creek Valley.

There are, however, other peculiarities of the courses of streams which do not appear to be referable to either of these causes (*see* Text-fig. 7). The eastern branch of Rocky Creek, for example, rises on the upper surface of the very resistant Main Felspathic Grit, and owing to monoclinal shifting (in Gilbert's sense, 27), the upper part of its course, which approximately follows the strike, has been moved down to the western edge of the dip-slope of felspathic grit. The easterly scarp of this dip-slope is very steep, but the stream, a mile from its source turns back across the line of the highest ridges and for half a mile flows along a niche cut in the scarp slope, before again turning at a sharp angle, and returning through a deep gorge to the upper surface of the dip slope once more, down which it continues for the remainder of its course. Though no sign of fracturing has been observed along the course of this lower gorge through the main grit, the approximate collinearity of a fault through the andesite in Sandy Gully, the gorge in question, and the most important tributary to Anstey's Creek, may be not without significance.

We may compare with this the course of Upper Currabubula Creek, from the western side of the main andesite sill through to the eastern, where it is separated by a very low divide from the head-waters of the tributaries of the Peel River, which it might be expected to join, but instead of so doing, it returns through the gap in the andesite-sill and flows north-westwards across the hard Kuttung rocks. Similarly, the western branch of Rocky Creek continues approximately along the dip slope of a band of (glacial?) conglomerate in the upper portion of the Kuttung Series, and is very little entrenched therein, but just where it would be expected to follow the natural slope down into Anstey's Creek it turns at a right angle, forming a small gorge through the conglomerate, to join the eastern branch described above. Again, there is the little gorge in which the western head-waters of Turi Creek cut across the mass of pyroxenic andesite. Also, the passage of Werrie's Creek through Kuttung rocks at the Gap to the west of the township, rather than southwards along the soft Werrie lavas in the depression followed by the railway line, is apparently a striking instance of the want of adjustment of streams to structures.

These features suggest that the present drainage scheme is a super-imposed drainage, now greatly modified by adjustment to structures through perhaps several cycles of change, an idea for which the writer is indebted to Mr. W. R. Browne. The presence of the *Glossopteris* sandstones at Werris Creek and in several other districts to the south and north, and again of Permo-Carboniferous marine rocks, and *Glossopteris* beds near Bowling Alley Point (25), both infaulted outliers, renders it probable that the intervening area was at one time covered by Permo-Carboniferous or Permian strata lying perhaps unconformably upon the Devonian and Carboniferous rocks. These have been almost completely removed and the original valley system existing on these rocks has been superposed upon the underlying complex of varied rocks. The extent to which the present drainage bears sign of its ancestry depends upon the ease of erosion of the rocks upon which the drainage was superposed. In the Tamworth Plains, carved out of yielding Barraba and Burindi mudstones, a high degree of maturity has been reached and a thickness of two thousand feet of sediments may have been removed from the greater part of the area. Where more or less resistant rocks occur they have been brought into greater or less relief, notably at Round Mountain, nine miles south of Tamworth, which is composed of a hard tuffaceous conglomerate (26) and rises several hundred feet above the plain. It is also the case in the Liverpool Plains where the underlying structures seem to have been more uniformly weak, and the base-levelling is more complete. But in the intervening zone the valley systems superimposed on the diverse structures have retained their position to a varying degree on the hard structures, though modified by monoclinal shifting and the more rapid development of valleys on the softer structures.

This suggestion must be considered in connection with that of the eastern margin of the Tamworth Plains, the discussion of which has been postponed until this region should be studied. Reference should be made for this to the topographic maps in the writer's previous papers (26) (28) (29) and to Text-fig. 9 herewith. The Moonbi Ranges to the north and south of Tamworth rise up from the Tamworth Plains to a level of about three thousand five hundred feet, rising to the south to four thousand feet, as about Hanging Rock. They are composed of the resistant jaspers and cherts, the altered equivalents of the Lower Tamworth (Middle Devonian) claystones and tuffs with perhaps older rocks

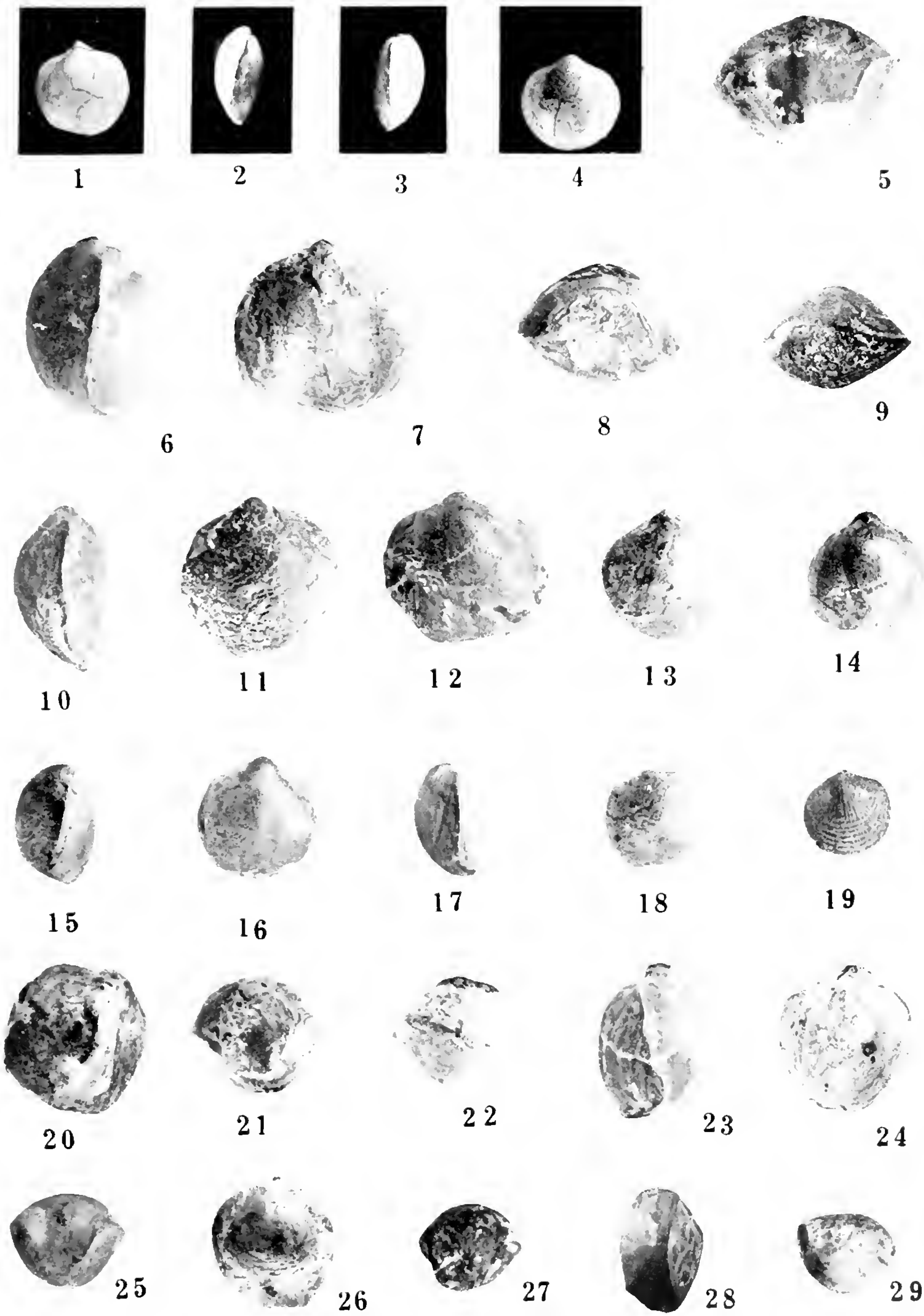


Text-fig.8. Block diagram of the Tamworth District.

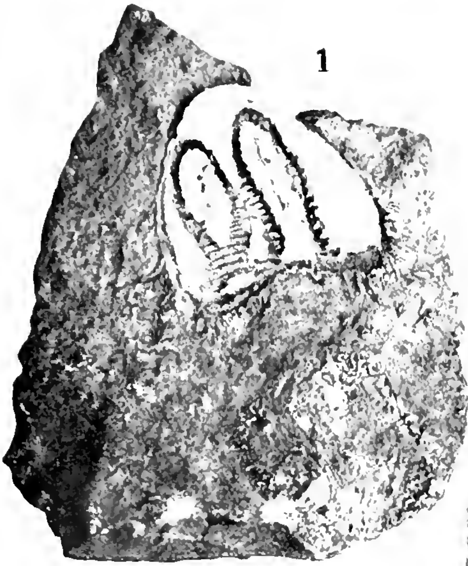
grouped together as the Eastern Series. West of them there is the zone of unaltered Tamworth rocks of less hardness, passing still westward into the Barraba series of mudstones with resistant tuffs. This forms the zone of foothills of the Moonbi Range, and in these differential erosion has had a considerable effect. In the series of hills in the Loomberah District, in which the ridges of harder rock reach a level approximating to three thousand feet, we may see the greatly dissected remnants of the plateau that once extended across to the Currabubula region, where again the resistant hills rise to a comparable general level.

The course of the Peel River is of special interest. It rises in two main head streams, Wombramurra Creek and the Peel River itself, which flow for the most part over the soft Barraba mudstones, the latter in a very open valley. This closes north of Nundle as the harder cherts of the lower portion of the Tamworth Series are encountered, and beyond the valley passes between steep rough hills, through the jasperoid rocks of the eastern series from Bowling Alley Point to Piallamore, but returns once more to the softer rocks of the Tamworth Series, and thence on to the Barraba rocks of the Tamworth Plains. This also may perhaps be an example, on a grand scale, of a superimposed river.

But this does not exhaust the variety of physiographic interest of this region. The small area lying between the Peel River and a line running north-north-westward from Tamworth to Moore Creek (29) has many of the features of a tilted block (*see* Text-fig. 8). A very mature aggraded surface slopes from the



Atrypidae of New South Wales.



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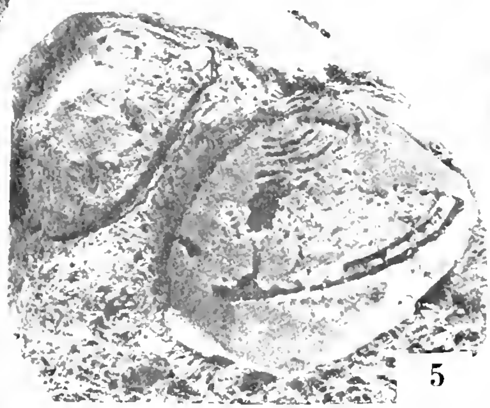

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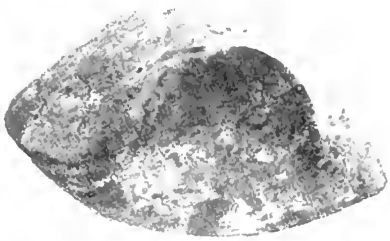

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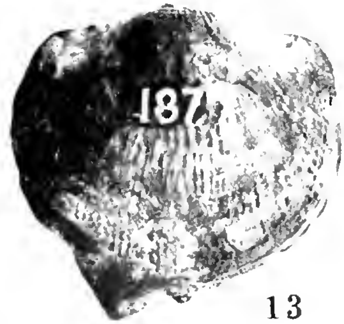

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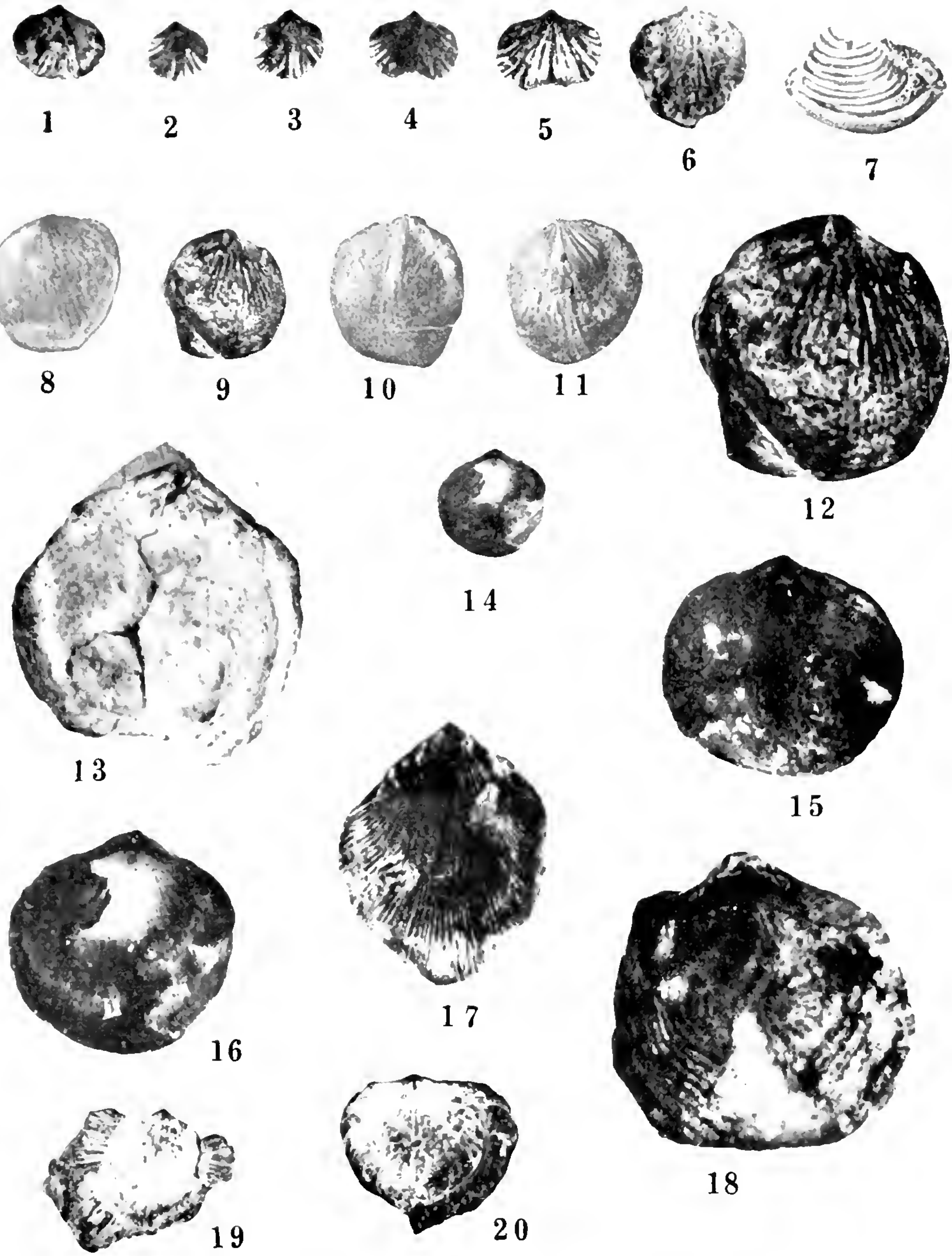
Atrypidae of New South Wales.



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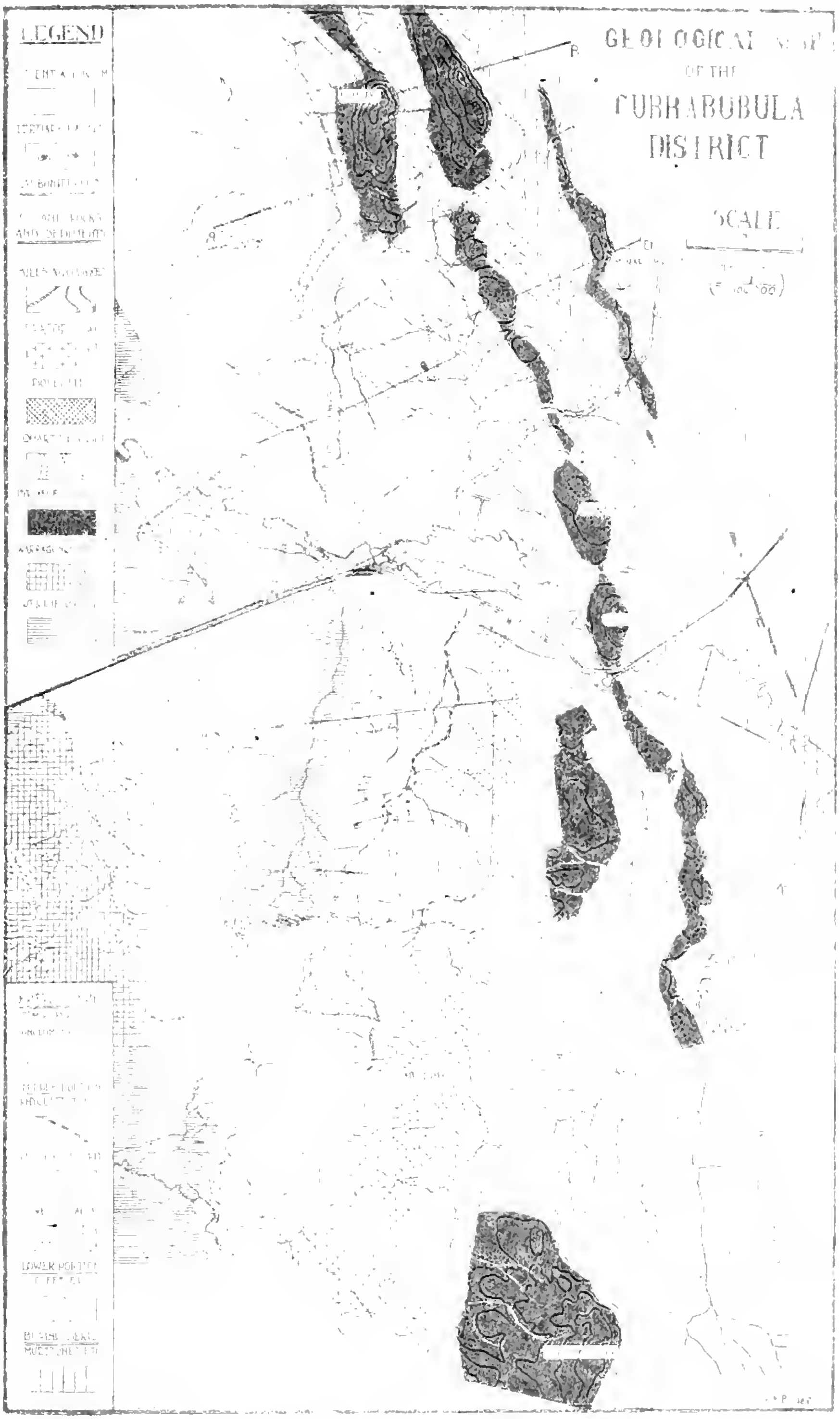
LEGEND
GEOLOGICAL MAP
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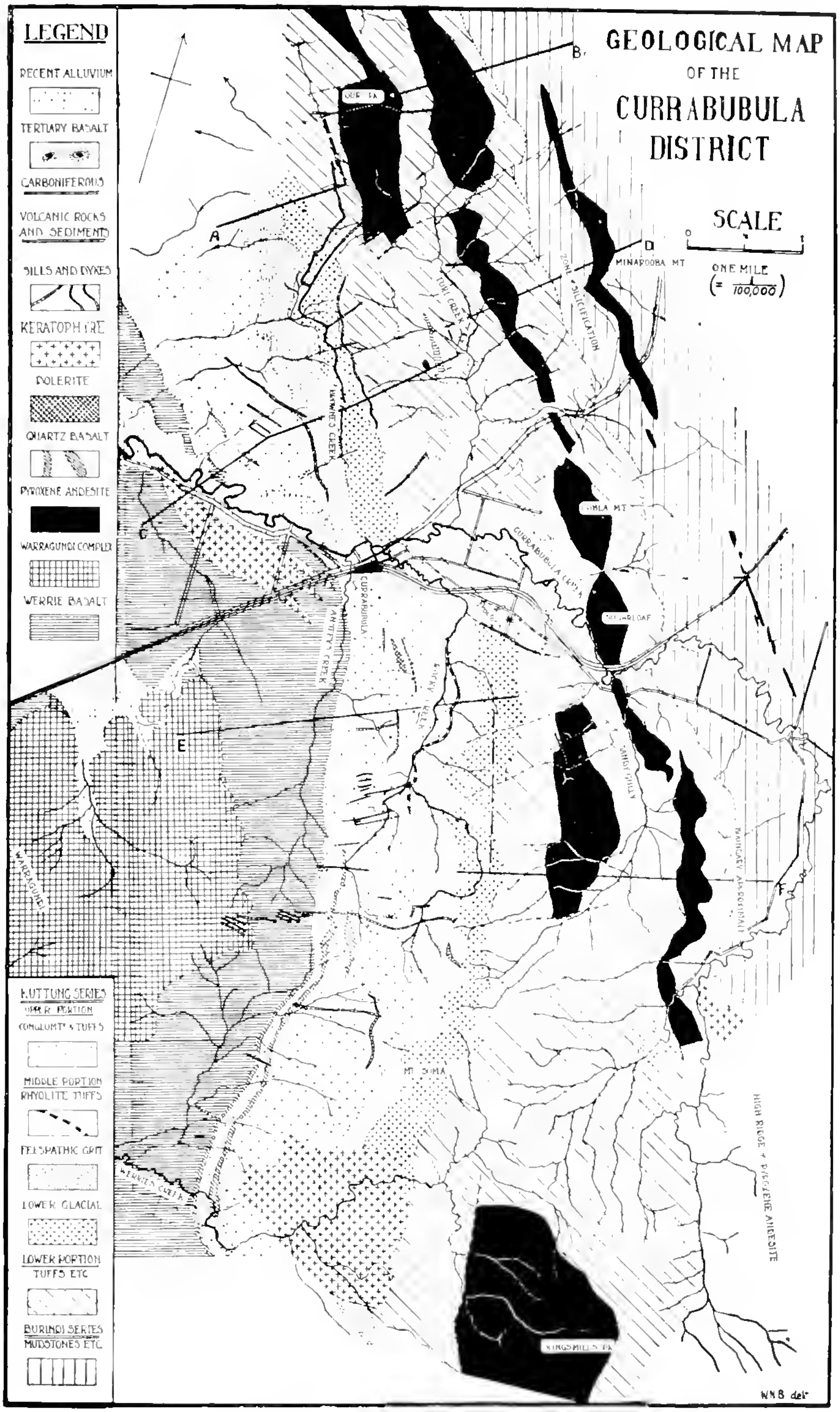

Geological Map of the Currabubula District.

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29. ———Part ii., *Ibid.*, xxxviii., 1913, pp. 569-596.

29*a*. ANDREWS, E. C.—The Geographical Unity of Eastern Australia. Proc. Roy. Soc. N.S.W., xliv., 1910, pp. 420-480.

29*b*. ———Notes on a Model of New England. *Ibid.*, xlvi., 1912, pp. 143-155 (and several other papers by the same author).

EXPLANATION OF PLATES XVII.-XVII*a*.

Plate xvii.—Geological Map of the Currabubula District.

Plate xvii*a*.—Topographical Map of the Currabubula District.

ORDINARY MONTHLY MEETING.

25th August, 1920.

Mr. J. J. Fletcher, M.A., B.Sc., President, in the Chair.

Mr. Norman Bartlett Friend, 42 Pile Street, Dulwich Hill, was elected an Ordinary Member of the Society.

The President made regretful reference to the death of Mr. F. M. Clements, who had been a member of the Society since 1911.

The Donations and Exchanges received since the previous Monthly Meeting (28th July, 1920), amounting to 2 Volumes, 49 Parts or Nos., 2 Bulletins, 1 Report and 2 Pamphlets, received from 45 Societies and Institutions and one private donor, were laid upon the table.

NOTES AND EXHIBITS.

Mr. T. Steel exhibited a portion of the liver of a domestic fowl showing a common pin one inch in length embedded in the liver substance. Both ends of the pin projected for several mm., and were enveloped in liver tissue, the head and point being distinctly outlined. The pin must have been swallowed and then worked its way through the tissues until it became fixed in the position found. Mr. Steel mentioned having been shown the crop of a domestic duck which was crammed with common pins picked up by the bird when running about a back verandah where dressmaking was going on.

Mr. W. W. Froggatt exhibited specimens of the larva of the Cup moth (*Apoda xylomeli*) on a Waratah from Sydney.

Miss V. Irwin Smith exhibited a female specimen of the common "bag moth" (*Metura elongata* Saunders), and gave an account of its observed method of progression up a vertical pane of glass. In climbing it clung to a narrow transverse bar of silky threads by its forelegs, while it spun a similar bar about half an inch higher up, and in two hours spun over 80 rungs and climbed a vertical distance of four feet. Each rung was composed of 7 or 9 strands, the rung always being commenced on the right side and finished on the left. The threads are not sticky, but each is glued down securely at both ends by some adhesive substance.

Mr. W. F. Blakely exhibited specimens from the National Herbarium of *Eupatorium glandulosum* H.B. et K. in Nov. Gen. et Sp., 1820, iv., 122, t. 346, and *Crepis setosa* Hall f. in Roem. Arch., i., 2, 1. The first is a native of Mexico, and is a garden escape, which appears to be well established in several places in the Port Jackson district, namely -Neutral Bay (J. White); Parramatta River near Gladesville bridge; Lane Cove River, Killara; head of salt water, Lane Cove River; between Marsfield and Epping (W. F. Blakely).

On the Lane Cove it is firmly established, and vegetates freely amongst the native vegetation, the moist loamy banks corresponding to some extent to the moist plateaus of its native environment, except that in its native country it thrives at an elevation from 5000 to 8000 feet, while here it flourishes at sea level, and appears to be sufficiently stable to be considered a naturalised alien. It is depicted in the Botanical Register t. 1732.

Crepis setosa is a native of Europe and Asia Minor, and is now recorded for the first time for Australia. Several plants were found growing in a lane off Florence-street, Hornsby (W. F. Blakely). In New Zealand it is classed as a roadside weed. For a ready reference to the description, see Hooker's Students' Flora of the British Isles, p. 228.

Mr. A. A. Hamilton exhibited a seed of *Butia yatay* Becc. (*Cocos yatay* Mart.), grown in the Sydney Botanic Gardens by J. H. Camfield, which had produced twin seedlings. Worsdell (Prin. of Plant Terato., 1, pl. 9) figures twin seedlings in the "Desert Rod" *Eremostachys laciniata*, and attributes the dichotomy (p. 94) to fasciation. Patterson (Journ. of Heredity, x., 350) figures an example of polyembryony in the "Mango," *Mangifera indica*, showing a series of seven seedlings arising from a single seed. The occurrence of twin stems in a seedling of *Acacia juniperina* has been noted by Mr. R. H. Cambage (Journ. Roy. Soc. N.S.W., xlix., 93.)

Mr. Fletcher exhibited a stunted branch of *Eucalyptus saligna* with a cluster of about thirty-five four-pronged female galls of the Coccid, *Brachyscelis munita* Schrader, together with numerous grouped or single male galls. One horn of one of the female galls, about 13 inches long, carries a small female gall.

A LIST OF THE SPECIES OF AUSTRALIAN CARABIDAE WHICH RANGE BEYOND AUSTRALIA AND ITS DEPENDENT ISLANDS.

By Thomas G. Sloane.

Only synonymy that is new is given, but occasionally references are given for species which have been generally known under a name that now has to be discarded in order that the evidence for the unfamiliar name may be easily found. The date of each name cited is given, so that, if it be not found in existing catalogues, it may be traced in the literature of the year given for its appearance.

Clivina australasiae Bohemann (1858).—Australia, New Zealand, Lord Howe Island.

Clivina dilutipes Putzeys (1868).—Australia, New Zealand.

Clivina ephippiata Putzeys (1867) [= *C. felix* Sloane, 1896 = *C. eximia* Sloane, 1896].—Having seen specimens from Java, and having obtained many more Australian specimens, chiefly from tropical Australia, I have no hesitation in placing my species *C. felix* and *C. eximia* under *C. ephippiata* as synonyms. The differences on which I relied to separate *C. felix* and *C. eximia* were not of specific value.—Australia, Celebes, Java.

Calosoma oceanicum Perroud (1864) [= *C. walkeri* Waterhouse, 1898].—Both *C. oceanicum* Perr., and *C. walkeri* Waterh., are known to me, but I cannot differentiate them. I brought this opinion before Mr. H. E. Andrewes, of London, and, after looking into the matter, he has written to me that he concurs in this synonymy.—Australia, New Caledonia.

Gnathaphanus licinoides Hope (1842) [= *Catadromus? impressus* Montrousier 1860; = *Harpalus alternans* Castelnau, 1868. *Cf.* Andrewes, Trans. Ent. Soc. Lond., 1919, p. 202].—Australia, New Guinea, New Caledonia.

Gnathaphanus philippensis Chevrolet (1841).—Australia, Malay Archipelago, S.E. Asia.

Gnathaphanus impressipennis Castelnau (1868).—Australia, New Caledonia, New Guinea, Sumbawa.

Diaphoromerus melanarius Dejean (1829).—I now restrict the genus *Gnathaphanus* to species having at least the third interstice of the elytra plurípunctate, and for that reason amongst others, refer *Harpalus melanarius* Dej. to *Diaphoromerus*.—Australia, New Caledonia.

Hypharpax australis Dejean (1829).—Australia, Lord Howe Island.

Pachytrachelus oblongus Dejean (1831).—I have received specimens of this species from the National Museum, Melbourne, ticketed Oenpili, N. Territory.—Australia, Malay Archipelago, India.

Amblystomus metallicus Blackburn (1887).—A specimen which I cannot differentiate from *A.* (*Thenarotes*) *metallicus* Blackb. was in the Van der Poll Coll. as from Sumbawa.—Australia (widely distributed), Sumbawa.

Amblystomus indicus Nietner (1858).—Mr. A. M. Lea sent me specimens ticketed Dalby, Queensland, which agree so well with Nietner's description of *A.* (*Megaristerus*) *indicus* that I am compelled to regard it as that species. Mr. H. E. Andrewes has sent me an Indian specimen under the name of *Amblystomus guttatus* Bates (1873) which is conspecific with the Queensland species.—Australia, Asia, Ceylon.

Amblystomus stenolophoides Nietner (1858).—Mr. F. P. Dodd sent me a species from Kuranda, Queensland, which agrees so well with Nietner's description of *A.* (*Megaristerus*) *stenolophoides* Niet., that I identify it as that species.—Australia, Ceylon.

Stenolophus smaragdulus Fabricius (1798).—Mr. H. E. Andrewes has recently published the synonymy of this species (Trans. Ent. Soc. Lond., 1919, pp. 178, 189). He reported the 5-spotted form, *S. quinque-pustulatus* Wied., as occurring in Queensland; it has been sent to me from Kuranda by Mr. F. P. Dodd.—Australia, Malay Archipelago, Asia.

Stenolophus dingo Castelnau (1868) [= *S. robustus* Sl. 1907].—When I described *S. robustus* I believed *S. dingo* to be conspecific with *S.* (*Acupalpus*) *piceus* Guer., but, having since received what I now consider to be the true *S. dingo* from N. Queensland, I believe my species to be the same as Castelnau's. The description of *S.* (*Amphibia*) *pallipes* Perroud (1860), is useless, but I believe it to be the same as *S. dingo*; the name *S. pallipes* was already in use in 1860, so Fauvel in 1882 proposed *S. grandiceps* to replace it, but, if I am right in my surmise as to its identity with *S. dingo*, this name was not required.—Australia, New Guinea, Java, (?) New Caledonia.

Bembidium opulentum Nietner (1858) [= *B. europs* Bates 1886 = *B. riverinae* Sloane 1894]—Mr. H. E. Andrewes has published the opinion that *B. opulentum* Niet. is the same thing as *B. europs* Bates (Ann. Mag. Nat. Hist., 1919, p. 472); I believe there is no doubt but that he is right in this. He sent me a specimen of *B. europs* which showed me that my *B. riverinae* was the same species. From Fauvel's treatment of his *B. hamiferum* (1882) in his Faune Analytique des Coléoptères de la Nouvelle-Calédonie (1903), it would appear as if it would also prove to be *B. opulentum*.—Australia (widely distributed), Sumbawa, Java, Ceylon, Southern Asia.

Tachys triangularis Nietner (1858).—Australia, New Caledonia, Malay Archipelago, Asia, Africa.

Limnastis pilosus Bates (1892) [= *Tachys setiger* Sloane, 1903].—After seeing specimens from Borneo, I have no hesitation in placing my *Tachys setiger* as a synonym of *L. pilosus* Bates.—Australia, Borneo, Burma.

Coelostomus picipes Macleay W.S. (1825).—Mr. H. E. Andrewes has gone very fully into the synonymy of this species;* it has been reported as having been found at Mount Ernest, Queensland, by d'Albertis (*teste* Chaudoir, under name of *Stomonaxus striaticollis* Dej., Col. Nov., 1, 1883, p. 39).—Australia, Java, S.E. Asia.

Morio longipennis Putzeys (1875).—Australia, New Guinea.

Catadromus tenebrioides Olivier (1790) [= *C. elseyi* White (1859)].—I have specimens from Australia and Java, but cannot differentiate them as separate species.—Australia, Java, Amboyna.

Chlaenioidius prolixus Erichson (1842).—Australia, New Caledonia.

* Trans. Ent. Soc. Lond., 1919, p. 160.

Chlaeniodus mellei Montrousier (1860). *C. herbaceus* Chaudoir (1865), the name usually given to this species, is a synonym.—Australia, New Caledonia.

Cosmodiscus rubripictus Sloane (1907).—A specimen from the Van der Poll Coll., was ticketed "Aru Is."; it agreed so closely with *C. rubripictus* Sl. (though smaller) that it was evidently conspecific.—Australia, Aru Islands.

Colpodes submetallicus White (1846) [= *Platynus marginicollis* Macleay 1871.]—Both *C. submetallicus* Wt. and *P. marginicollis* Macl. are in my collection, but I do not see specific distinctions between them.—Australia, New Zealand.

Colpodes lafertei Montrousier (1860).—Australia, New Caledonia.

Colpodes violaceus Chaudoir (1859).—Australia, New Guinea.

Dicranoncus queenslandicus Sloane. A specimen of this species has been sent to me by Mr. H. E. Andrewes, of London, ticketed Nilgiri Hills, and I have another specimen labelled "Ceylon."

Acphnidius adelioides Macleay (1825).—Australia, Malay Archipelago, Asia

Perigona nigriceps Dejean (1831).—A cosmopolitan species which I have described from Queensland as *P. australica*.

Dicraspeda nitida Sloane (1917). I described this as a species of *Eudalia*, but now consider it to belong to the older genus *Dicraspeda*.—Queensland, Java.

Chlaenius ophonoides Fairmaire (1843).—Australia, New Caledonia.

Chlaenius flaviguttatus Macleay W.S. (1825).—Mr. H. E. Andrewes has recently made known the fact that *C. flaviguttatus* Macl. must replace the more recent name *C. binotatus* Dej. (1826), under which this species has been generally known.—Australia, Java, Sumatra.

Chlaenius maculiger Castelnau (1868).—Australia, New Guinea.

Chlaenius hamifer Chaudoir (1856) [= *C. queenslandicus* Sloane, 1910].—After seeing specimens of *C. hamifer* sent to me by Mr. H. E. Andrewes, I have no hesitation in putting *C. queenslandicus* under it as a synonym.—Australia, Celebes, India

Hololeius nitidulus Dejean (1826).—Australia, Asia.

Catascopus elegans Weber (1801).—This species is widely distributed from Asia to Australia; Chaudoir considered Hope's *C. australasiae* (1842) a variety.

Miscelus morioformis Macleay (1876).—North Australia, New Guinea.

Lebia picipennis Macleay (1871).—Australia, New Guinea.

Celaenephes parallelus Schmidt-Goebel (1846).—Australia, New Caledonia, Malay Archipelago, S.E. Asia.

Dolichoctis tetrastigma Chaudoir (1869).—Australia, New Guinea, Celebes.

Phloeodromius plagiatus Macleay (1876).—Australia, New Guinea.

Pentagonica olivaceus Chaudoir (1877).—I obtained in the grass beside the margin of a small creek near Brisbane, one specimen of a species which I identify from the description as *P. olivaceus* Chaud.—Australia, New Caledonia.

Creagris labrosus Nietner (1858).—Australia, Java, Siam, Ceylon.

Agonochila binotata White. I cannot differentiate from one another, specimens of this species from New Zealand and Tasmania.

There are three exotic species, unknown to me in nature, which seem to resemble their nearest Australian congeners so closely that I believe there is a great probability of their being identical; comparisons certainly require to be made, as indicated below, before their validity as species can be recognised as absolutely settled.

Stenolophus sexualis Fauvel (1882), N. Caledonia, with *S.* (*Acupalpus*) *piceus* Guerin (1831), Australia.

Rhytisternus rugifrons Brown (1880), N. Zealand, with *R. miser* Chaudoir (1865), Australia.

Pentagonica vittata Brown (1880), N. Zealand, with *P. vittipennis* Chaudoir (1877), Australia.

The Carabidae of Tasmania.—Corrigenda.

Some errors escaped notice in my paper on the *Carabidae* of Tasmania, published in Part 1 of the present volume of these Proceedings, pp. 113-178, and attention is now directed to the following:—

Page 113, line 26 of text, *for* stria, *read* interstice.

Page 114. In the figures given the external stria has been omitted.

Page 118, line 27, *for* Australian, 1, *read* Australian 61.

Page 142, line 12, for *P. tasmanica* read *P. tasmanicus.*

Page 152, lines 32 and 33 *for* beside second stria, posterior puncture beside third stria, *read* beside third stria, posterior puncture beside second stria.

ON DENTAL INCRUSTATIONS AND THE SO-CALLED "GOLD-PLATING" OF SHEEP'S TEETH.

By Thos. Steel.

For many years past there have appeared from time to time, in newspapers and magazines published all over the world, statements as to the occurrence of a metallic incrustation on the teeth of sheep. The incrustation in question is usually found more or less thickly coating the sides of the molar teeth, and, being frequently of a shining, yellowish, metallic appearance, has been popularly attributed to gold supposed to have been derived from particles of that metal scattered about the pastures. So deeply-rooted is the popular belief that the incrustation consists of gold, my friend, Mr. J. H. Campbell, informs me that persons have brought jaws of sheep to the Royal Mint, Sydney, with a view to selling them for the supposed adherent gold. Quite recently, it was most confidently asserted by correspondents in *Nature** that the incrustation consisted of iron pyrites, and various fantastic theories were put forward to account for the presence of this substance in such a situation.

In 1905 Professor Liversidge exhibited at a meeting of the Royal Society of New South Wales† part of a sheep's jaw, heavily coated with yellow metallic-looking deposit, and read a descriptive note with a qualitative analysis, clearly showing the true nature of the substance to be a deposit derived from the saliva, and that the metallic appearance was due to the refraction of light by the overlapping edges of the thin lamellae of the deposit. Again, in July, 1905, the same gentleman exhibited and explained the deposit at a meeting of the Sydney section of the Society of Chemical Industry. Similar specimens were exhibited by Horan to the New South Wales Naturalists' Club in 1913.‡

As will be shown in this paper, the presence of such deposits is by no means confined to the teeth of sheep, but is a common occurrence on those of a very large variety of animals, including man. It is, in fact, a dental calculus analogous to those occurring in the urinary tract.

The earliest account of the true nature of dental incrustations with which I have met, occurs in the Annals of Philosophy.§ In the course of a series of articles entitled "General Views of the Composition of Animal Fluids," Berzelius gives a correct explanation of the nature of the deposit from human teeth, and his analysis of a specimen, which will be quoted further on.

In 1834, Dr. G. Bennett|| records having observed a layer of "metallic substance" incrusting the teeth of kangaroos, and correctly diagnosed it as "tartar"

*Nature, xcix., 1917, pp.264, 284, 290, 306; c., 1917, p.106.

†Journ. Roy. Soc. N.S.Wales, xxxix., 1905, p.33; also Chem. News, xcii., 1905, p.115; Jour. Soc. Chem. Ind., xxiv., 1905, p.1039.

‡Australian Naturalist, ii., 1913, pp.174, 187.

§Thomson's Ann. Phil., ii., 1814, p.380.

||Wanderings in New South Wales, i., 1834, p.294.

precipitated from the saliva. He mentions its occurrence in the ox and sheep, and remarks that on account of its yellow colour it is frequently mistaken for gold. He quotes the analysis by Berzelius mentioned above.

In a paper published in 1879, "On Macrodontism," N. de Miklouho-Maclay‡ described and figured the huge projecting teeth which he observed in natives of the Taui or Admiralty Islands, and refers to a sketch in *Nature** which he describes, however, as a caricature. In a subsequent paper† he explains that further investigation had shown that he was mistaken in supposing that the projections were due to dental malformation, but that they really consisted of an enormous deposit of "tartar," probably largely due to the habit of these people of chewing betel nut and lime. The deposit could be detached, leaving the teeth quite normal. The late Mr. P. R. Pedley, surgeon-dentist, who examined the deposit, identified it as dental tartar. Unfortunately there is no record of a chemical examination having been made. Miklouho-Maclay proposed the term "odontolithiasis" for this condition.

From the stocks of bones passing through a large bone charcoal factory in Sydney, I have been able to examine the teeth of numerous sheep and also those of oxen, horses, pigs, etc., and to secure ample material for a complete chemical analysis of the deposit from the teeth of sheep and oxen. From other sources I have obtained sufficient for quantitative analysis from the teeth of a number of animals, including man. By the courtesy of the late Mr. R. Etheridge, specimens from the teeth of animals in the Australian Museum, Sydney, were secured, sufficient in a few cases for full analysis, and in a considerable number of others for qualitative determination. Mr. H. A. Longman, F.L.S., Director of the Queensland Museum, kindly allowed me material from the skeleton of a camel. In all such cases care was taken to insure that the deposit obtained was pure and not contaminated with lime which may have been used in the preparation of skeletons.

Very commonly the taxidermists appear to have carefully cleaned the teeth. My kinsman, Mr. A. Ross Brown, B.D.Sc., L.D.S., of Windsor, Melbourne, and my friend, Mr. J. Darton, surgeon dentist, Petersham, furnished me with an ample supply from human teeth, secured in the course of their professional practice in the operation of "scaling." Mr. Charles Hedley, Acting Curator of the Australian Museum kindly gave me facilities, with the aid of Messrs. Thorpe and Troughton, to examine the large collection of skulls in the Museum. To Professor J. Douglas Stewart, of the Veterinary School, Sydney University, I am indebted for explaining to me details regarding the structure of teeth and giving me other information. To all of these gentlemen I desire to tender my best thanks. Further material was obtained from specimens in my own collection and passing through my hands. In addition to examining the dental deposit, I have, in the cases of the ox and camel, made an analysis of the cement or cementum layer (*crusta petrosa*). In these animals this layer is strongly developed, extending well up on the exposed part of the tooth, and can be readily separated. The incrustation could, in most cases, be easily flaked off from either the cement or the enamel and the surface beneath was always quite sound.

The figures following give the results. The samples were ground, and air-dried at ordinary temperature.

‡Proc. Linn. Soc. N.S. Wales, iii., 1879, p.169.

*Nature, xvi., 1877, p.251.

†Proc. Linn. Soc. N.S. Wales, x., 1886, p.682.

ANALYSES OF DENTAL INCRUSTATIONS.

	Man	Sheep	Ox	Camel	Dromedary	Rhinoceros	Babirussa	Cement layer (*Crusta petrosa*) Ox	Cement layer (*Crusta petrosa*) Camel
Lime (CaO)	40·75	28·00	29·38	37·75	37·00	46·13	47·50	35·69	36·21
Magnesia ($Mg\,O$)	0·18	4·19	3·69	0·27	0·18	0·56	0.68	1·12	0·98
Phosphoric oxide (P_2O_5)	34·73	26·55	28·17	29.33	29·48	7·95	7·14	26·68	26·88
Carbon dioxide (CO_2)	1·32	1·45	1·10	2·70	2.88	22·65	41·63	2·90	1·80
Organic matter*	17·23	24·65	23·90	16·20	16·82	17·48		23·54	24·74
Water at 110° C.	5·38	11·03	10·30	11·65	10·40	3·85	2·63	9·35	8·66
Sand	0·10	2·30	2·00	0·60	0·30	0·55	0·39	nil	nil
Undetermined and loss	0·31	1·83	1·46	1·50	2·94	0·83	0·03	0·72	0·73
	100·00	100·00	100·00	10·000	100·00	100·00	100·00	100·00	100·00
*Containing nitrogen	1·20	1·48				0·74			
Sp. Gr.	2·317	2·025						2·112	

Miklouho-Maclay mentions that specimens of teeth similarly incrusted to those which he describes were forwarded by F. A. de Roepstorff from the Nicobar Islands to Professor Virchow, Berlin.† The deposit from these was analysed by Salkowski, and the results published by Virchow, the following being the figures:—

Water	5.95
Organic matter	9.10
Silica and iron oxide	.87
Iron phosphate	2.26
Lime	45.24
Magnesia	.68
Phosphoric oxide	30.73
Carbon dioxide	4.87
	99.70

This shows more lime and carbon dioxide and considerably less organic matter than I found in the normal incrustation from human teeth. Probably this is a result of the addition of carbonate of lime from the lime-betelnut habit, but the high phosphoric acid shows that essentially the deposit has been derived from the saliva. The presence of so much iron phosphate is peculiar, and I am unable to explain it. I found no appreciable iron in any of my samples.

The analysis by Berzelius mentioned above, is thus stated:

Earthy phosphates	79.0
Mucus	12.5
Peculiar salivary matter	1.0
Animal matter soluble in muriatic acid	7.5
	100

There is no mention of water. It is probable that Berzelius merely ignited and took the ash as "earthy phosphates," and the organic substances include water. For a rough comparison it will suffice to consider the "phosphates" as being tribasic phosphate of lime and to lump together the organic substances. This would give:—

†Verh. Berlin. Ges. Anthrop., June, 1881, p.219.

Lime	43.
Phosphoric oxide	36.
Organic matter and water	21.
	100.

These figures agree very well with my analysis of the human product. In my examination I found the total loss on ignition, including water and carbon dioxide, was 24 % and the ash 76 %.

In my analysis, in every case the sand was in the form of mechanically embedded grains. It will be noticed that the incrustations from the Rhinoceros and Babirussa (a pig-like animal from N. Celebes) differ from the others in containing but little phosphoric acid and a considerable proportion of calcic carbonate. In both of these the scale, when detached, was in appearance much like that from the sheep and ox, being in clean shining flakes. In man it is chalky-looking and has not got the metallic, or more commonly, nacreous look of that from the sheep. The similarity in composition between most of the incrustations and that of the cement layers of ox and camel is striking. Ordinary mammalian bone has also a very similar composition.*

In making the analyses, care was taken in separating lime and magnesia, by double precipitation of the lime in the cold to avoid co-precipitation of magnesia. The proportions of lime and phosphoric acid present are such as to indicate that the phosphate of lime does not exist entirely as the tribasic ($Ca_3 P_2 O_8$), but that a variable amount of the tetrabasic ($Ca_4 P_2 O_9$) is also present. I have found this to be a usual condition in many natural phosphates such as those from Ocean Island.

Bearing in mind the analogy between these dental salivary incrustations and urinary calculi, a careful examination was made of those from man, sheep and ox for oxalic and uric acids, but with entirely negative results.

I have examined the deposit from a large variety of animals in addition to those already mentioned, using micro-chemical methods when the amount available was minute, and in every case have found it to be of substantially the same nature. The quantity present varies from a mere trace of brown film, to a heavy incrustation packed round the crowns of the teeth and forming a continuous coating along the sides as much as a quarter of an inch in thickness. It is heaviest in herbivorous animals and in man. The teeth of the carnivorae and rodents are usually very clean; this is well seen in dogs, cats, mice and rats, though all of these, particularly when old, and also rabbits, frequently have a thin brown film even on the incisors. Some individuals are more predisposed to dental incrustation than others. This is well-known in man, and I have noticed it in sheep and other animals. The teeth of snakes, lizards and fish in so far as I have noticed, appear to be always quite free from deposit.

I do not think that the nature of the pasture, as has sometimes been asserted, has anything particular to do with the abundance or otherwise of the deposit on sheep's teeth, but that it is purely a physiological idiosyncrasy. Sheep and oxen very commonly have the teeth coated with a uniform, thin, dead black film, but this does not differ in composition from the thicker deposit. The common pig has very clean teeth. I have examined many hundreds of pigs' jaws, and have never noticed more than traces of a brown film.

*Watt's Dict. Chem., vi., 1879, 1st. Supp., 357.

Extended observation has satisfied me that the incrustation, in greater or less degree, is common to all mammals, and also to a number of other animals, in every case being of the same general character. I have found it, for instance, in the crocodile (*C. porosus*) Queensland, killer whales (*Orca gladiator*), and in one individual or another of practically every mammalian species examined. It will suffice to give the names of a few as indicating the scope of the investigation: Tapir, eland, American bison, hippopotamus, various bears, dog, cat, rat, mouse. Examination of the skulls of marsupials in the Australian Museum collection and elsewhere disclosed numerous examples: *Macropus major*, quite as heavy as that of the sheep, *M. giganteus*, *M. rufus*, *Phascolarctus cinereus*, *Phascolomys mitchelli*, *Dasyure*, and many others. The original observations of Dr. Bennett are thus completely confirmed. Fossil marsupial teeth from Wellington Caves, New South Wales, in the Australian Museum, still have adhering brown patches which I take to be the same deposit. Wherever the teeth of animals were noticed to have a yellow or brownish tint as in aged rats, minute examination showed this to be due to the same cause.

In response to queries from me, Mr. Brown has supplied me with the following very interesting notes:- "Tartar forms on artificial *plates*, especially lower plates, quite as readily as on the natural teeth; it is an everyday occurrence to see that. It is deposited along the lower portion of the lingual side of the *plate*, and dentists are continually asked by patients what it is and how to remove it. I do not remember seeing teeth forming part of a bridge with tartar deposited on them, but frequently find that the gum having slightly receded after the bridge has been fixed a slight deposit is to be seen round the gingival margin of the natural roots to which the bridge is attached. Porcelain crowns (pivots) and gold crowns or caps remain free from deposit. I once had to remove from an elderly woman's mouth a little lower plate having three teeth on it, and there was such an accumulation of tartar all about the whole structure and the remaining teeth that two of the latter were extracted in the removal of the plate; these, however, were loose from pyorrhoea. In this case the tartar had certainly encroached to some extent on the artificial teeth. The patient informed me that she had not removed the denture since the dentist put it in place many years before. This case was an exceptional one, and as I have mentioned, I do not remember seeing deposit on artificial teeth at any other time."

I think it is probable that the nature of the surface of porcelain teeth and gold crowns inhibits the adhesion of deposit. In the case of the urinary tract, it is well known that any solid foreign body, such as a piece of broken catheter, soon becomes coated with phosphate, and that a little blood clot or even bacteria may form the nucleus of a urinary calculus.

ON THE STRUCTURE OF THE RESIN-SECRETING GLANDS IN SOME AUSTRALIAN PLANTS.

By Marjorie I. Collins, B.Sc., Linnean Macleay Fellow of the Society in Botany.*

(With Text-figures 1-12.)

Introduction.

While engaged upon an investigation of the resinous secretion of the bud in certain Australian genera of the Natural Orders *Sapindaceae*, *Leguminoseae* (Sub-Order *Mimoseae*), *Compositae*, *Goodeniaceae* and *Myoporineae*, the writer's attention was drawn to certain types of glandular hair, some of which have not been recorded previously for these Orders.

Since in all cases the developmental stages throw an interesting light upon the structure of the mature gland, and since the results obtained might prove to be of systematic value, it is thought desirable to place these observations on record.

Glandular hairs are described for the following species:—*Dodonaea viscosa* Linn. (*Sapindaceae*), *Acacia rupicola* F. v. M., *A. armata* R Br., *A. pycnantha* Benth., *A. verniciflua* Cunn., (*Leguminoseae*, Sub-Order *Mimoseae*), *Ixodea achilleoides* R.Br., *Helichrysum semipapposum* DeCand., and *Humea cassiniacea* F. v. M. (*Compositae*), *Myoporum serratum* var. *insulare* R.Br., *Myoporum serratum* var. *viscosum* R.Br., and *Eremophila latifolia* F. v. M. (*Myoporineae*).

My thanks are due to Professor Osborne, University of Adelaide, for the interest he has shown during the progress of the work.

Description of Glandular Hairs.

N. O. SAPINDACEAE.

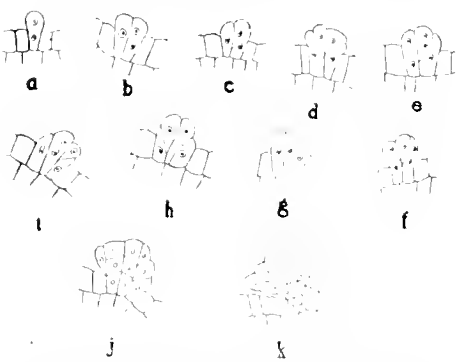
In his account of the *Sapindaceae*, based upon Radlkofer's monograph (2), Solereder states that glandular hairs are widely distributed, and are present on young leaves throughout the order (3, p. 230). The glands are described as being multicellular peltate scales, in which the cells of the shield either show a radial arrangement (*Aratera*), or are polygonal and irregularly placed (*Filicium*, etc.). It is recorded that in some genera, *e.g.*, *Melanodiscus*, the external glands are analogous to glandular shaggy hairs, since they possess a palisade-like secretory region at the periphery.

In *Dodonaea viscosa*, which was examined by the present writer, the glandular hairs resemble the *Melanodiscus* type. They are large in proportion to the thickness of the young leaf, and show a tendency towards radial arrangement of the

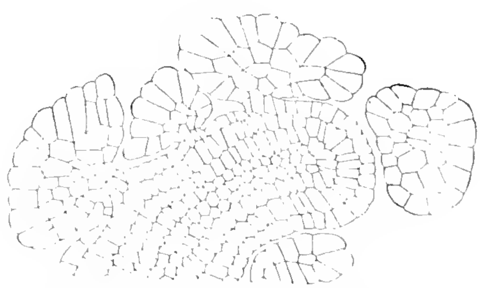
*The observations recorded in this paper were made while the writer held the position of Demonstrator in Botany, The University of Adelaide.

peripheral head-cells. Sometimes this tendency is very marked, giving the gland a colleter-like appearance, while often there is no sign of peripheral elongation, the gland merely being a mass of polygonal cells, irregularly arranged.

Development of the Glands.—The first sign of gland development in *Dodonaea viscosa*, is the projection from the epidermis of a papillose cell which reaches a height of about twice that of the adjacent epidermal cells (Text-fig. 1*a*). The nucleus divides and the first wall is formed in a vertical direction, dividing the initial cell of the gland into two cells of equal size (Text-fig. 1*b*). The second division follows in either of the cells thus formed. The wall is either placed in a slightly oblique position, when the resulting cells are unequal in size (Text-fig. 1*c*) or it may be vertical, when the resulting cells are equal (Text-fig. 1*g*). Whether the mature gland possesses a pedestal region, made up of two or three rows of cells, depends upon the manner in which this second wall is formed in the young gland. From observations on a number of glands it seems probable that there are never more than two vertical divisions in the first stages of development, while in a number of cases there is only one. The vertical divisions are followed by a series of oblique divisions (Text-fig. 1*c-f*, *h-i*), which result in the formation of a projecting cell mass almost spherical in contour (Text-fig. 1*j*). At this stage there is a marked increase in the size of the cells making up the gland. Those at the periphery tend to elongate in a radial manner, causing the differentiation of the gland into marginal and central regions (Text-fig. 1*k*). The mature glands are large peltate hairs which overlap one another and spread out to cover a considerable area of the epidermis (Text-fig. 2). The multicellular



Text-fig. 1. (a–k). Stages in the development of the glandular hairs of *Dodonaea viscosa* Linn. (x 200).



Text-fig. 2. Mature glands of *Dodonaea viscosa* crowded and overlapping on surface of young leaf. Note their height in comparison with thickness of leaf. (x 120).

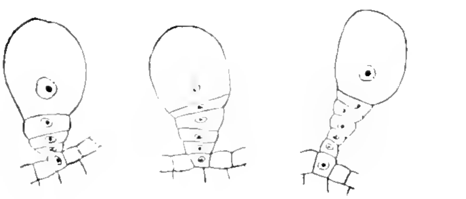
head is borne upon a pedestal of 2 or 3 rows of cells which may become more numerous by later divisions. At maturity the radial elongation of the peripheral cells of the gland is often partly and sometimes totally obliterated by a series of irregular divisions which occur during the later stages of development (Text-fig. 2).

N. O. LEGUMINOSEAE (Sub-order *Mimoseae*).

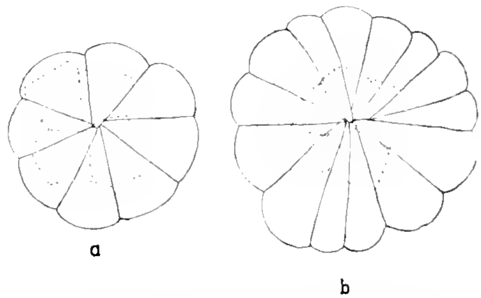
Solereder refers to the constant formation of glandular hairs in the *Mimoseae*. The glands may possess a uniseriate stalk of varying length, with a multicellular head divided by both horizontal and vertical walls, *e.g.*, certain species of *Parkia, Entada, Acacia*, and *Albizzia* (3, p. 296), or the head may be shield-like and consist of two layers of cells (certain species of *Mimosa*). Glands with a short stalk and a few head cells have been observed in *Acacia dodonaefolia* Willd., *A. exsudans* Lind., and *A. leprosa* Sieb. (3, p. 296).

In species of *Acacia*, *A. rupicola* F. v. M., *A. verniciflua* Cunn., *A. armata* R.Br., *A. pycnantha* Benth., found in the neighbourhood of Adelaide, the writer observed four distinct types of glandular hair hitherto unrecorded for the genus *Acacia*.

A. rupicola.—In *Acacia rupicola* the mature gland consists of a uniseriate stalk of from three to six small cells surmounted by a large balloon-like head cell (Text-fig. 3). The cells which make up the stalk are not cut off from the base of the head cell, but are formed by a series of parallel transverse divisions within the stalk rudiment. The head cell appears to be more actively secretory than the stalk cells. The glands of *A. rupicola* differ from the uniseriate type of gland already recorded for species of *Acacia* by Solereder, in that the head is always unicellular; they probably represent a simpler type of gland than any previously recorded for the *Mimoseae*.



Text-fig. 3.—Mature glands of *Acacia rupicola* showing uniseriate stalk of varying length and inflated head cell. (x 230).

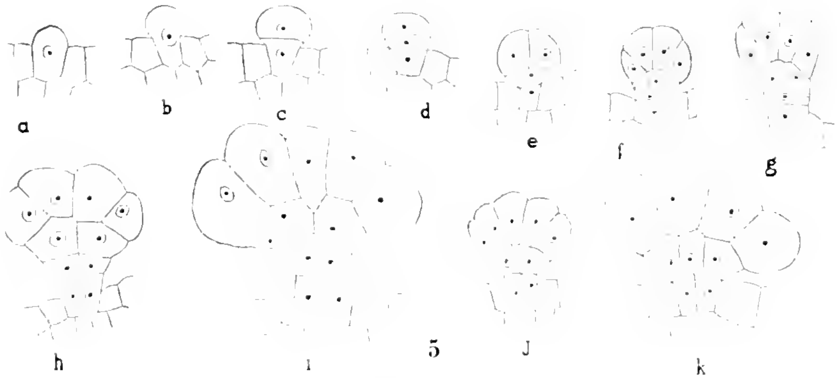


Text-fig. 4. Surface view of glands of *Acacia verniciflua* showing head cells and upper tier of stalk. (x 230).

Acacia verniciflua.—In *Acacia verniciflua* the mature gland resembles the type recorded for species of *Mimosa* with shield-like head and consisting of two layers of cells (3, p. 296). Here the normal mature gland is made up of a large head of from eight to sixteen radiating cells in a single layer, supported by a stalk of one or two rows of cells (Text-fig. 4*a*, *b*). Each row of the stalk normally consists of four cells, but in some cases irregular divisions may occur, converting the stalk region into a mass of cells of variable number.

Gland Development.

After the first horizontal division differentiating the gland rudiment from the epidermis, a second horizontal division parallel to the first separates the head and stalk rudiments (Text-fig. 5*a*-*d*). The third division is vertical in the median plane of the head, and is followed almost immediately by a horizontal division within the stalk, cutting off a second stalk cell (Text-fig. 5*e*-*f*). Further vertical divisions are now formed in the head, many of which are quite radial, others nearly so. Closely following the first of these vertical divisions in the head, two vertical divisions appear bisecting the uppermost stalk cell in planes at right angles (Text-fig. 5*g*). Similar divisions are then formed in the second stalk cell and ultimately in the basal epidermal cell (Text-fig. 5*h*). Owing to the position of the original hori-



Text-fig. 5.- (*a–h*). Stages in the development of the normal gland of *Acacia verniciflua*; *i*, shows commencement of irregular divisions in the upper tier of the stalk; *j*, and *k*, types of gland formed by the omission of the second stalk cell. (x 230).

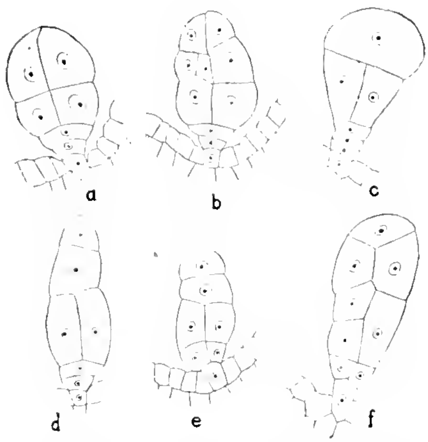
Text-fig. 6 Mature gland of *Acacia verniciflua* in which the two-tiered nature of the stalk has been obliterated by irregular divisions during the later stages of development. (x 230).

zontal division, at a level sometimes above that of the neighbouring epidermal cells, these basal cells often project for some distance, and appear to form part of the gland (Text-fig. 5*h*, *i*, *j*).

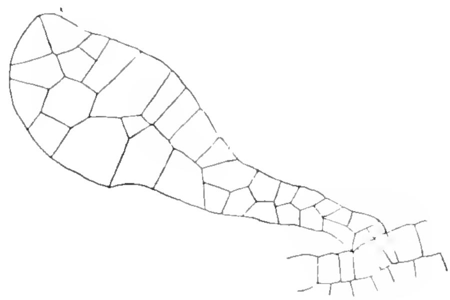
In Text-fig. 5*h* we have what is probably the normal type of gland, in which each tier of the stalk is made up of four cells. Text-fig. 5 *j* and *k* represent a type of gland often met where the second stalk cell has been omitted.

With growth of the gland cells, however, an irregular division often takes place in the upper tier of the stalk which is then made up of five or six polygonal cells, irregularly arranged (Text-fig. 5*i*). When this irregular division proceeds to the second tier of the stalk, the resulting gland becomes more complex, the shield like head being supported by an irregular mass of cells in which all trace of the two-tiered stalk is obliterated (Text-fig. 6).

Acacia armata. During the development of the glandular hairs in *A. armata* there is marked variation in the sequence and number of cell divisions. This variation is accountable for the number of gland forms which are mingled freely on the surface of the young phyllode. These gland forms resemble one another, in that the head is always vertically elongated and never shield-like. What appears to be the normal type of gland is figured in Text-fig. 7*a*. There the head is composed of an octant of cells, and is supported by a short stalk of two cells. The stalk may possess two or three cells (Text-fig. 7*a-c*), but is often absent



Text-fig.7.—(*a-d*). Gland forms of *Acacia armata* in which stalk region is present; *e-f*, types where stalk is absent. (x 200).



Text-fig.8.– Glandular hair from the base of the phyllode in *Acacia pycnantha*. (x 200).

(Text-fig. 7*e-f*). The head in the greater number of glands is characterised by vertical and horizontal divisions which vary in number and sequence (Text-fig. 7*b-e*). Text-fig. 7*f* shows a new type of gland which has arisen by the omission of the divisions giving rise to stalk cells.

Acacia pycnantha.—In *A. pycnantha* the glandular hairs are restricted to a zone at the base of the phyllode. The mature glands are elongated in form, and show no differentiation into head and stalk region. They are multicellular, club-shaped bodies in which both vertical and horizontal walls are formed (Text-fig. 8). These glands are of interest in that they resemble the stalkless type of gland found in *A. armata* (Text-fig. 7*f*), and could conceivably have arisen from this type by the interpolation of further divisions.

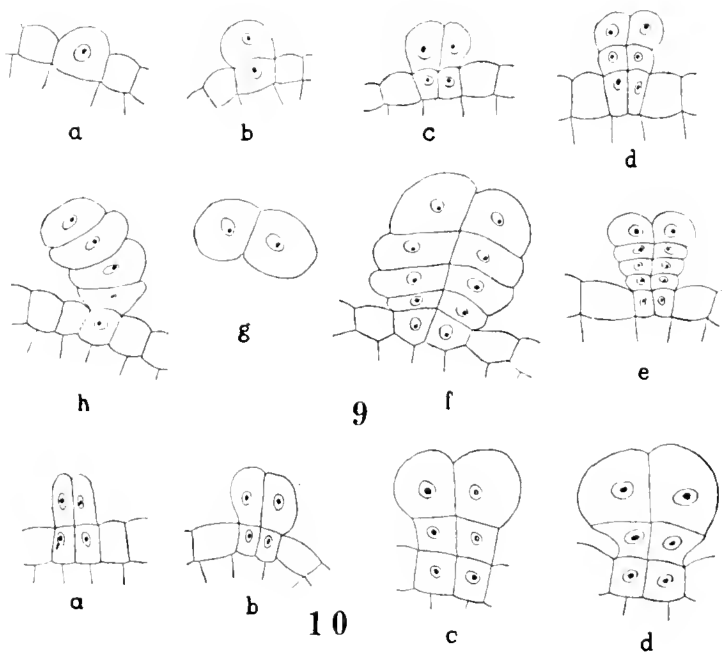
N. O. COMPOSITAE.

Resin-secreting glandular hairs are widely distributed in the N. O. *Compositae*, and have been recorded by various investigators (1, 4, 5, 6, 7). The most common type of gland is shortly stalked and possesses a head divided by a median vertical wall into two rows of cells. These are recorded for species of *Anthemis*, *Baccharis*, *Brachylaena*, etc. (3, p. 460), and have been observed by the writer in *Ixodea achilleoides* R.Br., *Humea cassiniacea* F. v. M., and *Helichrysum semipapposum* DeCand. The glands figured by Vogl for a species of *Chrysanthemum* (*see* 3, i., p. 458, fig. 103*h*, after Vogl), evidently represent a transitional stage between those observed by the writer for *Helichrysum semipapposum* and *Ixodea achilleoides*.

Gland Development.—In these three types the first transverse division which cuts off the rudiment of the gland from the epidermis is followed by a median vertical division in both gland rudiment and basal epidermal cell (Text-figs. 9*a-c*, 10*a-b*). This vertical division is followed by a series of transverse divisions parallel to the first transverse wall formed. In the case of *Helichrysum semipapposum* the median vertical division is followed by one transverse division only. The gland cells then increase in size, the upper pair being markedly inflated (Text-fig. 10 *c, d*). In *Ixodea* and *Humea* there are three transverse divisions following the median vertical division, so that the mature gland possesses two vertical rows, each of four cells surmounting a basal epidermal cell (Text-figs. 9*e-f*). In the glands of a species of *Chrysanthemum* figured by Solereder after Vogl (3, i., p. 458, fig. 103*h*.), only two transverse divisions follow the vertical division.

N. O. MYOPORINEAE.

Glandular hairs are of common occurrence in the two genera of *Myoporineae*—*Myoporum* and *Eremophila*. Solereder states that these glandular hairs possess "varied structure within the individual species, but agree in the fact that the



Text-fig.9.—(*a-f*). Stages in the development of the glandular hairs of *Ixodea achilleoides*; *g*, *h*, surface and lateral views of glandular hairs. (x 280).

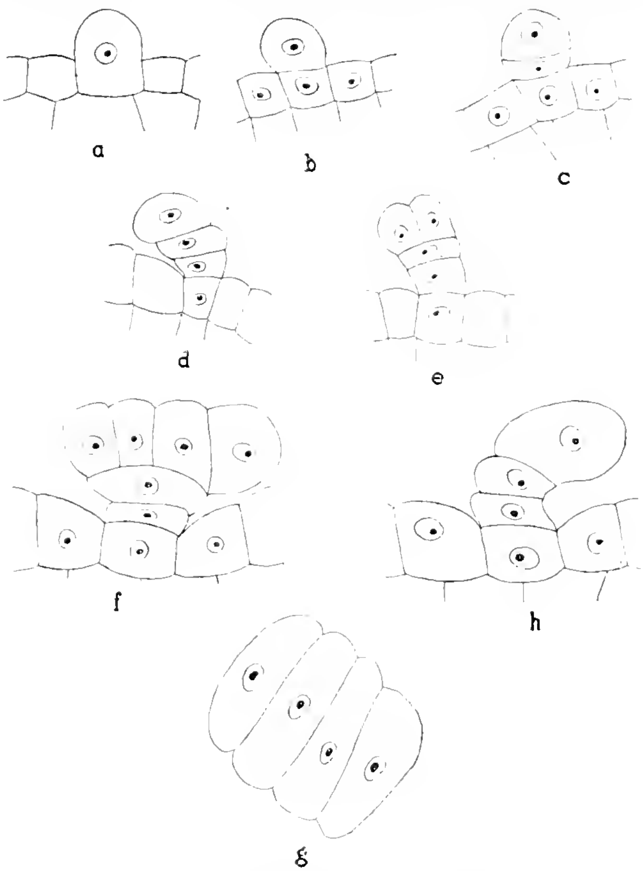
Text-fig.10.—(*a-d*). Stages in development of the glandular hairs of *Helichrysum semipapposum*. (x 280).

glandular head is, in almost all cases, divided by vertical walls only" (3, p. 626). Glandular and clothing hairs are also known to occur in the same leaf-bud, and, according to Solereder, transitional forms of a dual nature are often found (3, p. 627). These facts suggest that glandular hair formation in the *Myoporineae* is in an unstable condition. Observations made by the writer upon gland development in *Myoporum serratum* and *Eremophila latifolia* give additional evidence in support of this view.

The most common type of gland in the *Myoporineae* is that found in species of *Myoporum*, *e.g.*, (*M. serratum* var. *insulare* R.Br., and *M. serratum* var. *viscosum* R.Br.), where a large shield, consisting of four cells in a row, is placed excentrically upon a stalk of two cells.

Gland Development.

Myoporum serratum.—In the initial stages of gland formation a spherical projection from an epidermal cell is cut off from the remaining epidermal cells by a transverse wall (Text-fig. 11*a*, *b*). A second transverse division differentiates the gland rudiment into head and stalk regions (Text-fig. 11*c*). A third transverse division now takes place in the stalk (Text-fig. 11*d*), and is immediately followed by a vertical division in the median plane of the head (Text-fig. 11*e*). The 5th and 6th divisions are also vertical in the head, and parallel to the first head division (Text-fig. 11*f*). Growth of the cells continues after division has ceased.



Text-fig.11.—(*a*–*f*). Stages in the development of the glandular hairs of *Myoporum serratum*; *g*, *h*, surface and lateral views of the glands. (x 280).

In the gland head there is greater growth of the cells to one side causing the eccentricity noted above (Text-fig. 11*f, h*). This unequal lateral growth always occurs in the longitudinal plane of the leaf, and is directed towards the leaf apex. Text-fig. 11*g* shows gland in surface view.

Eremophila latifolia.—In *Eremophila latifolia* the general plan of gland development resembles that of *Myoporum*. Here, however, the head shield is composed of eight cells and shows two distinct forms within the species.

After the differentiation of the young gland into head and stalk region, the first division which takes place is vertical in the median plane of the head. This is either followed immediately by a horizontal division forming a second stalk cell, or the latter is postponed until the later head divisions have taken place. From the number of glands found in which a head shield with full number of divisions is supported by a single stalk cell, it seems probable that this second stalk division is often omitted. The later divisions in the head are all vertical and according to the arrangement of the walls, give rise to two distinct types of head shield.

In one type the vertical divisions are formed in a radial manner and result in a subspherical shield of 8 radiating cells (Text-fig 12*a*). In the other type two sets of parallel or almost parallel divisions meet the original, median vertical

b a

Text-fig.12. (*a–b*). Surface view of the two gland forms of *Eremophila latifolia*. (x 230).

division at approximately equal angles, and result in the formation of a shield of eight cells arranged in two rows of four (Text-fig. 12*b*).

The relation between these types of gland and that of *Myoporum* is obvious. All the gland cells in *Eremophila latifolia* are characterised by the inclusion of a clustered crystal of calcium oxalate.

All text-figures were made at table level, tube at 160 mm., with the aid of Zeiss camera lucida and with Leitz objectives 3 and 6, oculars 2 and 4.

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*The works marked thus were not directly accessible to the writer.

THE GEOLOGY AND PETROLOGY OF THE GREAT SERPENTINE BELT OF NEW SOUTH WALES.

Part IX.—The Geology, Palaeontology and Petrography of the Currabubula District, with Notes on Adjacent Regions.

By Professor W. N. Benson, B.A., D.Sc., F.G.S., W. S. Dun, and W. R. Browne, B.Sc.

Section B.—Palaeontology.

By W. S. Dun, Government Palaeontologist and Lecturer in Palaeontology, The University of Sydney, and W. N. Benson, B.A., D.Sc., F.G.S., Professor of Geology, The University of Otago, N.Z.; formerly Linnean Macleay Fellow of the Society in Geology.

With an Appendix by F. Chapman, A.L.S., Lecturer in Palaeontology, The University of Melbourne.

(Plates xviii.-xxiv.; Text-figures 10-17.)

(i.) Descriptive Portion.

(W. S. Dun and W. N. Benson.)

In the following section we have remarked upon the noteworthy features of all fossils obtained by us from Currabubula and the shelly ridge in the south-east of the parish of Babbinboon, and also the extensive collection from the latter area presented to us by Mrs. Scott, to whom we are greatly indebted. The opportunity has been taken to examine also the undescribed fossils in the collection of the Australian Museum and that of the Geological Survey which were obtained in the region around Carroll, Somerton and Babbinboon, chiefly by Mr. Donald Porter, and the late Charles Cullen. We are thus able to give a list of the known forms, including critical descriptions of five forms previously known in the State but only from provisional determinations, seven new records for the State, and fifteen species and three varieties which we believe to be new. We are indebted to Professor Lawson, D.Sc. and Mr. Chapman for the description of several of the fossils. Apart from the leaf impressions of *Rhacopteris*, *Aneimites* and *Archaeocalamites* in the Kuttung, which do not call for special notice, two silicified plant remains are noteworthy. They were found on the eastern slopes of Mts. Cobla and Sugarloaf, three miles east of Currabubula. Professor Lawson describes these as follows:—"The first is represented by a single specimen about four inches in either dimension; portion of a large stem of gymnospermous wood. The cellular structure shows no sharp definition; the tracheids may be made out rather vaguely, and these are traversed by numerous medullary rays, some of which are several cells in width, others only a single cell. Vague indications of bordered pits appear in the tracheids, but on account of the poor definition of the tracheids themselves, it is impossible to determine how many rows of these are present on the tracheid. From the evidence of their more or less circular outline as seen on the radial wall, one is inclined to the conclusion that there is only a single row of these in each tracheid. The length of a single tracheid cannot be defined."

The second form is illustrated by two specimens possibly originally united; the one has roughly the appearance of a portion of a stem about five inches in diameter, though really a bundle of parallel roots, each 5 to 8 mm. in diameter, the other shows its fascicular nature more evidently. The tissues are preserved in a red jasper, and dusty haematite considerably obscures the structures. "The cellular structure has been quite disintegrated. There is a solid core of woody tissue traversed by innumerable medullary rays that run almost from the very centre to the cortex, traces of the latter being quite evident (*see* Plate xxi., figs. 11, 12). All trace of protoxylem seems to have been destroyed. There appears no sign whatever of annular rings, though the secondary wood is of considerable thickness, the average radius of the roots being 6—7 mm. There is no trace of pith structure. The secondary wood starts abruptly upon an indefinite mass showing no cellular structure, but which we may interpret to be at least the position of the phloem, the entire phloem having been replaced by silica. An outstanding feature of the secondary xylem is the apparent uniformity of its cellular structure. If its elements are tracheids, which seems to be the case, they appear to be uniform in their size and structure from the position of the phloem to the cortex. From the longitudinal section all traces of bordered pits have been completely obliterated. To what group of plants these roots belong it would be difficult to say until further evidence is obtained as to the detailed structure of their protoxylem and other tissues." The slides are in the collection of the University of Sydney.

Mr. Chapman describes, in the appendix, the occurrence of *Girvanella* in the oolitic limestones of the Parish of Babbinboon.

The marine fossils of the Burindi Series so far obtained from the Currabubula, Somerton, Carroll and Babbinboon Districts comprise the following forms:—

COELENTERATA.

ZAPHRENTIS (PLEROPHYLLUM) CULLENI Eth. fil.

Mem. Geol. Surv. N.S.W., Pal. No. 5, pt. 1, 1891, p. 13, t. 9, f. 1-7.

This form occurs rather abundantly near the railway cutting four miles east of Currabubula. Collected by Benson.

ZAPHRENTIS SUMPHUENS Eth. fil.

Mem. Geol. Surv. N.S.W., Pal. No. 5, pt. 1, p. 16, t. 11, f. 4-6.

This form was described from the Somerton District; it also occurs in the south-eastern portion of Babbinboon. Collected by Benson.

ZAPHRENTIS SP. INDET.

This is a large form, the calyx of which is about an inch in diameter, but is stated by Dr. Smith (in a private communication) to be too poorly preserved to admit of specific determination. It occurs in the small mass of limestone north of the railway cutting four miles east of Currabubula.

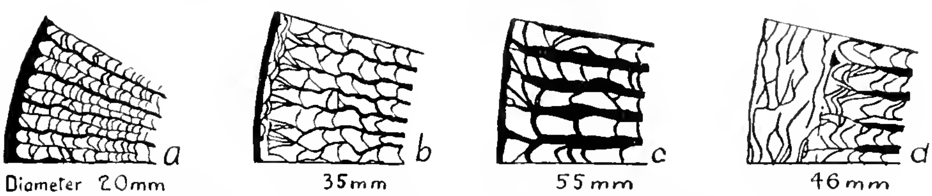
LITHOSTROTION SP.

Mitchell has reported finding a specimen of this genus, as recognised by Sowerby, at Perimbungay, near the junction of the Peel and Namoi Rivers in 1831 (9).

AMYGDALOPHYLLUM ETHERIDGEI, gen. et sp. nov. (Plate xviii.; Text-fig. 10.)

The material for the investigation of this form consists of one specimen showing the external form, but not that of the interior of the calyx, and four other specimens from which have been obtained six transverse and two longitudinal sections.

The corallum (Plate xviii., fig. 1) is simple and turbinate, marked by slight growth ridges, and rapidly increasing in diameter from apex to the bell-like calyx. The length of the corallum must have been originally about sixty millimetres; its greatest diameter is forty-two. The external wall has been removed for the most part, exhibiting the ends of the septa, which follow the plan, normal to the Rugosa, of addition at four points. Where the coral has a diameter of about ten millimetres there are thirty-eight septa visible, but where the diameter is thirty-five millimetres the number of visible septa is increased to between ninety and a hundred. Transverse sections show that the outer wall was thin, and very slightly undulating, being apparently devoid of rugae and costae. The septa are in two cycles, the longer reaching to the columella, the shorter extending to the inner limit of the dissepimental zone. Septa of both cycles are stout, generally increas-



Text-fig. 10.—Section of portions of the corallum of *Amygdalophyllum etheridgei*, gen. et sp. nov., to show the relation of the septa to the wall. Babbinboon.

ingly so as they proceed further from the columella, this being especially marked within the dissepimental zone. Generally the longer septa are more thickened than those of the second cycle, but in some cases this distinction is not noticeable in the outer parts. The septa of both cycles nearer the apical portion of the corallum pass directly into the wall (Plate xviii., f. 3; also Text-fig. 10*a*), but later they become much thinner as they approach the wall, somewhat flexuous in some cases, and supported from the wall by a number of obliquely placed lamellae (Plate xviii., fig. 2, Text-fig. 10*b*) In the sections of greatest diameter the septa may not reach the wall at all, but near it branch out into the oblique supporting lamellae which in turn are joined to the wall (*see* Text-fig. 10*c*). Indeed, in some cases, the wall is replaced by a broad zone of vesicular tissue composed of long cells flattened parallel to the outer surface (*see* Text-fig. 10*d*). The septa spring from the inner side of this zone. In regard to the illustrations, it should be noted that the originals of Text-figures 10 *a* and *d* are cut from the same corallum. The greatest number of septa observed in a transverse section was sixty of the longer cycle, and an equal number of intervening septa of the shorter cycle. No trace of a fossula is present. Some variation is seen in the manner of attachment of the longer septa to the columella. In some cases (Plate xviii., fig. 4) they pass directly into the columella and appear to radiate from its outer margin, though two or three of the septa occasionally coalesce before reaching the columella; in other cases (Plate xviii., fig. 2) they are crowded together, bent, and even broken as if they had been twisted and thrust against the columella. Intermediate stages of partial twisting occur (*e.g.*, Plate xviii., fig. 3), but this does not seem to be referable to the stage of growth.

The most remarkable feature of the coral is the nature of the columella which is a thick solid rod of roughly elliptical cross section, one end of the major axis being drawn out into a sharp point, directed probably towards the cardinal septum (Plate xviii., figs. 2, 4). As in the case of *Lithostrotion*, this appears to be essentially an enlargement of the plate joining the cardinal and counter septa. This plate may be clearly seen in the centre of the columella (Plate xviii., figs. 4, 6) and in the larger transverse sections is about three millimetres long and a fifth of a millimetre in width. About it has been deposited a layer of lime carbonate 3 mm. thick, so that the major and minor axes of the columella are as much as 9 and 5 or 6 mm. respectively. This layer is made up of fibres radiating from the original plate within, and to a less extent from the extensions of this plate into the septa at either end (Plate xviii., fig. 6). The other septa also appear to be continued into the structure of the stereoplasm and to join the primitive plate. The connection is most clear in the cases where the septa are not twisted (Plate xviii., fig. 4), in which case the darker, rather flexuous fibres of the columella are continued into the centre of the septa. Between such dark lines connecting with the septa are intervening dark lines, as if corresponding to the distant septa of the secondary cycle. In other cases the relation of lines to septa is not so clear, and if the septa are much twisted about the columella, the connections are more or less destroyed (Plate xviii., fig. 6). Sometimes the dark lines cannot be separated from the general radiating structure, which closely resembles that of oolite. At other times this resemblance is rendered still more striking by the development of concentric layers in the thickening of the columella (Plate xviii., fig. 4).

The dissepimental zone extends about three quarters of the distance, more or less, from the wall to the columella. The vesicles are most closely packed in that portion which is nearest to the columella and forms a half to a third of the width of the dissepimental zone. The outer and inner limits of this zone of closely packed vesicles may have the dissepiments so thickened as to form more or less continuous walls, the latter or thecal wall at, or just within, the circle touching the ends of the shorter septa. Generally, however, there is little or no sign of these structures. The oblique but nearly longitudinal section (Plate xviii., fig. 5) shows that the dissepiments are ranged in a steeply descending series; the largest vesicles in the central portion of the dissepimental zone are about three millimetres in length, and one in width, though usually they are about half that size, and less than that in the region of closest packing.

The tabulae are somewhat irregularly spaced, being frequently about a millimetre apart, and often closer together. They have a general upward arching, but this is not marked. Sometimes they are continuous across several septa, but at other times are confined to one interseptal space. There is no apparent stereoplasmic thickening on the tabulae and very little if any on the dissepiments.

This form appears to be closely related to *Koninckophyllum inopinatum* Eth. fil., which occurs in the Carboniferous limestone of Lion Creek, Stanwell, near Rockhampton.* It differs from this form, however, in that the primary septa reach and unite with the columella, while those of *Koninckophyllum* do not do so, and that the septa of the second cycle are two-thirds or three-quarters of the length of the primary septa, instead of being only one-half as in the case of *Koninckophyllum*. In some respects also the form appears to be allied to *Cyathaxonia*, as pointed out in a private communication from Dr. Stanley Smith. Though the corallite is simple, its structure resembles that of such forms of *Lithostrotion* of much smaller diameter, as *L. stanvellense* Eth. fil., which Dr. Smith has recognised in the Burindi Beds at Hall's Creek, south of Bingara.** It is interesting to note that his remark that the stoutness of the columella, and the tendency of the septa to end in the area of dissepiments, and not quite reach the epitheca, features which are present in the form described here, are features which distinguish the Australian forms of *Lithostrotion* from the British types. On account of the shape of the transverse section of the columella, we have adopted for this genus the name *Amygdalophyllum*, suggested to us by Professor David, F.R.S. The species, the only one yet known, we dedicate to the late Robert Etheridge, Junr., in appreciation of his fifty years of work on the Geology and Palaeontology of Australia. This form was collected in the south-east of Babbinboon by Mrs. Scott and Benson. The type material will be placed in the collection of the Geological Survey.

DIPHYPHYLLUM SP. INDET.

Indefinite specimens provisionally referred to this genus were obtained by Cullen from the Parish of Moorowarra. These are recorded as numbers 4510 and 4515 in the collection of the Geological Survey. This is perhaps a *Lithostrotion* (*cf.* Smith, 1920, *loc. cit.*).

TRYPLASMA ? SP. INDET.

A very indefinite fragment doubtfully referred to this genus is found on specimen 4419 in the collection of the Geological Survey, and was obtained by Cullen in the Parish of Moorowarra.

MICHELINIA TENUISEPTA (Phillips).

Calamopora tenuisepta, Phillips, Illus. Geol. York., ii., 1836, p. 201, t. 2, f. 3.
Michelinia tenuisepta, De Koninck, Anim. Foss. Terr. Carb. Belg., p. 31, t. c., f. 3; R. Etheridge, Junr., Mem. Geol. Surv. N.S.W., Pal. No. 5, pt. 1, 1891 p. 28, t. 4, f. 1.

The form was found in New South Wales first at Carroll, and compared dubiously by Mr. Etheridge to the above species. Later and more perfect specimens have confirmed the determination. Our specimen was collected by Mrs. Scott in the south-east of Babbinboon.

*R. Etheridge, Junr., Geol. Surv. Queensland, Bull. 12, 1900, pp.20-21, t.1, f.2; t.2, f.9, 10. According to a private communication from Dr. S. Smith, Etheridge's *Koninckophyllum* is certainly not Thompson's *Koninckophyllum*.

**S. Smith, On *Aphrophyllum hallense*, gen. et sp. nov. and *Lithostrotion* from the Neighbourhood of Bingara, N.S.W. Proc. Roy. Soc. N.S.W., liv., 1920.

CRINOIDEA.

CACTOCRINUS ? BROWNEI, sp. nov. (Plate xix., fig. 1.)

The specimen is an external cast, in a ferruginous mudstone or argillaceous limonite, of a part of a calyx showing the upper portion of the first columnal and the right and left massed basal plates, the anterior not being visible. In the radial cycle can be seen the hexagonal anal plate, broad and symmetrical in form, with its superimposed inter-radial plates, of which three cycles are preserved The plates generally are characterised by their regularity of form and hexaradiate ornamentation, the point of radiation being marked by a tubercle. No definite idea can be obtained as to the nature of the tegmen, nor as to the condition of the anal opening, nor yet of the brachia. The general form of the calyx is globose and somewhat depressed. The form is not comparable directly with any known form except perhaps *Cactocrinus ectypus* (Meek and Worthen), though differing widely from it in ornamentation. The classification of the *Actinocrinidae*, so characteristic of the Lower Carboniferous formations, is based on the condition of the anal tube, and the conformation of the brachials, information as to which cannot be obtained from our specimen. It appears, however, from the shape of the radial and fused brachial plates to approach closely to Wachsmuth and Springer's *Cactocrinus.*

Dimensions: Height of calyx, 18.5 mm.; breadth of calyx, 26.0 mm.; height of anal plate, 4.0 mm.; breadth of anal plate, 4.0 mm.; height of right posterior radial plate, 4.5 mm.; breadth of right posterior radial plate, 3.7 mm.

We name this in honour of our colleague, Mr. W. R. Browne, B.Sc. Our specimen was collected by Mr. W. Donaldson, south of the railway line, four miles east of Currabubula, and is now specimen No. F12,454 in the collection of the Geological Survey.

A fragment of a calyx with an ornamentation very similar to that shown on *C. brownei* which has been figured and described as *Actinocrinus* sp. indet. was found in the Star Beds near Rockhampton, Queensland.*

BRYOZOA.

THAMNISCUS SP. INDET.

King. Ann. Mag. Nat. Hist., (2), iii., 1849, p. 389.

In manuscripts left by the late Mr. R. Etheridge, Junr., a form not determinable specifically was described as belonging to this genus. It was collected in the parish of Moorowarra, south of Somerton, by Cullen, and near Carroll by Porter.

FENESTELLA SPP. INDET.

Indeterminate specimens belonging probably to this genus, occur four miles east of Currabubula. Collected by Benson.

BRACHIOPODA.

ORTHOTETES (SCHELLWIENELLA) CRENISTRIA (Phillips).

Orthotetes crenistria, Dun, Rec. Geol. Sur. N.S.W., vii., 1902, p. 82, t. 23, f. 11. and Bibliography.

*R. Etheridge Junr., in Geol. Pal. Qsld., 1892, p.207, t.7, f.9.

Schellwienella crenistria, Thomas. The British Carboniferous *Orthotetinae*, Mem. Geol. Surv. Gt. Brit., Pal. I., Pt. ii., 1910, p. 92.

This readily recognised form was found by Benson at the railway cutting four miles east of Currabubula, and again in the south-east of Babbinboon. The largest specimen found, if perfect, would have had a breadth of 70 mm. and length of 40 mm.

According to De Koninck (30) this form is rather rare in the Lower Carboniferous but very abundant in the upper beds of the Carboniferous Limestone. Modern British workers, however, have divided *O. crenistria* into a number of varieties of which the most important form is termed *Schellwienella crenistria* and recognise the species *sensu stricto* extending from the base of the Carboniferous up to the zone C_2,* while varieties, *e.g.*, var. *senilis*, extend up to the zone D_2. It has even been found in the Millstone Grit of the Welsh Border (31, p. 251) (? a facies of D_2). It is apposite here to cite a remark of Davidson (31, p. 290) apropos of *Streptorhynchus crenistria var. senilis*.—"Some palaeontologists seem disposed to erect this important variety into a distinct species, and it cannot be denied that in some localities, particularly in Australia, it alone occurs."

CHONETES ASPINOSA Dun.

Dun, Rec Geol Surv. N.S.W., vii., 1902, p. 69, t. 19, f. 1-3. t. 20, f. 1-5.

This species was proposed by Dun to receive forms previously classed as *Chonetes* cf. *comoides Daviesiella* cf. *comoides*, or *Productus* cf. *giganteus*. Probably should be here included the form referred to the last designation which was obtained by Mr. Pittman from Somerton. Forms compared, but not identified with, any one of the three above-mentioned species, are cited as occurring between the zones C_1 and D_1 in the Carboniferous rocks of Great Britain.

CHONETES cf. HARDRENSIS (Phillips).

For Bibliography *see* De Koninck, Pal. Foss. N.S.W. Mem. Geol. Surv. N.S.W., Pal. No. 6, 1898, pp. 66-8.

Two small specimens, not well preserved, which may be referred to this species were obtained by Benson from the railway cutting four miles east of Currabubula. The dimensions of these were length, 5 mm., breadth, 8 mm.

This form occurs both in Devonian and Carboniferous beds of this State as elsewhere, though De Koninck (*op. cit.*) urges that specific differences may be found between the types belonging to the two Periods. This, however, does not appear to be the view of modern British workers who record it as ranging from the base of the Carboniferous System up to the zone C_2.

PRODUCTUS HEMISPHAERICUS (Sowerby). (Plate xix., fig. 8.)

Jas. Sowerby Min. Conch., 1822, t. 328; *Productus giganteus* var. *hemisphaericus*, Davidson, Brit. Carb. Brach., 1858, p. 144, t. 40, f. 4-9.

Of this form there is only the cast of a pedicle valve available for study. It agrees so closely with Davidson's diagnosis and figure that no individual description is necessary here. Its dimensions are: Length, 28 mm.; breadth, 35 mm.; length of hinge line, 30 mm.

This form was obtained by Benson from the south-east of Babbinboon, and is in the collection of the University of Sydney. It was also recorded by Dun as

*For the explanation of this notation, see p.368.

the provisional determination of a shell from Rawdon Vale. In Great Britain and Ireland this form ranges between the zones S_1 and D_2.

PRODUCTUS cf. LONGISPINUS (Sowerby).

Jas. Sowerby, Min. Conch., i., 1814, p. 154, t. 68, f. 1; Davidson, Brit. Carb. Brach., 1858, p. 154, t. 35, f. 5-17.

This small form is represented by a single pedicle valve obtained by Benson from four miles east of Currabubula. It is a depauperate form, 7 mm. long and 6 mm. broad, but otherwise conforms to Davidson's diagnosis. The species was provisionally recorded as being found at Greenhills, near Paterson, in 1898. This form is "present in almost any Carboniferous district where brachiopoda have been found." In Great Britain it ranges from the zone S_2 to the zone D_2.

PRODUCTUS MURICATUS (Phillips). (Plate xxiii., figs. 1-3.)

Phillips, Illus. Geol York., 1836, t. viii., f. 3; Davidson, Brit. Carb. Brach., 1858, p. 153, t. 32, f. 10-14.

This shell is sub-circular in outline, the hinge line somewhat shorter than the greatest width of the shell. The pedicle valve is very evenly rounded so as to give an almost semicircular profile. It is ornamented by numerous rounded ribs with a small amount of reticulation near the beak. This is large and incurved. Except for the absence of spines (and our specimens are only casts), this form agrees closely with Davidson's diagnosis.

Dimensions of three forms:

	a	b	c
Breadth in millimetres..	18	18	18
Length from beak to margin	15	18	15
Convexity	9	7	9

This form is remarkably abundant at the south-eastern portion of Babbinboon, and was also collected by Pittman from the "Whale's Egg," five miles south of Somerton, in 1897, being represented by specimens 1574, 1575, and 1578 in the collection of the Geological Survey.

Davidson (31) states that it occurs in the Millstone Grit, Upper and Lower Limestone Series of Scotland. In England and Ireland it occurs in the zone of D_1.

PRODUCTUS PUSTULOSUS (Phillips).

Phillips, Illus. Geol. York., ii., 1836, p. 216, t. 7, f. 1-5; Dun, Rec. Geol. Sur. N.S.W. vii. 1902, p. 72, t. 23, f. 1, 2, 3, 4, and Bibliography.

This form was determined provisionally for this district on specimens No. 4579 and 4610 in the collection of the Geological Survey, obtained by Cullen from two miles west of Mt. Urani. These have not been re-examined by us.

This form is present in the Lower Limestone Series of Scotland (31), and ranges in England and Ireland from zone Z_2 to D_2.

PRODUCTUS SEMIRETICULATUS (Martin). (Plate xix., figs. 2-7; Text-fig. 11.)

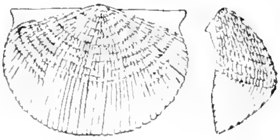
Dun, Rec. Geol. Surv. N.S.W., vii., 1902, p. 79, t. 23, f. 1-9.

A number of examples of this very variable species are figured to show the range of characters. Figures 2 and 3, Plate xix., illustrate a form, which we will term (*a*), in which the radial ridges are very marked and extend only about a quarter of the way from the beak to the margin. Figures 4 and 5 illustrate (*b*), a form that is rather crushed so that the curved outline is fractured. The radial and transverse ridging is not so deeply marked, but the sinus is more noticeable. It has a heavier, coarser ornamentation than the majority of the examples of this species from the Burindi Beds. The shell (*c*) in Figures 6 and 7, is smaller than the other forms, and the outline of the pedicle valve seen in profile is more acutely elliptical than usual. The well-marked concentric ridging covers more than a third of the surface of the valves. The radial ridges, however, are not so continuous as usual. The fourth specimen, Text-fig. 10, is distinguished from the other forms by its greater breadth relative to the length, by the presence of prominent ears, by the even convexity of the pedicle valve and by the fact that the reticulate area covers almost half the shell. The dimensions of these four shells are as follow:—

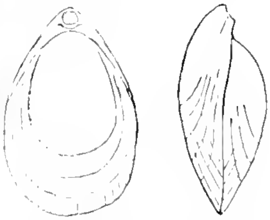
	a	*b*	*c*	*d*
Breadth in millimetres	30	36	17	24
Length of hinge line	27	34	15	23
Distance from beak to margin	23	—	—	17
Convexity of pedicle valve	10	—	11	9

This form was collected by Porter near Carroll; by Mrs. Scott and Benson in the south-east of Babbinboon.

According to Davidson (31), it extends through the Calciferous Sandstone of Scotland into the Upper Limestone, and is also found in the Millstone Grit of



Text-fig. 11.—*Productus semireticulatus*, Babbinboon.



Text-fig. 12.—*Dielasma sacculum* var. *amygdala* (Dana). Somerton.

the Welsh Border. Frech (32) states that it occurs in the lower portion of the Viséan in France and Belgium, and in Russia, and in America it is found throughout the Upper and Lower Carboniferous Formations (33).

ORTHIS (SCHIZOPHORIA) RESUPINATA (Martin). (Plate xix., figs. 10, 11.)

Anomites resupinata, Martin, Petrif. Derb., 1809, p. 12, t. 49, f. 13-14; *Schizophoria resupinata*, Dun, Rec. Geol. Surv. N.S.W., vii., 1902, p. 78, t. 21, f. 3-9 and Bibliography there cited.

This widely distributed form has been obtained from most of the known fossiliferous localities in the Somerton District, and was also found by Benson four miles east of Currabubula. None of the forms are well preserved, but those here figured conform in all essentials to the diagnosis of the species. In both, the margin forms a smooth curve but the sinus is rather marked in one, while in the other the beak is more prominent and separated from the ears by a marked flexure. Its margin also is elliptical rather than quadrate. The length of the form from beak to margin is from 30 to 35 millimetres; the breadth is 45.

According to De Koninck (30) who first recorded this form in New South Wales, it ranges throughout the whole of the Carboniferous System. In Scotland it is found from the Upper Limestone Series to the base of the Calciferous Sandstone (31). In England and Ireland the range is from the zone Z_2 to that of D_1.

ORTHIS (RHIPIDOMELLA) AUSTRALIS (McCoy). (Plate xix., fig. 9.).

Orthis australis, McCoy, Ann. Mag. Nat. Hist., xx., 1849, p. 234, t. 13, f. 4-4A; *Rhipidomella australis*, Dun, Rec. Geol. Sur. N.S.W., vii., 1902, p. 81, t. 21, f. 10-11, and Bibliography there cited.

The specimens obtained by Mrs. Scott from the south-east of Babbinboon, are all such as show the external form only, and therefore difficult to assign to either *Orthis michelini* or *Orthis australis*. The known abundance of the latter, and improbability of the occurrence of the former may be taken as deciding the nomenclature of these specimens. The size is normal or rather small. Breadth, 21 mm., length, 19, and depth or thickness, 5 mm. Less well developed specimens were collected by Benson four miles east of Currabubula, and by Cullen from Somerton.

RHYNCHONELLA PLEURODON (Phillips).

Terebratula pleurodon, Phillips, Illus. Geol. York , ii., 1836, p. 222, t. 12, f. 25, 30; *Rhynchonella* (*Pugnax*) *pleurodon*, Dun, Rec. Geol. Surv. N.S.W., vii., 1902, p. 18, t. 23, f. 10, 11 and Bibliography.

This form is represented by specimens Nos. 4385, 4434, 4435, in the collection of the Geological Survey, obtained by Cullen from the Parish of Moorowarra, south of Somerton. These have not been critically examined by us. The species, however, has been determined critically in specimens from Clarencetown occurring in the Burindi rocks, and is also abundant in the Upper Devonian rocks of Mt. Lambie and Yalwal. In Scotland it is known in the Calciferous Sandstone and Lower Limestone Series (31).

RHYNCHONELLA (?) SP. INDET. (Plate xix., fig. 13.)

A single specimen of an indeterminate form which may be related to this genus has been obtained by Mrs. Scott from the south-east of Babbinboon. Its length and breadth are about 8 millimetres, and it is ornamented by fourteen strongly-marked radiating ribs. The evidence is insufficient to justify our assigning this to any known species.

DIELASMA SACCULUM (Martin) var. HASTATA (Sowerby). (Plate xix., fig. 12.)

Terebratula hastata, J. Sowerby, Min. Conch., 1824, t. 446, f. 2, 3; *Dielasma sacculum* var. *hastata*, Dun., Rec. Geol. Surv. N.S.W., vii., 1902, p. 83, t. 21, f. 13, and Bibliography cited.

Numerous examples of this form have been obtained by Mrs. Scott from the south-east of Babbinboon. The dimensions show considerable variation, the following measurements being representative:—

	a	*b*	*c*	*d*
Length (beak to margin)	20	27	18	9
Breadth	16	16	11	10
Thickness	8	—	8	—

The last is a small form obtained by Benson from the railway-cutting, four miles east of Currabubula.

This form ranges from the base of the Carboniferous to the Upper Limestone Series in Scotland (31), and is most abundant in the Upper Carboniferous Limestone of Belgium, though extending to the lower portion (30). In England it ranges from C_1 to D_1. It also is found in the Permo-Carboniferous beds of this State.

DIELASMA SACCULUM (Martin) var. AMYGDALA (Dana). (Text-fig. 12.)

Terebratula amygdala, Dana, Amer. Jour. of Science (4), ii., p. 152; *also* in Report Wilke's U.S. Explor. Exped., Geol., 1849, p. 682, t. 1, f. 2*a*, *b*.

This variety differs from *D. hastata* in its very elongated form. The figured specimen, now in the collection of the University of Sydney, was obtained by Mrs. Scott from the south-east of Babbinboon, and has the following dimensions:—Length, 27 mm., breadth, 17 mm., thickness, 12 mm.

This form also has been obtained from the Burindi rocks at Somerton, represented by specimen 1511 in the collection of the Geological Survey. This was figured (Mem. Geol. Surv. N.S.W., iv., t. 33, f. 8) as *D. hastata*. At present its Museum label is *D. hastata amygdala* (Dana).

The form was first described from the Upper Marine Permo-Carboniferous Beds which are probably Permian (4).

SPIRIFERA BISULCATA (Sowerby.) (Plate xxi., fig. 1.)

J. Sowerby, Min. Conch., iii., 1820, p. 17, t. 23, f. 2, 3; Davidson, Brit. Carb. Brach., 1856, p. 31, t. 4, f. 1 (?); t. 5, f. 1; t. 6, f. 1-19; t. 7, f. 4; L. G. de Koninck, Foss. Pal. N. Galles, 1877, (English Translation, 1898, p. 192-3, t. 14, f. 5.)

This form is smaller than *S. striata*, and is characterised by the deep sulcus on either side of the mesial fold. The form figured here closely resembles Davidson's figure (*Op. cit.*, t. 6, f. 8) of Sowerby's type specimen. There are thirteen ribs on either side of the sinus, in which are three obtusely rounded ribs. Length, about 25 mm.; breadth 26 mm. Locality,—S.E. Babbinboon. Collected by Mrs. Scott. This form was also obtained by Mr. Pittman, 5 miles S.E. of Somerton. In the railway-cutting, four miles east of Currabubula, Benson has collected small and rather more transverse specimens, with a greater number of ribs, resembling Davidson's t. 6, f. 19. This form has the sulci on either side of the mesial fold more strongly marked, and small ribs intercalated near the margin separate the three low, broad ribs on this fold, and these are slightly sinuous. Length, 15 mm.; breadth, 32 mm. De Koninck points out that this species is very abundant in the upper beds of the Carboniferous Limestone at Visé in Belgium and in Great Britain, but occurs also in the Lower Limestone Series and Calciferous Sandstones of Scotland (31). In England and Ireland the range is from the zone C_2 to D_2, and also extends into the Millstone Grit (31, p. 251).

SPIRIFERA DAVIDIS Dun.

Rec. Geol. Surv. N.S.W., vii., 1902, p. 323, t. 60, f. 1, *a-f*.

This species was obtained by Cullen from the Parish of Moorowarra, south of Somerton, and also near Carroll. (*See* specimens 4360, 4374 and 4390 of the collection of the Geological Survey). Nothing need here be added to the description previously given.

SPIRIFERA DUPLICICOSTATA (Phillips). (Plate xxiii., fig. 4.)

Phillips, Illus. Geol. Yorks., ii., 1836, p. 218. t. 10, f. 1; Davidson, Brit. Carb. Brach., pp. 24, 221, t. 3, t. 7-10; t. 4, f. 3, 5-11, 15-16?; t. 5, f. 35, 37; t. 52, f. 6.

The pedicle valve is very similar to Davidson's t. 4, f. 15-16, though it is too imperfect to permit the observation of the marked inflection of the marginal region. There is, however, a broad sulcus with about thirteen fine ribs therein, and about thirty-five striations on either side. While originally considering the forms illustrated in these figures as *S. humerosa*, Davidson later (p. 221) states that he is inclined to refer these forms to *S. duplicicostata*. This course is therefore followed here. The specimen is No. F.1652 of the Geological Survey collection, and was obtained near the "Whale's Egg," five miles south-east of Somerton by Mr. Pittman. This form occurs in the zone of D_1 in England.

SPIRIFERA cf. MOSQUENSIS (Fischer). (Plate xx., figs. 4, 5, 6.)

Choristites mosquensis, Fischer de Waldheim, Programme sur les *Choristite*, p. 8, No. 1, 1837, and Oryctogr. du gouv. de Moscow, 1831, p. 140, t. xxii., f. 3; t. xxiv., f. 1-4; *Spirifera mosquensis*, De Verneuil and Keyserling, Russie et Oural, Vol. II., p. 161, t. v., f. 2; Davidson, Brit. Carb. Brach., p. 22-3, t. iv., f. 13, 14; t. xiii., f. 16.*

This form differs from *S. striata* in the greater length of the shell. In our form there are about sixty ribs, which are very much broader on the sinus than towards the ears, about ten ribs occurring on the sinus and mesial fold. There is very little sign of concentric ornamentation. The length of hinge line is rather less than the greatest width of the shell, and the area on the pedicle valve has almost parallel sides and is about 3 mm. wide, and marked with faint vertical striation.

Dimensions: Breadth, 37 mm. (length of hinge 33 mm.); length of pedicle valve, 35 mm.; thickness of shell, 23 mm.

Our specimen was obtained by Mrs. Scott from the shelly ridge in the S.E. of Babbinboon, and is in the collection of the University of Sydney. Other specimens from Carroll Gap have been received by the Australian Museum from Mr. D. A. Porter; and these forms approach more closely to Davidson's illustration of *S. mosquensis* than does our specimen in the more marked character of the median fold.

According to Frech (32) this species is a characteristic fossil of the lower portion of the Upper Carboniferous. A variety of it occurs in the zone D_2 in England.

SPIRIFERA PINGUIS (Sowerby). (Plate xxi., figs. 9, 10.)

Sowerby, Min. Conch., iii., 1820, p. 125, t. 271; Davidson, Brit. Carb. Brach., p. 50, t. 10, f. 1-12; *S. pinguis* var. *rotundatus*, L. G. de Koninck, Foss. Pal. N. Galles Sud., 1877, English Translation 1898, p. 185, t. 14, f. 2, 2*a*; *S. pinguis*, Dun, Rec. Geol. Surv. N.S.W., vii., 1902, p. 84, t. xxii., f. 1, 2, 5.

The specimens obtained from Mrs. Scott are typical examples of the species. The larger has a length of 43 mm. and a breadth of 40 mm., there being eight

* Davidson states: "Prof. L. G. de Koninck assures me that the true Russian *Spirifera mosquensis* has not been found in Great Britain, and that what has been referred to it are merely variations in shape of *Spirifera striata*, and I feel inclined to adopt the Professor's view." Brit. Carb. Brach., Suppl., 1880, p.315.

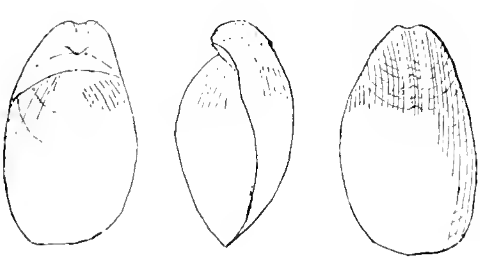
ridges on either side of the sinus, which, however, are unusually coarse in character. The other form is slightly less elongated proportionately. The length is 29 mm. and breadth 32 mm. Locality: Shelly Ridge, S.E. of Babbinboon. De Koninck states that this is one of the most abundant forms in the Middle Carboniferous Limestone. In Great Britain this form ranges throughout the zones C_1-C_3.

SPIRIFERA PINGUIS var. ELONGATA, var. nov. (Plate xx., fig. 11; Text-fig. 13.)

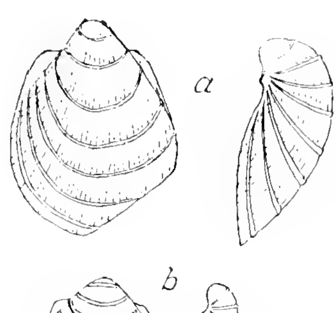
This form differs from *S. pinguis* in the greater elongation of the shell. Two specimens have come under our notice. That illustrated in Plate xx., fig. 11, is a single pedicle valve with much the same form as *S. reedi* (Davidson), though twice the size. It has an elongate-oval outline; the hinge line is shorter than the greatest width of the shell, and the cardinal angles are rounded. The beak is of moderate size and strongly incurved over a triangular delthyrium. The shell is smoothly convex with a broad medial sinus extending into a tongue-like projection of the margin. On either side are about ten low, rounded ribs; concentric lamellar growth lines cross the sinus near the margin. The other, shown in Text-figure 13, is even more markedly elongate, and somewhat distorted in outline. The shell has been largely removed but sufficient remains to show that the ornamentation was much finer than in the first specimen, about twenty ribs occurring on one side of the mesial fold on the brachial valve, and the ornamentation of the pedicle valve appears to have been as fine. A few concentric growth lines are present on each valve. The dimensions are:—

	Fig. 11.	Text-fig. 13.
Length in millimetres	34	24
Breadth	26	19
Length of hinge line	15	12
Total thickness	—	18
Depth of pedicle valve	11	10

The first of these forms was obtained by Benson in the south-east of Babbinboon, and is in the collection of the University of Sydney. The second (Specimen No. F 4360 of the Geological Survey Museum, N.S.W.) was obtained by Cullen from Reserve 121, Parish of Moorowarra.



Text-fig.13.—*Spirifera pinguis* var. *elongata*, var. nov. Moorowarra.



Text-fig.14.—*Posidoniella*? spp. indet. Babbinboon.

SPIRIFERA STRIATA (Sowerby). (Plate xx., figs. 1-3.)

Sowerby, Min Conch., 1820, t. 270; Davidson, Brit. Carb. Brach., 1852, p. 19, t. 2, f. 12, 14; t. 3, f. 2-6; *Ibid*, Carb. Suppl., 1880, p. 274, t. 31, f. 1, 2, 3, 4; Dun, Rec. Geol. Surv., N.S.W., vii., Pt. 2, 1902, p. 83-4, t. xxii., f. 6-9, and Bibliography.

As may be seen from Davidson's figures, there is considerable variety in the forms grouped under this species. Three specimens are illustrated here. That represented by Plate xx., fig. 1, closely resembles Davidson's illustration (*op. cit. supra*, t. 3, f. 4), though the ribs are not so numerous. It is the most alate of the three. There are about fifty radial ridges crossed by faint concentric lines. The sinus of the pedicle valve is somewhat deeply impressed near the margin, which is here flexed rather sharply and projected like a tongue in the dorsal direction. The beak is not quite centrally placed in one form. Its dimensions are (restored): Breadth, 55 mm.; length, 23 mm. The other forms are less broad. That shown in Plate xx., fig. 3, has forty strongly-marked ribs, on which slight beading gives the only traces of concentric ornamentation. The (restored) breadth is 36 mm., the length 25, and thickness 14 mm. That shown in Plate xx., fig. 2 has less accentuated ribbing with scarcely any other ornamentation. There are about fifty ribs which are much narrower and more closely spaced towards the ears than in the median portion of the shell. Breadth (restored), 56 mm.; length, 30 mm.; thickness, 18 mm. These three forms were collected by Mrs. Scott from the south-east of Babbinboon. They were also obtained by Mr. Pittman in 1897 from the "Whale's Egg," 5 miles S.E. of Somerton.

This form appears to occur throughout the Carboniferous limestone, and is most characteristic of its lower portion (Davidson, *op. cit. sup.* p. 21). The recent workers record the range of the form in the British Isles as from the zone of C_1 to that of D_1.

SPIRIFERA STRIATO-CONVOLUTA, sp. nov. (Plate xx., figs. 7, 8.)

This form is intermediate in character between *S. striata* (Sowerby) and *S. convoluta* (Phillips). It is broader in proportion to the length than *S. striata* but not so broad as *convoluta*. The hinge line resembles that of *convoluta* in extending the full width of the shell. The area also is narrow, with parallel sides, is marked by faint transverse striation, and pierced by a triangular delthyrium. The ribs, both simple and intercalated, are about sixty in number, and are almost as numerous as in the larger forms of *S. striata*, and more so than is normal for *S. convoluta*, though Davidson illustrates a form of *S. convoluta* (Brit. Carb. Brach., t. 5, f. 9-10) in which the broad mesial ribs are succeeded (but on one side only) by numerous narrower ribs, there being altogether twenty-seven ribs on this side of the shell as against twenty on the other side. Our form is more symmetrical and the ribs decrease gradually in size from the mesial portion to the ears of the shell. The rather sinuous character of the ribs accords with *S. convoluta* rather than *S. striata*, though it is not unknown in the latter. There is little sign of a concentric ornamentation, for the form is partly decorticated, but the growth lines give an appearance of overlapping lamellae. The valves are approximately of equal convexity the shallow sinus on the pedicle valve corresponding to a mesial fold on the dorsal which becomes more elevated near the margin, and is bent backwards into a tongue-like projection. No internal structures are visible. Dimensions: Length, 25 mm.; breadth, 49 mm.; thickness, 9 mm. Collected by

Mrs. Scott from the Shelly Ridge in the S.E. of Babbinboon. The type-specimen is No. F 12461 in the Museum of the Geological Survey.

SPIRIFERINA INSCULPTA (Phillips).

J. Phillips, Geol. Yorkshire, ii., 1836, p. 216, t. 9, f. 2-3; Davidson, Brit. Carb. Brach., p. 42, t. 7, f. 48-55; De Koninck, Foss. Pal. N. Galles Sud, 1877. English Translation, p. 197.

A portion of the pedicle valve of a specimen of this form, corresponding, as far as could be seen, to the diagnoses of Davidson and De Koninck, was found by Benson four miles east of Currabubula. It is a pedicle valve, moderately convex, ornamented by five large bold angular ribs, separated by deep narrow grooves. Length of valve, 8 mm.; breadth, 11 mm.; thickness, 25 mm. De Koninck states that this form belongs principally to the upper beds of the Carboniferous limestone (30). It is recorded from the Upper Limestone Series only in Scotland (31). In England it ranges from the zone of C_1 to D_2.

SYRINGOTHYRIS EXSUPERANS (De Koninck).

Spirifera exsuperans, L. G. De Koninck, Foss. Pal. N. Galles Sud, 1877 English Trans., 1898, p. 195, t. 15, f. 1; *Syringothyris exsuperans*, A. H. Foord, Geol. Mag. 1890, p. 149, 153; R. Etheridge fil., Rec. Geol. Surv. N.S.W., vi., Pt. 2. 1897, pp. 43-49.

An example of this form has been recorded from "a shelly ridge twenty miles west of Tamworth," possibly that we have examined in the south-east of Babbinboon, where a distinctive fragment of this form was obtained by Mrs. Scott.

RETZIA cf. ULSTRIX (De Koninck).

Terebratula (Crispata) ulstrix, De Koninck, Anim. Foss. Belg., p. 292, t. 19, f. 5; *Retzia ulstrix*, Davidson, Brit. Carb. Brach., 1858, p. 88, 218, t. 18, f. 14, 15; t. 54, f. 45.

A specimen referred provisionally to this form has been recorded from the parish of Beetive at a spot to the south-east of Mt. Uriari. It has not been examined by us. This specimen is in the collection of the Geological Survey.

ACTINOCONCHUS PLANOSULCATUS (Phillips). (Plate xxi., figs. 3, 6.)

Spirifera planosulcata, Phillips, Geol. Yorkshire, ii., 1836, p. 220, t. 10, f. 12; *Athyris planosulcatus*, Davidson, Brit. Carb. Brach., 1859, p. 80, t. 16, f. 2-13 15; De Koninck, Foss. Pal. N. Galles Sud., 1877, English Translation, 1898, p. 172, t. 9, f. 6; *Actinoconchus planosulcatus*, R. Etheridge, fil., Rec. Geol. Sur. N.S.W., v., Pt. 4, 1898, p. 177, t. 19, f. 18; Dun, Rec. Geol. Sur. N.S.W., vii., 1902, p. 87, t. 21, f. 17; t. 22, f. 12-14.

Of the forms figured here, the larger has a length of 24 mm. and breadth of 36 mm., the size of the single valve being thus nearly three times as great as the Australian form described by De Koninck. The other is somewhat smaller and less oblong-ovate. Length, 23mm.; breadth, 27 mm. This shows numerous traces of the ornamental fringes extending from the lamella, but the shell is smoothly convex, whereas the other form shows the characteristic broad shallow sinus. Collected by Mrs. Scott from Shelly Ridge, S.E. of Babbinboon, and by Cullen from Parish of Moorowarra.

De Koninck points out that this form occurs mostly in the Upper portion of the Carboniferous (Limestone?) especially at Visé. It occurs in the Upper and

Lower Limestone Series in Scotland, but not in the Calciferous Sandstone (31) In England and Ireland it ranges between the zones S_1 and D_1.

SEMINULA SUBTILITA (Hall). (Plate xxi., figs. 2, 4, 5.)

Terebratula subtilita, Hall (In Stransburg), Explanation of the Valley of the Salt Lake of Utah, 1852, p. 409, t. 2, f. 1 *a*, *b*, 2 *a*, *b*, *c*; Davidson, Brit. Carb. Brach., p. 18, t. I, f. 21, 22; *Seminula subtilita*, Hall and Clarke, Pal. New York, viii., pp. 93-98, t. xlvii., f. 17-31.

This form was the first example of this widespread genus to be recognised in this State, but it has since been recognised in the beds at Gosforth, which are probably transitional between the Burindi and Lower Marine Permo-Carboniferous Beds (4). The species is protean, and "one feels at first disinclined to include under the same specific designation the broadly ficiform, the narrow elongate, the sinuate, non-sinuate and tri-lobed forms, which are customarily thus referred, but the very abundant material shows the impossibility of separating them." (Hall and Clarke, *op. cit.*, p. 95). Our form is a very neat shell. The margin is smooth, non-sinuate, and the test is ornamented by fine radial striae and broader concentric bands with a few irregular growth lines. Its length is 18 mm.; breadth, 25 mm.; hinge line, 19 mm.; total thickness about 16 mm. It was obtained by Mrs. Scott in the shelly ridge in the south-east of the parish of Babbinboon, and now is in the collection of the University of Sydney.

This form is widely developed in the Upper Carboniferous beds in the United States, but is found rarely in the St. Louis Limestone belonging to the Upper portion of the Mississippian System, the American equivalent of the Viséan Formation (33). In Belgium, however, it descends to the Tournaisian, according to De Koninck, as cited by Davidson (31, p. 219).

PELECYPODA.

SANGUINOLITES TRIRADIATUS, sp. nov. (Plate xxiii., fig. 8.)

Sanguinolites, McCoy, Synop. Carb. Limestone Foss., Ireland, 1844, p. 47; Brit. Pal. Foss., Fasc., ii., 1852, p. 276.

The shell is very elongate, the beak anterior and the lower posterior margin projects beyond the hinge line. It is characterised by the presence of three obtusely-rounded carinae, extending from the umbo to the posterior margin. It is also marked by numerous delicate concentric growth lines. It differs from *S. tricostata* (De Koninck)*, which is the most nearly allied form, in that our form is much narrower and the carination is less pronounced than in the Belgian form (which is found in the Viséan Series). The dimensions of *S. triradiata* are: Height, 10 mm.; length, 28 mm.; thickness, 25 mm. The species is based upon Specimen F. 4584 of the collection of the Geological Survey, obtained by Cullen from the parish of Moorowarra, south of Somerton.

SANGUINOLITES SP. INDET. (Plate xxiii., fig. 11.)

This form does not appear very closely similar to any of the forms we have seen figured, but is not sufficiently well preserved for specific description. It has a carina forming a low rounded ridge except near the margin of the shell, and another running a short distance below it, commencing as an angular ridge near the umbo, but fading out into the general curve of lower posterior margin.

*Faune Calc. Carb. Belg., v., 1885, p.84, t.15, f.15.

There is a faint sign of concentric ornamentation. The superior extent of the shell is slightly saddle-shaped. The dimensions of the shell are: Length, 35 mm.; height, 15 mm.; thickness, 7 mm.

This form is represented by Specimen No. 4642 in the collection of the Geological Survey, and was obtained by Cullen from the parish of Moorowarra.

EDMONDIA SP. INDET.

This form is represented by Specimen No. 4363 in the collection of the Geological Survey obtained by Cullen from the parish of Moorowarra.*

CTENODONTA SP. INDET.

A form provisionally referred to this species was obtained by Mr. Pittman from Carroll.*

NUCULANA SP. INDET.

This form is represented by Specimen No. 4689 in the collection of the Geological Survey. Collected by Cullen from Mt. Uriari.

PARALLELODON CARNEI, sp. nov. (Plate xxi., fig. 7.)

Parallelodon, Meek and Worthen. Proc. Chicago Acad., i., 1866, p. 17.

This is represented by the cast of a single left valve covered with a little of the original shelly material. It is nine mm. in height. The hinge line is seven mm. long and shows no sign of teeth. The umbo is three mm. from the anterior end, and from it radiate many delicately marked striae crossed by a few concentric folds. This form resembles *P. argutus* (Phillips) of the European Carboniferous, but is more delicately ornamented. It is named in honour of Mr. J. E. Carne, the late Government Geologist. It was collected by Mrs. Scott from the south-eastern portion of Babbinboon.

PTERONITES (?) TANIPTEROIDES Eth. fil.

R. Etheridge Junr. Rec. Geol. Surv. N.S.W., viii., Pt. 3, 1907, p. 193, t. 37, f. 9-10; t. 38, f. 10.

Obtained from the west of Mt. Uriari.

PTERONITES SUB-PITTMANI (?) Eth. fil.

R. Etheridge, Jun., Rec. Geol. Sur. N.S.W., iv., Pt. 1, 1894, p. 29, t. 6; *ibid.*, viii., Pt. 3, 1907, p. 194, t. 38, f. 3.

In the original specimen of this species the umbo was missing, and the form could not, therefore, be distinguished from the Devonian form, *P. pittmani*. It was suggested, however, that should further collecting yield forms with a well-developed umbo, such differences might be found as would justify the erection of a new species—*P. sub pittmani*. The form originally described was obtained from west of Mt. Uriari, and is in the collection of the Geological Survey.

KOCHIA STRIATA, sp. nov. (Plate xxi., fig. 8.)

Kochia, Frech, Die Devonischen Avieuliden Deutschlands, 1891, p. 72; Clarke, New York State Museum, Memoir No. 6, 1904, p. 26, t. 13, f. 1-8.

This form at first sight resembles a capulid genus, but the shape of the umbilical region, and its relation to the posterior margin of the shell, together with the presence of a slightly developed posterior ear, lead to the conclusion that it ought to be placed in Frech's genus, *Kochia*. The umbo is a little posterior of the

*Annual Rep. Dept. Mines, N.S.W., 1897, p.200.

median line, incurved and directed anteriorly. On the posterior ear can be seen a sharp fold along the hinge line. The shell is ornamented by simple and interpolated radial folds spaced eight or ten to a centimetre and traversed by a few faint concentric undulations. The height of the type specimen is 42 mm.; the height of the umbo above the hinge-line, 14; the breadth, 35, and the thickness of the single valve is 18 mm.

It was collected by Donald Porter from Swain's Conditional Purchase Lease, seven miles south-east of Carroll, and is in the Museum of the Geological Survey, No. F 1811.

CONOCARDIUM SP. INDET.

An indefinite shell which has provisionally been referred to this genus is seen in Specimen No. 4424 in the collection of the Geological Survey, obtained by Cullen from the parish of Moorowarra, south of Somerton.

POSIDONIELLA ? SPP. INDET. (Plate xxiii., fig. 6; Text-fig. 14 *a*, *b*.)

Posidoniella, De Koninck, Faune Calc. Carb. Belg., 1885, p. 184.

These three forms all occur in the south-east of Babbinboon, and were obtained by Mrs. Scott. The following features are common in the three shells, which are obviously generically related. The shell has a prominent beak or umbo, incurved and placed subcentrally, generally slightly anterior. The hinge line is straight with round angles producing small ears. They are marked with a few (five to eight) prominent ridges, with broad sulci between, in which are seen thin radial striae sometimes extending as spines from the margin. The two forms, *a* and *b*, are rather inflated, but *c* is much flatter. The shells are rather like the illustrations of forms of *Posidoniella*; particularly marked is the resemblance of (*a*) to *Posidoniella subsulcata*,* as illustrated by Dr. Wheelton Hind, but they differ from that form in the sub-central character of the umbo and its general prominence above the hinge line. They resemble *Athyris roysii* to some extent, are the possessors of a lamellar fringe as shown in *b* (which is the only bilaterally symmetrical form), but differ from it in the presence of so few concentric ridges, and usually asymmetric character and anterior inclination of the umbo. Tentatively, however, these forms have been assigned to the genus *Posidoniella*, awaiting the investigation of further material.

The following are the characters of the three forms:—

(*a*). This is the form illustrated in Text-fig. 14*a*, and two specimens of it are available. The following are the dimensions of this form:—Height, umbo to margin, 13, 14 mm.; length, 11, 12 mm.; length of hinge line, 9 mm.; height of umbo above hinge, 4 mm.; thickness of valve, 6 mm.; number of concentric folds, 7—8.

The beak in both cases is not quite central, and the middle line is very slightly oblique to the normal to the hinge line. The ears, however, are very nearly equal and the hinge line is straight. The radiating striae are marked.

(b). This also is represented by two specimens, and is proportionately broader than the first. The following are the chief dimensions of the two specimens:—Height, 6.5, 6.2 mm.; length, 8, 7.2; length of hinge-line, 5, 4.5; height of umbo above hinge-line, 2.5, 2.5; thickness of valve, 3.7, 3.5.

In both there were five marked concentric folds with intervening fine radial markings, which are continued into a fringe along the margin of one of these

*Brit. Carb. Lamell., II. (iii.), 1904, t.25, f.2–6.

specimens. (The drawing is a composite of the characters of both.) The ears are scarcely developed, the straight hinge-line being broadly rounded on the extremities. These shells appear to be quite symmetrical about the middle line.

(*c*). The form illustrated in Plate xxiii., fig. 6, is represented by a single specimen only. The shell is depressed and subquadrate, the lower margin being almost semicircular. The shell is depressed, the beak scarcely rising above the hinge line. The anterior ear is marked, but rather smaller than the posterior ear which extends to a sharp terminal angle. The hinge line is straight and slightly oblique to the middle line of the shell. The umbo is subcentral but slightly anterior. There are seven prominent, rather angular, concentric folds crossed by radial striae. No sign of adductor scars is noticeable. The dimensions of this shell are: Height, 10 mm.; length, 9 mm.; thickness, 2.5 mm.

The specimens are numbered F.12457 in the collection of the Geological Survey.

SPATHELLA SP. INDET. (Plate xxiii., figs. 5, 7.)

Spathella, Hall, Geol. New York, Pal. v. (i.), Lamellibranchiata, 1885, p. xxxiii.; Wheelton Hind, Brit. Carb. Lamellibranchiata, ii., 1897, p. 153, t. 23.

There are two specimens which we refer to this genus with some hesitation, seeing that they are certainly specifically distinct from any forms of which we have seen figures. The larger form is an internal cast. The shell is elongated, rounded at the terminations, with a sub-anterior umbo, which is narrow and slightly incurved. There are faint traces of concentric growth lines and the anterior adductor scar is strongly marked, but the posterior is faint. The smaller form is almost exactly half the size of the larger, and differs in the marked character of the concentric growth lines giving the shell a lamellar appearance. It is slightly constricted along a band running obliquely from the umbo to the middle of the lower margin. The dimensions of these two shells are as follow:—Length, (*a*). 32, (*b*) 15 mm.; height, (*a*) 16, (*b*) 7; thickness (only one valve), (*a*) 7, (*b*) 3.

The two forms are found on Specimen No. F. 4650 in the collection of the Geological Survey, and were obtained by Cullen from the hills, two miles west of Mount Uriari.

PANENKA PORTERI, sp. nov. (Plate xxi., fig. 10.)

Panenka, Barrande, Système Sil. Bohême, vi., 1881, p. 128.

This interesting shell is represented by a specimen in the Australian Museum here illustrated, and Specimens 1752-3-4-5 and -7 in the collection of the Geological Survey, obtained by Mr. Donald Porter from Swain's Conditional Purchase, 8 miles south-east of Carroll, and also by No. 1756, from Goonoo Goonoo. The form illustrated has a length of 51 mm., and breadth of 57. The thickness of the single (right) valve is 14 mm. It is folded into numerous simple or interpolated straight, obtusely-rounded, radiating ridges, spaced about ten to the centimetre. There is no concentric ornamentation or imbrication, though there are a few growth lines and concentric undulations placed irregularly. The posterior ear is strongly developed, flange-like, and striated. The umbo is acute, highly incurved and slightly carinate. The posterior adductor scars are high and faintly marked.

Our forms resemble most closely *Panenka multiradiata* (Hall), a Devonian form, but are more delicately ornamented than this American type. The umbo is also more acute and incurved. This form is named in honour of Mr. Donald Porter, the first to make extensive collections of Burindi fossils in this region.

ENTOLIUM AVICULATUM (Swallow).

Etheridge and Dun, Mem. Geol. Sur. N.S.W., Pal. No. 5, Vol. ii., Pt. 1, 1906, p. 36, t. 15, f. 1-4 and Bibliography.

This form was obtained by Cullen from Mt. Uriari, near Somerton.

ENTOLIUM SP. INDET.

An indeterminate form belonging to this genus, represented by Specimen F. 4544 in the collection of the Geological Survey.

AVICULOPECTEN SPP. INDET.

cf. *Aviculopecten knockonensis*, De Koninck, 1877, Pal. Foss. N.S.W. (1898), p. 232; *Aviculopecten granosus*, *ibid.*, p. 234, t. 22, f. 10; *Aviculopecten* sp., Etheridge and Dun, Mem. Geol. Sur N.S.W., Pal. 5, 1904, p. 14. 20, t. 15, f. 10, 11, 12.

Indeterminate forms, which, according to Etheridge and Dun, are not determinable specifically, have been obtained by Cullen from the hills west of Mt. Uriari. Two of these may be similar to the forms which De Koninck compared with *A. granosus* and *A. knockonensis* respectively, and a third form also is present.

LEIOPTERIA (?) AUSTRALIS Eth. fil.

Etheridge, Junr, Rec. Geol. Surv. N.S.W., v., 1898, p. 178, t. 19, f. 19.

This form is represented by Specimens 4539, 4568, 4571 and 4579 in the collection of the Geological Survey, which were obtained by Cullen in the hills west of Mt. Uriari.

SCALDIA SP. INDET. (Plate xxi., fig. 9.)

Scaldia, Ryckholt, Mélanges Palaeontologiques, 1852, t. 10, f. 24-26; *ibid.*, 1853, p. 67.

This form is a single right valve, oblong-ovate in shape, with the beak slightly anterior, and the surface ornamented with fine radial striae and delicate concentric growth lines. The shell substance is thin. Its dimensions are: Length of hinge-line, 27 mm.; breadth of valve, 33; height of valve, 27; thickness, 11.

It is less elongate than the form described as *Scaldia ? depressa* by De Koninck,* derived from the Burindi rocks of Buchan on the Gloucester River, and differs also from the Belgian forms described by the same author, and also from the American forms to which we have made reference. It is not, however, sufficiently well preserved for specific description. The specimen is in the collection of the Australian Museum, and was obtained by Mr. Donald Porter from Carroll.

GASTROPODA.

PTYCOMPHALUS CULLENI, sp. nov. (Plate xxiii., figs. 12, 11.)

Ptycomphalus, Agassiz, Traduct. Conch. Min. de Sowerby, 1838, p. 222, t. 115, f. 1, 2, 3.

The shell is turbinate, elevated and markedly umbilicate, consisting of about five whorls with impressed sutures. The aperture is sub-circular. The slit-band is placed medianly between two prominent ridges, and above the upper of these ridges there are five finer ridges, while below, between the slit-band and the

*Pal. Foss. N.S.W., (1898), p.203, t.15, f.6-7.

umbilicus, the ridges or spiral striae are more than a score in number and extend into the umbilicus itself. The faintly marked and delicate growth lines cross these ridges, giving the shell a slight sub-cancellate appearance. Two specimens are available of this form, respectively 4684 and 4642 in the collection of the Geological Survey. The dimensions of these are: Diameter of base, 29 mm., or in the more complete shell 25 mm. In the latter also the height of the shell is 17 mm.; the height of the aperture is 12 mm. and the breadth 14 mm. These forms were collected by Cullen from the Parish of Moorowarra, south of Somerton.

MOURLONIA ORNATA, sp. nov. (Plate xxii., fig. 1.)

Mourlonia, De Koninck, Ann. Mus. Roy. Nat. Hist. Belg., viii., 1883, p. 75.

This beautiful fossil is represented by Specimen No. 4382 in the collection of the Geological Survey, obtained by Cullen from the Parish of Moorowarra, south of Somerton. The shell is turbinate and elevated, only two whorls are present, the upper part having been broken away. The body whorl is highly distended, oval in cross section, with two marked ridges limiting the narrow slit-band on the periphery. Between these and the upper suture there are four small spiral ridges alternating with four others that are still smaller. On the lower side of the slit-band there are several less distinct ridges. These are traversed by delicate growth lines giving a sub-cancellate appearance. There is a small umbilicus. The dimensions are: Probable height, 25 mm.; diameter of base, 21 mm.; height of body whorl, 12 mm.; breadth, 13.5 mm.; angle of spire, 70°.

MOURLONIA SP. INDET. (Text-fig. 15.)

The forms are turreted, but depressed, the spiral angle being about 95°. They consist of three or four pentagonal whorls with strongly impressed sutures. The upper surfaces of the whorls are excavated and bordered by a strongly-ridged shoulder, below which the flattened area of the broad slit-band slopes outwards and downwards to the lower angular ridge, where the whorl bends sharply in towards the umbilicus. Below this, but lying nearer to the periphery than to the centre of the broad flat umbilicus, is a third but very subordinate angular ridge.

The specimens are internal casts only, and do not show the external ornamentation. The dimensions of two specimens are as follow:—Height, 8 mm., 8.5 mm.; diameter, 15 mm., 22 mm.; height of aperture, 6, 8; breadth, 9, 10 mm.

These forms of this type were obtained by Mrs. Scott in the south-east of Babbinboon.

WORTHENIA (?) CANALICULATA Eth. fil.

R. Etheridge, Jun., Rec. Geol. Surv. N.S.W., viii., Pt. 3, 1907, p. 192, t. 38, f. 4.

This specimen was obtained at Carroll by D. A. Porter, and is in the collection of the Geological Survey.

GOSSELETINA AUSTRALIS var. ALTA, var. nov. (Plate xxii., figs. 5, 6.)

Gosseletina australis, Etheridge, Junr., Rec. Geol. Sur. N.S.W., ii., 1890, p. 82; *ibid.*, vii., 1907, p. 192, t. 37, f. 6, 7, 8; t. 38, f. 7, 8.

This shell consists of four or five convex whorls; the spire is short and depressed, and the height of the body whorl is slightly greater than the height of the remainder of the shell. It is regularly convex, almost circular in cross section. The slit band is placed nearer to the suture than to the greatest periphery of the shell, but is not preserved in our specimens, a little patch of obliquely striated test from below the slit band serving to indicate its position.

The following are the dimensions of two specimens: Height of spire, 9, 9mm.; diameter of base, 17, 21; height of aperture, 9, 9; breadth of aperture, 9, 10; angle of spire, 115°.

This variety differs from the type of the species in the greater height of the spire proportionately to that of the body whorl. These forms were collected by Mrs. Scott from the south-east of Babbinboon, and are Nos. F 12455 in the collection of the Geological Survey.

GOSSELETINA MACKAYI, sp. nov. (Plate xxii., fig. 2.)

The spire consists of four or five whorls, the first three being discoid, but the body whorl is depressed so that the top of the aperture rests against the middle line of the previously-formed whorl. The whorls are turreted, with a sharp angle placed half-way between the suture and the periphery and marked by low tubercles. The slit-band is half way between this angle and the suture. The aperture cannot be seen.

The dimensions are: Height of spire, about 16 mm.; diameter of base, 32; height of body whorl, 11.

The specimen is a cast obtained by Mrs. Scott from the shelly ridge in the south-east of Babbinboon, and named after her parents in appreciation of their hospitality and helpfulness. The type is specimen No. F 12456 in the collection of the Geological Survey.

GOSSELETINA SCOTTI, sp. nov. (Plate xxii., figs. 3, 4.)

Shell composed of four or five whorls, the cross section of which is very characteristic. The suture is rather deeply marked, and the slit-band lies at a sharp angle close to the suture line, less than a quarter of the distance from the margin to the periphery, and beneath it is another but much fainter ridge. The margin is rounded and subangular. There is a small umbilicus.

Dimensions: Height, 8 mm.; breadth of base, 20; height of aperture, 8; breadth of aperture, 9; angle of spire, 135°.

This form differs from *G. australis* in its greater size, and the position and angular character of the slit band. It was obtained by Mrs. Scott from the shelly ridge in the south-east of Babbinboon. The type is specimen No. F 12458 in the collection of the Geological Survey.

YVANIA KONINCKII Eth fil.

Baylea koninckii, Etheridge, Junr., Rec. Geol. Surv. N.S.W., ii., 1890, p. 82; *Yvania koninckii*, *ibid.*, Geol. Pal. Qld. and N. Guinea, 1892, p. 288, t. 41, f. 7; *ibid.*, Rec. Geol. Surv. N.S.W., viii., 1907, p. 192, t. 38, f. 2, 3.

This form is represented in our region by Specimen 1804 in the collection of the Geological Survey, obtained from Carroll by Donald Porter.

PORCELLIA PEARSI Eth. fil. (Plate xxii., fig. 7.)

R. Etheridge, Junr., Geol. Pal. Q'sland and N. Guinea, 1892, p. 290, t. 15, f. 7, 8.

This form is represented by Specimen 1376 in the collection of the Geological Survey, and was obtained by Cullen from the parish of Moorowarra. It consists of a cast of the base of a single shell. It contains about four or five approximately quadrangular whorls, with rounded angles, the lower exterior angle of each whorl bearing prominent tubercles. The shell is loosely coiled into a low spiral with a very broad umbilicus, the conical angle of which is about 120°. The base is 18 mm. in diameter and the body whorl at the aperture is 6 mm. in diameter.

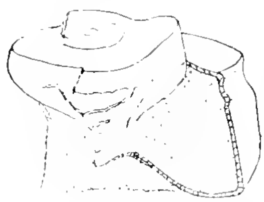
This species was instituted by Etheridge to include forms obtained from the Star, Gympie, and Middle Bowen Series of Queensland.

PHANEROTREMA AUSTRALIS, sp. nov. (Plate xxiii., fig. 13; Text-fig. 16.)

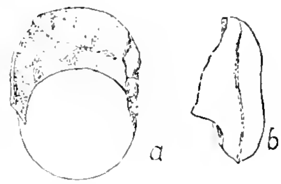
Phanerotrema, Fischer, Man. Conchyl., 1887, p. 851.

The shell is depressed, sub-turbinate, and umbilicate, consisting of four or five rapidly enlarging whorls, coiled into a laterally compressed or oval spiral. The superior whorls are rounded, but the greatly enlarged body whorl is flattened on the upper portion with a distinct shoulder, at the angle of which is

Text-fig. 15.—*Mourlonia* sp. indet. Babbinboon. (x $\frac{1}{3}$).



Text-fig. 16.—*Phanerotrema australis*, sp. nov. to show form of body whorl. Babbinboon.



Text-fig. 17.—*Bellerophon* cf. *hiulcus* Martin, and *Bellerophon* sp. indet. Babbinboon.

situated the slit-band between two ridges. The rounded lower surface of the body whorl passes forward into a sharp lower peripheral angle making a sub-quadrate aperture. A little of the original test preserved on the original of Text-fig. 16 is composed of three layers, and is marked with very fine growth lines descending obliquely forward just below the slit-band.

Dimensions:	Plate xxiii., fig. 13.	Text-fig. 15.
Height of spire	12 mm.	—
Body whorl near aperture..	29 mm.	34 mm.
Height	15 mm.	16 mm.
Breadth	15 mm.	16 mm.

The first of these has an angle of spire of 135°, but the tip of the spire has been broken from the second shell. The first shell is Specimen 4659 in the collection of the Geological Survey; the second was obtained by Mrs. Scott from the south-east of Babbinboon, and is in the collection of the University of Sydney.

PHANEROTREMA AUSTRALIS var. ALTA, var. nov. (Plate xxiii., figs. 9, 10.)

This form differs from the type of the species in the more elevated character of the spire, the dimensions being: Height, 25 mm.; breadth, 30 mm.; aperture of whorl, height and breadth, 20 mm. It consists of four whorls with a spiral angle of 110°. In the form studied there was faint evidence of some concentric spiral striae, crossed by growth lines. The form is represented by Specimen 4642 in the collection of the Geological Survey obtained by Cullen from Moorowarra.

MURCHISONIA SP. INDET.

Forms referable to this genus were obtained by Mr. Pittman from near Carroll.*

BELLEROPHON SPP. INDET. (Text fig. 17.)

Out of several specimens of *Bellerophon* collected by Mrs. Scott, east of Babbinboon, two types only appear to be represented. Both are so poorly preserved as to be incapable of specific determination. The larger is broad and oval, the mouth broadly crescentic. The umbilicus (to the right of Text-fig. 17*a*) is wide and shallow. The upper edge of the lip is thickened, and there seems to be no umbilicus. There is only the faintest indication of a slit-band, and no sign of ornamentation. The height is 13 mm. and greatest diameter 23. The height of the aperture is 18 mm., and breadth 10.

This form is evidently closely related to *B. hiulcus* (Martin)† (*Cf.* Sowerby, Min. Conch., t. 470, f. 1).

The second form, Text-fig. 17*b*, is narrower and markedly carinate. The fragment of the lip preserved indicates that it had a widely spreading mouth. This form is probably more allied to *B. costatus*, though it is apparently rather narrower than the typical form of that species. (*See* Sowerby, *op. cit.*, t. 470, f. 4.) The specimen is an internal cast only, and no sign of ridging or other external ornamentation is to be found.

EUOMPHALUS CARROLLENSIS, sp. nov. (Plate xxii., fig. 9.)

The shell is sub-turbinate to sub-conical, consisting of five to six whorls of which all but the body whorl are sub-circular in cross section, while the latter has a broad flattened upper surface, and is entirely of the *pentangulatus* type. The ornamentation of the shell consists of numerous growth lines of the normal Euomphalid type. Dimensions: Height of spire, 15 mm.; breadth, 33; height of body whorl, 9; spire angle, 120°.

The specimen was obtained at Carroll, and is Specimen No. 2771 in the collection of the Geological Survey.

EUOMPHALUS CERA (Eth. fil.).

R. Etheridge, Jun., Rec. Geol. Surv. N.S.W., vi., 1896, p. 17, t. 1, f. 5, 6.

The specimens examined from the south-east of Babbinbood (which were obtained by Mrs. Scott) resemble in all respects the illustrations of *Euomphalus cera* given by Etheridge, save that they are smaller than the illustration. As no dimensions or statement of the multiplication involved in illustrating are mentioned, the following are given as the dimensions in millimetres of several forms examined:—

Height of shell	4	5	—
Diameter	16	20	24
Height of aperture	4	5	6
Breadth	5	7	8

EUOMPHALUS PENTANGULATUS (Sowerby).

J. Sowerby, Min. Conch. Grt. Brit., 1814, p. 97, t. 45, f. 1 and 2; R. Etheridge, Junr., Rec. Geol. Surv. N.S.W., viii., pt. 3, 1907, p. 196, t. 38, f. 1.

The specimen closely resembles that from Moonan Brook, described and figured by Etheridge. Its dimensions are: Height of shell, 9 mm.; breadth of shell, 29; height of aperture, 7; breadth of aperture, 10.

*Annual Rept. Dept. Mines, N.S.W., 1897, p.200.
†Petref. Derbiensis, 1809, t. 40, f. 4.

This form is represented by Specimen 4370 in the collection of the Geological Survey, obtained by Cullen from Moorowarra Parish, and another from Carroll.

STRAPAROLLUS DAVIDIS, sp. nov. (Plate xxii., fig. 10.)

Straparollus, Montfort, Conch. Syst., Vol. ii., 1810, p. 174.

The form is sub-discoid, and consists of five or six gently enlarging whorls which are sub-circular in cross section, making a low spiral with an extremely broad umbilicus. The shell is ornamented by transverse striae which cross the whorls almost perpendicularly. The dimensions are: Height of spire, 7 mm.; diameter of base, 24 mm.; height of aperture, 5 mm.; breadth, 6 mm.; angle of spire, 135°. This form has no analogy among the Belgian Carboniferous forms described by De Koninck, but is not unlike *S. clymenoides* (Hall) from the Devonian (Schoharie Grit and Helderberg Series) of the United States. The specimen upon which this species has been instituted is No. F 1773 in the collection of the Geological Survey, and was found at Carroll by Mr. J. G. Griffin. We dedicate the species to Professor David, F.R.S.

NATICOPSIS BREVISPIRA (Ryckholt). (Plate xxii., fig. 8.)

P. de Ryckholt, Melanges Palaeontol., Pt. i., 1847, p. 78, t. 3, f. 8, 9 (*non* Roemer); De Koninck, Faune Calc. Carb. Belge, Pt. 3, 1881, p. 22, t. 1, f. 23, 24, 25, 26.

Several small specimens are available for examination. The spire has four whorls ornamented with fine striae with the same sinuosity as is general for this genus. The form agrees fairly closely with De Koninck's diagnosis, the following being the dimensions of the largest example: Height of spire, 12 mm.; width, 14; height of aperture, 10; width, 6; spiral angle, 135°.

Some callus occurs on the inner margin, but its tubercular nature cannot be observed. In Belgium this form occurs in Stage VI. of the Carboniferous Limestone at Visé. That chosen for illustration is No. 1814 of the Geological Survey, and was obtained at Carroll.

NATICOPSIS GLOBOSA (Hoeninghaus). (Plate xxii., figs. 15, 16.)

Hoeninghaus, Verzeichniss des von E. W. Hoeninghaus dem Museum der Universitat Bonn uberlassen Petrifacten Sammelung, 1829, p. 8; De Koninck, Faune Calc. Belg., Pt. 3, 1881, p. 15, t. 1, f. 1, 2, 8, 9, 10, 11; t. 2, f. 25.

Our specimens are the internal casts of three individuals, one of which has been slightly flattened by crushing parallel to the spire. The spire is composed of four or five whorls. The measurements of the two forms are as follows:—

	A.	B. (figured).
Length of spire	10 mm.	17 mm.
Breadth	10 mm.	14 mm.
Length of aperture	9 mm.	14 mm.
Breadth	7 mm.	flattened.
Spiral angle	114°	110°

This form was collected by Mrs. Scott from the S.E. of Babbinboon, and examples are Specimen No. F 12459 in the Museum of the Geological Survey, and two others in the collection of the University of Sydney.

In Belgium, this form occurs in Stage VI. of the Carboniferous Limestone at Visé. It is also found at Bolland, in Yorkshire, near Glasgow, and in the Chester Group (Upper Mississippian) in Illinois.

NATICOPSIS OBLIQUA, sp. nov. (Plate xxii., figs. 13, 14.)

This form has some resemblance to *N. consimilis* (De Kon.), but differs from it specifically. It is also quite unlike any American form of which we have information. It is an internal cast, the spire consisting of five or six whorls. The last whorl is for the most part below rather than around the preceding whorls. The distinguishing feature is the very eccentric position of the spire in regard to the upper surface of the last whorl.

The dimensions are as follow:—Height of spire, 13 mm.; breadth of base, 18; height of aperture, 14; breadth of aperture, 8; angle of spire, 115°.

The specimen was obtained by Mrs. Scott in the south-east of Babbinboon, and is No. F 12460 in the collection of the Geological Survey.

MACROCHEILUS FILOSUS (Sowerby).

Littorina filosa, Sowerby, in Mitchell's Three Expeditions into Eastern Australia, 1838, p. 15, 38, t. 3, f. 5; Morris, in Strzelecki's Phys. Descr. of N.S.W. and Van Diemen's Land, 1845, p. 285, t. 18, f. 14; *Macrocheilus filosus*, De Koninck, 1877, Pal. Foss. N.S.W., (1898), p. 264, t. 23, f. 16.

This form was among the first fossils found in the district, and was obtained by Mitchell at Perimbungay, just below the junction of the Peel and Namoi Rivers.

PLATYCERAS SP. INDET.

Specimen 1811 of the collection of the Geological Survey has been referred to this genus. It was obtained near Carroll.

LOXONEMA BABBINBOONENSIS Eth. fil.

Etheridge, Junr., Rec. Geol. Surv. N.S.W., viii., 1907, p. 194, t. 38, f. 5, 6.

This form was collected by Stonier from the parish of Babbinboon, and probably near the south-eastern portion.

LOXONEMA SP. INDET.

Rec. Geol. Surv. N.S.W., viii., 1907, p. 195, t. 37, f. 4, 5.

This form, according to Etheridge, resembles *L. leferrei* and other species in ornamentation, but is not identical with any of them. It was obtained by Porter from Carroll.

LOXONEMA SP. INDET. (Plate xxii., figs. 11, 12.)

The specimens figured were obtained by Mrs. Scott from the south-east of Babbinboon. These are greatly weathered examples, possibly of *L. rugifera*.

Specimens of *Loxonema*, generally in an obscure and imperfect state of preservation, are very abundant in the last-mentioned locality. Mitchell was probably referring to a *Loxonema* when he mentioned the presence of *Terebra* in this region.*

CONULARIA SP. INDET.

An indeterminate form, possibly referable to this genus, was obtained by Benson, four miles east of Currabubula. Another example has been reported from Somerton.

*Three Expeditions into Eastern Australia, i., 1838, p.38

Hyolites sp. indet.

Specimen 4682 in the collection of the Geological Survey contains an indefinite tapering form that has been referred to this genus. Its occurrence at Carroll has also been reported.

SCAPHOPODA

Dentalium sp. indet.

Several indefinite forms, possibly referable to this genus, have been found by Mrs. Scott in the south-east of Babbinboon. The largest of these is quite straight and the remaining portion is 46 mm. in length. It is oval in cross section with diameters of 8.5 and 6.5 mm., tapering to diameters of 4 and 3 mm.

CEPHALOPODA.

A group of exceedingly imperfectly preserved cephalopods have been obtained from the Somerton-Carroll District, which have been provisionally referred to the following old and comprehensive genera, it being quite impossible to determine them closely and on modern lines.

Orthoceras sp. indet.

Specimen 4491 in the collection of the Geological Survey, obtained by Cullen from the Parish of Moorowarra.

Trochoceras sp. indet.

Collected by Mr. Pittman at Rangira.

Cyrtoceras sp. indet.

Specimen 4682 of the Geological Survey, obtained from Somerton.

Cyrtoceras (? Gyroceras) sp. indet.

Specimen 1843 of the Geological Survey, obtained by Mr. Pittman at Rangira.

Gomphoceras sp. indet.

Specimen 1835 of the Geological Survey from Carroll.

TRILOBITA.

Phillipsia (?) robusta (Mitchell).

Phillipsia grandis, Eth. fil., Mem. Geol. Surv. N.S.W., Pal. No. 5, Pt. ii., 1892, p. 128, Text-fig. 5; *Phillipsia* (?) *robusta*, J. Mitchell, Proc. Linn. Soc. N.S.W., xliii., 1918, p. 451, t. 47, f. 1, 8.

This form was obtained by Porter at Swain's Conditional Purchase Lease, seven miles south-east of Carroll.

Phillipsia sp. indet.

A fragment of a small pygidium was obtained by Benson, four miles east of Currabubula. It has unfortunately since been lost.

APPENDIX.

Lower Carboniferous Limestone Fossils from New South Wales.

By Frederick Chapman, A.L.S., Palaeontologist to the National Museum and Lecturer on Palaeontology, Melbourne University.

(With Plate xxiv., figs. 1-8.)

A few months ago Dr. W. N. Benson forwarded for my inspection a rock specimen composed largely of the corallum of a species of *Chaetetes*, from the parish of Moorowarra, New South Wales. Accompanying these were some thin slides of other limestones from New South Wales, including three apparently new polyzoa and some interesting oolitic structures. At Dr. Benson's request I have written the following notes on these minute fossil remains.

PLANTAE.

CYANOPHYCEAE (Blue-green Algae.)

Genus Girvanella Nicholson and Etheridge.

Girvanella sp.

Description.—The granules forming an oolitic limestone from the Lower Carboniferous, represented in the present collection, are circular to ovoid in section. In many cases the filamentous growth of which they are formed enwraps adventitious particles near their periphery, as distinct from the nuclei, and which apparently were washed against the grains during the process of their formation. This precludes any idea of a mere chemical deposition, as it denotes a thread-like thallus, free at the extremity during its winding growth and ready to tangle on to surrounding fragments.

The structure of the thallus in these oolitic grains is clearly that of *Girvanella*, although the preservation is such as to present some difficulty in their study under high powers. The thallus consists of a fine tube, whilst here and there in its course are indications of strings of minute globular cells, probably reproductive.

The nuclei upon which the pellets are moulded consist of shell-fragments, pieces of Polyzoa, ossicles (arm and stem joints) of Crinoids and Echinoid plates. A four-rayed sponge-spicule is also present.

Comparisons.—In 1900 Mr. G. W. Card, A.R.S.M., gave an account of "Oolitic Limestones from Lion Creek, Stanwell, near Rockhampton."* In this paper Mr. Card describes an oolite very similar in character to the present, formed of *Girvanella* tubules enwrapping various nuclei, as coral fragments, crinoid ossicles and other organic particles. The age of this rock is either Carbopermian or Carboniferous. From the occurrence of ?*Lithostrotion* and some other older-ranging corals, one would judge the balance of evidence as supporting a Carboniferous age.

Mr. Card also records† oolitic limestones from New South Wales and Queensland as follows:—

*Queensland Geol. Surv., Bull. 12, 1900, pp.25–32, Pl. iii.

†*Op. cit.* p.31.

1. Yellow Rock Limestone, Upper Muswell Creek, Muswell Brook, N.S. Wales; probably of Carboniferous age.(*?)
2. Manning River N.S. Wales, containing Foraminifera and of similar geological age.(*?)
3. Bingara, N.S. Wales. Of Lower Carboniferous age.*
4. Rocky Creek, Horton River, N.S. Wales *
5. Mount Siluria, 4 miles S.W. of Gracemere, W. of Rockhampton, Queensland.
6. Co. Murchison, Parish of Horton, N.S. Wales.*
7. Co. Murchison, Parish of Pallal. (*Girvanella.*)*
8. Torryourn, Paterson, N.S. Wales*.
9. Yass District, N.S. Wales. Upper Silurian.

The present specimens closely resemble the Stanwell Oolites.

Occurrence.—Lower Carboniferous Limestone. Parish of Babbinboon, N.S. Wales.

Note.—Many of the oolite granules show the presence of dolomite crystals, probably due to metasomatism, and perhaps the result of a slight deformation of the rock. The result of rock movements within the mass is seen also in the partial solution of the granules where the surfaces under greatest pressure have dissolved or become etched; whilst others have been faulted and re-cemented.

The matrix of these oolites is now chiefly calcitic. All the grains are fairly evenly spaced, a fact probably due to the simultaneous and radial crystallization of the original aragonitic deposit.

ANTHOZOA.

Sub-Order **Tabulata.**

Genus CHAETETES Fischer.

CHAETETES SPINULIFERUS, sp. nov. (Plate xxiv., figs. 1, 2.)

Description.—Corallum, massive, growing on a base of stony or argillaceous material and expanding over an irregular area.

Corallites tubular, polygonal, more generally pentagonal or tetragonal, occasionally hexagonal, and sometimes with one wall incurved, indicating division by fission; multiplying by division at frequent intervals, radiating and strongly curved; walls fairly thick and imperforate, with spinules resembling those seen in *Alveolites.* Tabulae numerous, not very regular, thin, occasionally incomplete. Diameter of corallites averaging about 1 mm. Longest diameter of corallites (worn and incomplete), 8 cm.

Relationships.—The strongly-curved corallites with their short spinules, best seen in longitudinal section, at first sight recall *Alveolites.* The calicular orifices, however, are polygonal and not lunate, and the walls are not perforated. It is a true tabulate coral since the tubes are all of one kind and do not show imperfect fusion of the walls as in the Monticuliporoids.

There is an interesting species, formerly described as *Chaetetes petropolitanus* by Lonsdale, from the Ordovician of Russia,† which (in its thin-walled corallites and irregularly contracted tubes resembles the above species; it differs, however, in having no spinous projections on the corallite walls. The transverse

*These limestones are in the Burindi formation W.N.B.

†Murchison, Geol. of Russia (Corals by Lonsdale), Vol. i., 1845, p.596, Pl.A, figs.10, 10*a*.

view of the corallites in the Russian species is not given, but they are said to be polygonal and irregularly arranged. The species has since been referred to *Monticulipora* on account of its double-walled structure.

Undoubtedly the nearest allied form is the "*Alveolites*" *septosa* Milne Edwards and Haime,† a coral described from the Mountain Limestone (Upper Carboniferous) of Corwen, near Bristol, Lee in Northumberland, in Westmoreland, Derbyshire and Ireland; also at Novgorod, Russia. *Chaetetes septosus* M. Edw. and Haime sp. has been shown by Messrs. Nicholson and Etheridge‡ to belong to the genus *Chaetetes* and not to *Alveolites*. That species differs from the present *Chaetetes spinuliferus* in the greater development of the septal teeth and spines seen in vertical section at or near the junction of the tabulae, and also in the more irregular growth of the corallite walls, which in *C. septosus* are nearly uniformly parallel. The form of the corallites in transverse section and the development of the septal tooth are in both species nearly comparable.

Occurrence.—Lower Carboniferous Limestone. Parish of Moorowarra, New South Wales.

POLYZOA.

Order **CYCLOSTOMATA**.

Genus FISTULIPORA McCoy.

FISTULIPORA MICROSCOPICA, sp. nov. (Plate xxiv., fig. 8.)

Description.—Zoarium small, parasitic or encrusting; more or less lamellate; zooecial tubes sparsely tabulate, open and flexuose; interspaces with two or more series of vesicles. Diameter of zooecial tubes, .13 mm, diameter of vesicular cells, .08 mm.; height of zoarium, 2.5 mm.

The zoarium is seated on a base of calcareous algae and is in turn overgrown by a similar organism. The zooecial openings are not clearly seen, but all other structures point to its being a typical *Fistulipora*, although of such small dimensions.

Comparisons.—This species resembles *Hexagonella*,* another of the Fistuliporids, in structure, but is more minute and is not dendroid in habit of growth. The interzooecial tissue is more horizontally extended in vertical section, and the mesopores are larger than in *Fistulipora incrustans* Phillips sp.,§ which our species otherwise much resembles. Moreover, *F. incrustans* is a larger form, having zooecia of twice the diameter of *F. microscopica*. It is interesting to note that *F. incrustans* is also a Carboniferous species, being found in the Carboniferous Limestone of Yorkshire, Northumberland, Derbyshire, West of Scotland, and Ireland.

Occurrence.—In Lower Carboniferous Limestone. Parish of Moorowarra, New South Wales.

Genus CYCLOTHOTRYPA, gen. nov.

Zoarium adnate or encrusting and repent; filling up interstices in shells, etc. Apertures of surface maculae sub-circular; vesicular tissue not well developed.

†Mon. Pal. Soc., vi., 1852, p.157, Pl. xlv., figs.5, 5*a*, *b*.

‡Journ. Linn. Soc. Lond., xiii., 1877, p.365.

**See* Hinde, Geol. Mag., Dec. iii., Vol. vii., 1890, p.200, Pl.viii., fig.6; Pl.viiia., figs. 5, 5*a–d*.

§Phillips, Geol. Yorkshire, Pt. ii., 1836, p.200, Pl. i., figs.63, 64 (*Calamopora incrustans*). *Also* Nicholson and Foord, Ann. Mag. Nat. Hist., ser.5, vol.xvi., 1885, p.500.

CYCLOIDOTRYPA AUSTRALIS, gen. et sp. nov. (Plate xxiv., figs. 3, 4.)

Description.—Zoarium encrusting; surface maculae sub-circular, slightly larger than the surrounding zooecial tubes. Vesicular tissue rare. Tabulae very irregularly developed. Diameter of a typical zoarium, about 7 mm.; diameter of a macula, .33 mm.

Observations.—This genus is of later appearance than the typical *Cyclotrypa* (Devonian of North America). The character of the central zooecial openings (maculae), being typically sub-circular or ovoid, as well as the open-structured and rare vesicular tissue, seem to distinguish this Lower Carboniferous fossil.

Occurrence.—Lower Carboniferous. Parish of Moorowarra, New South Wales.

Order **TREPOSTOMATA**.

Genus HALLOPORA Bassler (*Callopora* J. Hall pre-occupied.)

HALLOPORA FRUTICOSA, sp. nov. (Plate xxiv., figs. 5, 6, 7.)

Description.—Zoarium at first encrusting, then bluntly ramose or bushy. Zooecia sub-circular or ovoid, surrounded by polygonal mesopores, sometimes very abundantly developed. Zooecia tabulate at distant intervals; mesopores filled with vesicular tabulae. Walls of zooecia thick, of the mesopores thin. Diameter of a branch, 3.4 mm.; diameter of zooecia, *circ.* .33 mm.

Occurrence.—Lower Carboniferous. Parish of Moorowarra, New South Wales.

Note.—The range of this genus in North America is from the Ordovician to the Devonian.

(ii.) A COMPARISON OF THE BURINDI FAUNA WITH THE LOWER CARBONIFEROUS FAUNAL SUCCESSION IN THE BRITISH ISLES.

(W. N. Benson.)

The discussion of the Burindi Beds in an earlier paper in this series laid stress on the fact (first brought to the writer's notice by Dr. Stanley Smith) that the occurrence of *Lithostrotion* in this series of beds indicates that some portions at least of it are newer than the lowest Carboniferous rocks. As remarked (p. 269), "Dr. Vaughan (37) states, *e.g.*, '*Lithostrotion* both massive and dendroid, enters the early Viséan' (Upper Moiety of the Lower Carboniferous) 'in North America, Britain and Belgium. It may be, therefore, that the true base of the Carboniferous System lies at some unrecognisable horizon in the Barraba Mudstone. For the purpose of mapping, however, the base of the Burindi Series is the lowest recognisable horizon that can be traced."

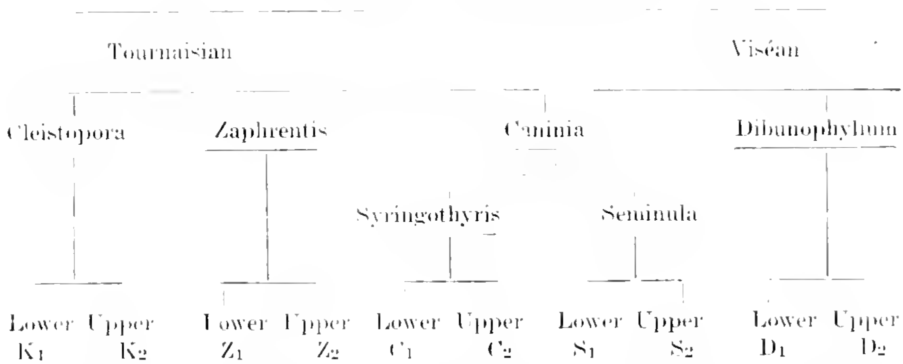
One of the objects of the detailed palaeontological study of these beds was to discover its bearing upon this point. For this purpose, the stratigraphically classified lists of Carboniferous forms given by Davidson for Scotland (31) and by the late Dr. Vaughan (34, 35, 36, 37, 38, 39),* Sibly (40, 41, 42, 43), Douglas (44), Garwood (45), and Parsons (46) have been examined to ascertain the position of forms with representatives in New South Wales. The results have been noted in regard to British forms described on the previous pages. The significance may be considered briefly. The stratigraphical classification and

*Unfortunately the modern investigation of the Carboniferous Rocks of Belgium by Carpentier, Delpine and Dordolot, cited by Vaughan (39), are not accessible to the writer at the present time.

notation adopted by Dr. Vaughan has not yet been applied to Australian Geology. In most simplified form we may record it thus:—

LOWER CARBONIFEROUS,—Avonian Series.

(= Dinantian = Mississippian.)



The division between the Tournaisian and the Viséan was placed at first between the *Syringothyris* and *Seminula* Zones (34), but now part of the Upper Syringothyris Zone, C_2, is included by Vaughan and the Belgian authorities in the Viséan (39).

The brachiopods afford our best group of forms for comparison with British types on account of the better determination. Out of twenty-three species occurring in the Somerton, Carroll and Babbinboon region, the following are found in the British Isles, together with the highest and lowest horizon recorded for each in England and Ireland by workers publishing since 1905. In the second column are Davidson's records for Scotland in 1880, referred as far as possible to the new terminology.

Orthotetes crenistria and varieties	K_1 to D_2 and M.G.*§	
Chonetes hardrensis	K_1 to C_2	(D_2)
Productus hemisphericus	S_1 to D_2	
longispinus	S_2 to D_2	(K_1?)†
muricatus	D_1	(M.G.)§
pustulosus	Z_2 to D_2	
semireticulatus‖	Z_1 to D_2 (and M.G.*§)	(K_1? M.G.)§
Orthis (Schizophoria) resupinata	Z_2 to D_1	(K_1 ?)
Rhynchonella pleurodon	D_1	(K_1 ?)
Dielasma hastatum	C_1 to D_1	(K_1 ?)
sacculum	S_1	

**See* (31), p.251, but this may be a phase of D2.
†K_1 ? = Calciferous Sandstone.
§M.G. = Millstone Grit.
‖Passes into Upper Carboniferous in Russia.

Spirifera bisulcata	C_2 to D_2 and M.G.	(K_1 ?)
duplicostata	D_1 to D_2	
*mosquensis var.**	D_2	(U.C.)
pinguis	C_1 to C_2	
striata†	C_1 to D_2	
Spiriferina insculpta	C_1 to D_2	
Actinoconchus planosulcatus	S_1 to D_2	

Perhaps the best manner to obtain an approximate idea of the average horizon of such a fauna is to accord numerical values to the zones from K_1 (= 1) to D_2 (= 10), and obtain thus the arithmetical average position of the Burindi fauna by comparison with the modern British work. It is then found that the Burindi fauna centres in the S_1 (the Lower *Seminula*) zone, near the base of the Viséan. If, however, we consider also the older Scottish records and place a value of 12 on the Millstone Grit, and 14 on a form rising higher than this we find the same result.§ Comparing this with our Australian faunae we may note that the fact that *Rhynchonella pleurodon* descends into the Upper Devonian may be balanced against the ascent of *Dielasma sacculum* var. *hastata*, and var. *amygdala* to the higher parts of the Upper Marine Permo-Carboniferous Series.

Quite in accordance with this conclusion we may note that *Michelinia tenuisepta* which occurs in our region, ranges in Great Britain from Z_2 to D_1, and that *Seminula subtilita*, though it occurs in the Tournaisian of Belgium and its equivalent in America, and is sometimes in the equivalent of the Viséan Beds: it is chiefly found in the Upper Carboniferous Formations of that continent. Moreover, there appears at several localities in Great Britain, in the Middle of the Lower Carboniferous Beds (C and S zones), a great influx of species of gastropods, particularly *Euomphalus*, *Bellerophon*, *Loxonema*, *Straparollus* and *Naticopsis*, genera also well represented in the Burindi fauna. It is questionable, however, whether this is a factor of correlative value, being possibly influenced by the general shallowing of the British province at this epoch.

A wider study of the Burindi fauna shows a somewhat similar result. In a later part of this series of papers the writer hopes to give a complete census of the Burindi fauna as far as is known for the region extending from Port Stephens to the Gwydir River near Moree (Gravesend). We may, however, anticipate this by stating the results of study of the ranges, so far as the writer can ascertain them, in the British Isles of the remaining brachiopods that also occur in the Burindi fauna in New South Wales. The following are stated in the same way as before:—

Orbiculoidea nitida	C_1	U.C.M.‖
Leptaena analoga	K_1 to D_2	
Chonetes laguessiana	K_1 to Z_2	
papilionacea (and varieties)	Z_1 to S_1	

*According to Frech this passes into the Upper Carboniferous.

†Passes into the Upper Carboniferous in Russia.

§In this calculation it is assumed that all forms recorded from the Calciferous Sandstone extend as low as K_1. If, as may well be the case, this assumption is not strictly true, the average Burindi horizon would then be somewhat higher than indicated above.

‖U.C.M. Upper Coal Measures.

Productus aculeatus	Z_2 to D_2	(K_1 ?)
*cora**	Z_2 to D_1	(K_1 ?)
fimbriatus	S_1 to D_1	
flemingii (= *burlingtonensis*)	K_2 to C_1	
punctatus	C_1 to S_1	(K_1 ?)
scabriculus	C_1 to D_1	(K_1 ?)
undatus	Viséan†	
Reticularia lineata	Z_1 to D_2	
Spiriferina octoplicata‡	K_1 to C_1	
Cyrtina carbonaria	S_1 to D_1	

The average position of this fauna, calculated in the same manner as before, is in the middle of the Lower *Syringothyris* zone, C_1, or, if we take into account the Scottish records, the result is merely to bring the average down to the base of the same zone. Combining the two lists we reach as an average derived from the thirty-one British brachiopods in the Burindi Series, a horizon in the middle of the Upper *Syringothyris* zone, or as nearly as possible on the dividing line between the Tournaisian and Viséan. This accords with Professor David's view that the Burindi Series is approximately coeval with the Osage Series (Middle Mississippian), the Burdiehouse Limestone of Scotland, the Viséan System of Europe and perhaps the Lipak Series of Spiti in the Himalayas (4). Analysing the lists more closely, we may point out that *Spiriferina octoplicata*, occurring in the Clarencetown district, is confined to the Tournaisian, and particularly characterises the zone K_2. *Orthis resupinata*, though its mutations extend to the *Dibunophyllum zone*, is characteristically abundant in Z_2, and *Leptaena analoga* and *Chonetes papilionacea*, both most common in the southern region, are chiefly confined to the Tournaisian in Britain, though Parsons records the former as common in the D_2 zone in Leicestershire.§ On the other hand, the Productids, with the exception of *P. flemingii*, are almost all Viséan, and the exclusively Viséan forms of *Lithostrotion* appear in the northern, but not so far as it is yet known with certainty, in the southern region of the Burindi Series. There is, therefore, perhaps some reason to hope that as the detailed stratigraphical study of the Burindi Beds proceeds, accompanied by refined palaeontological work, a regular succession of faunal zones may be shown to exist in this State as elsewhere. Such investigation, however, will be particularly difficult in the absence of much or regular variation in the lithology of the Burindi rocks.

It is of interest to recall the great contribution to this study made by Professor De Koninck over forty years ago. Summarising his study of the Carboniferous fauna of the State he said, "In order to deduce from the collection of species described the stratification of the formations which have furnished them, I have had to confine myself to the use of the eighty-one European species repre-

**P. cora* extends into the Upper Carboniferous (Uralian) Series in Russia.

†*Productus undatus* occurs in the Upper and Lower Limestone Series of Scotland = Viséan.

‡In regard to *Spiriferina octoplicata*, Davidson regards it as conspecific with a smaller form *Sp. cristata* in the Permian and accepts the former name. (Brit. Carb. Brach., 1863, p.267). Later (Suppl., 1880, p.258), he revives *octoplicata* as a varietal name, and some modern British workers consider it as of specific value. Mr. Dun remarks: (1902, p.88) "it appears that the term *octoplicata* is of more value from a stratigraphical than from a palaeontological point of view." Recent British work shows how important is the stratigraphical signifiance of this variety or species.

§Dr. Wheelton Hind, however, is of the opinion that the beds studied by Parsons should be assigned to the *Seminula* zone (46*b*).

sented among them and to study the beds in which they were found. This examination has proved to me that twenty-two of these are common to the upper, middle, and lower beds of the Carboniferous Limestone; thirty-six belong exclusively to the upper beds; five or six to the upper or middle beds; and six or seven to the lower beds. It must be observed that while the thirty-six species of the upper beds contain a small number of characteristic species, ... the middle and lower beds furnish no decidedly characteristic species. . . . . I believe then that I am right in concluding that the most of the Carboniferous rocks of New South Wales belong to the upper beds, that a part . . . may belong to the middle beds, and that, if the lower beds are represented at all, it is only by some insignificant spots where fossils are rare." (30). Perhaps it was because of the speedy recognition that these fossils came in part from what we now term Permo-Carboniferous beds, this very important conclusion of De Koninck has been almost entirely overlooked. Yet if we confine attention to the fossils as described by De Koninck, which come merely from the Carboniferous localities shown in the list appended by Professor David to the official translation of De Koninck's Memoir, we find that there are sixty-one European forms recognised by him. Setting aside from these sixteen, as being questionable identifications, and four the horizons of which are not specified, there remain forty-one usable determinations, of which twenty-four are of brachiopods. We find that of these forms, nine range throughout the Carboniferous Limestone, of which four are more abundant in the upper beds, four are chiefly in the lower beds, one in the middle beds; five forms occur in both the middle and upper beds, and twenty-two are almost wholly in the upper portion of the Carboniferous Limestone. On De Koninck's showing, therefore, the Burindi fauna is a very distinctly Viséan one. The difference between his conclusions and those now put forward is to be explained by the increased knowledge that has been gained during the forty years that have elapsed since De Koninck's work. It has thus been shown, for example, that nine of the brachiopods considered by him typically of Upper Carboniferous Limestone age, descend also into the middle portion, and that four of them (*L. analoga*, *C. laguessiana*, *C. papilionacea*, and *S. cristata* (*octoplicata*) are really most characteristic of the lower portion of the Carboniferous Limestone. Probably similar adjustments would be required in other groups.

It has been a pleasure to the writer to bear tribute to the excellence of the pioneering work of the Rev. W. B. Clarke, whose footsteps he has now followed from Crawney to Warialda; he has an added gratification in bringing into clearer light than before the remarkable results of the investigations of the Rev. W. B. Clarke's collections of Carboniferous fossils published over forty years ago by his distinguished Belgian colleague, Professor L. G. De Koninck, of Liège.

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EXPLANATION OF PLATES XVIII. XXIV

Plate xviii.

Amygdalophyllum etheridgei, gen. et sp. nov.

Fig. 1. Complete Corallum. (x $\frac{2}{3}$).
„ 2. Transverse section showing the manner in which the septa are crushed against the large pointed-oval columella. (x 2).
„ 3. Transverse section near tip of corallum. (x 2).
„ 4. Transverse section showing "oolitic structure" of the columella. (x 2).
„ 5. Vertical section showing dissepimental and tabular portions and columella. (x 2).

Fig. 6. Enlarged transverse section of the columella showing the median plate, and the relation of the radial portions of the columella to the septa. (x 5⅓).
Locality.—Babbinboon.

Plate xix.

Lower Carboniferous (Burindi) fossils from S.E. Babbinboon (except fig. 1.). All figures natural size, except fig. 13.

Fig. 1. *Cactocrinus brownei*, sp. nov. Cast of specimen obtained four miles east of Currabubula.
,, 2. *Productus semireticulatus* (Martin). Lateral aspect.
,, 3. ,, ,, Pedicle valve of same specimen as Fig. 2.
,, 4. ,, ,, Umbonal aspect.
,, 5. ,, ,, Pedicle valve of same specimen as Fig. 4.
,, 6. ,, ,, Pedicle valve.
,, 7. ,, ,, Lateral aspect of same specimen as Fig. 5.
,, 8. *Productus hemisphaericus* (Sowerby). Lateral aspect.
,, 9. *Orthis (Rhipidomella) australis* (McCoy). Brachial valve.
,, 10. *Orthis (Schizophoria) resupinata* (Martin). Pedicle valve.
,, 11. ,, ,, ,, Another specimen, pedicle valve.
,, 12. *Dielasma sacculum* var. *hastata* (Sowerby). Lateral aspect.
,, 13. An Indeterminate Rhynchonellid. (x 3).

Plate xx.

Lower Carboniferous (Burindi) fossils from S.E. Babbinboon. All figures natural size.

Fig. 1. *Spirifera striata* (Sowerby). Pedicle aspect.
,, 2. ,, ,, Brachial aspect.
,, 3. ,, ,, Pedicle aspect.
,, 4. *Spirifera* cf. *mosquensis* (Fischer). Brachial aspect.
,, 5. ,, ,, Lateral aspect.
,, 6. ,, ,, Pedicle aspect
,, 7. *Spirifera striato-convoluta*, sp. nov. Pedicle aspect.
,, 8. ,, ,, Brachial aspect.
,, 9. *Spirifera pinguis* (Sowerby). Pedicle aspect.
,, 10. ,, ,, Another example, pedicle aspect.
,, 11. *Spirifera pinguis* var. *elongata*, var. nov. Pedicle aspect.

Plate xxi.

Lower Carboniferous (Burindi) fossils, all from S.E. of Babbinboon, except Fig. 10.

Fig. 1. *Spirifera bisulcata* (Sowerby). Pedicle aspect. (x ⅓).
,, 2. *Seminula subtilita* (Hall). Brachial aspect. (x ⅓).
,, 3. ,, ,, Pedicle aspect. (x ⅓).
,, 4. ,, ,, Lateral aspect. (x ⅓).
,, 5. *Actinoconchus planosulcata* (Phillips). Pedicle aspect. (nat. size).
,, 6. ,, ,, Pedicle aspect of another example. (nat. size).
,, 7. *Parallelodon carnei*, sp. nov. (x 3).
,, 8. *Kochia striata*, sp. nov. (nat. size).
,, 9. *Scaldia*, sp. indet. (nat. size).
,, 10. *Panenka porteri*, sp. nov. Carroll. (x ⅓).
,, 11. Cross-sections of a bundle of roots of an indeterminate form of plant in the top of the Burindi or base of the Kuttung Series. (x 2).
,, 12. Enlarged microphotograph of one root-section. (x 7).

Plate xxii.

Lower Carboniferous (Burindi) fossils from District of Somerton, Babbinboon and Carroll.

Fig. 1. *Mourlonia*. Parish of Moorowarra. (nat. size).
.. 2. *Gosseletina mackavi*, sp. nov. S.E. Babbinboon. (x $\frac{4}{5}$).
.. 3. *Gosseletina scotti*, sp. nov. S.E. Babbinboon. (x $\frac{4}{3}$).
.. 4. ,, ,, Another view of the same specimen as Fig. 3 (x $\frac{4}{5}$).
.. 5. & 6. *Gosseletina australis* var. *alta*, var. nov. S.E. Babbinboon. (x $\frac{4}{5}$).
.. 7. *Porcellia pearsi* (Eth. fil.) Somerton. (x $\frac{5}{4}$).
.. 8. *Naticopsis brevispira* Ryckholt. Carroll. (x 3).
.. 9. *Euomphalus carrollensis*, sp. nov. Carroll. (nat. size).
.. 10. *Straparollus davidis*, sp. nov. Carroll. (x $\frac{5}{3}$).
.. 11. & 12. *Loxonema* sp. indet. S.E. Babbinboon. (x $\frac{2}{3}$).
.. 13. *Naticopsis obliqua*, sp. nov. S.E. Babbinboon. (x $\frac{4}{5}$).
.. 14. ,, ,, ,, ,, (x $\frac{5}{3}$).
.. 15. & 16. *Naticopsis globosa* Hoeninghaus. S.E. Babbinboon. (x $\frac{5}{4}$).

Plate xxiii.

Lower Carboniferous (Burindi) fossils from the Somerton District.

Fig. 1. *Productus muricatus* (Phillips) from S.E. Babbinboon. Brachial aspect. (x 2).
.. 2. ,, ,, Lateral aspect of pedicle valve. (x $\frac{4}{5}$).
.. 3. ,, ,, Pedicle aspect. (x $\frac{4}{3}$).
.. 4. *Spirifera duplicicostata* (Phillips) Reg. No. G.S. 1652 Somerton. (nat. size).
.. 5. *Spathella* sp. indet. Mt. Uriari. (x $\frac{4}{5}$).
.. 6. *Posidoniella?* sp. indet. S.E. Babbinboon. (x $\frac{4}{5}$).
.. 7. *Spathella* sp. indet. Mt. Uriari. (x $\frac{4}{5}$).
.. 8. *Sanguinolites triradiatus*, sp. nov. Mt. Uriari. (x $\frac{4}{5}$).
.. 9. *Phanerotrema australis* var. *alta*, var. nov. Viewed from above. Moorowarra. (nat. size).
.. 10. *Phanerotrema australis* var. *alta*. Lateral view. (nat. size).
.. 11. *Sanguinolites* sp. indet. Moorowarra. (x $\frac{5}{4}$).
.. 12. *Ptycomphalus culleni*, sp. nov. Moorowarra. (nat. size).
.. 13. *Phanerotremata australis*, sp. nov. Moorowarra. (nat. size).
.. 14. *Ptycomphalus culleni*, sp. nov. Moorowarra. (nat. size).

Plate xxiv.

Fig. 1. *Chaetetes spinuliferus*, sp. nov. Transverse section of corallum, showing irregular character of corallites and septal teeth. Spec. 4491F. (x 4).
.. 2. *Chaetetes spinuliferus*, sp. nov. Vertical section of corallum, showing corallites and thin tabulae. Spec. 4491F. (x 4).
.. 3. *Cycloidotrypa australis*, gen. et sp. nov. Transverse section of zoarium. Spec. 4405F. (x 18).
.. 4. *Cycloidotrypa australis*, gen. et sp. nov. Vertical section of zoarium attached to calcareous nodule. Spec. 4405F. (x 18).
.. 5. *Hallopora fruticosa*, sp. nov. Tangential section of a branch of the zoarium, showing zooecia surrounded with mesopores. Spec. 4405F. (x 13).
.. 6. *Hallopora fruticosa*, sp. nov. Vertical section of zoarium showing sparsely tabulate zooecial tubes and vesicular character of the mesopores. Spec. 4405F. (x 18).
.. 7. *Hallopora fruticosa*, sp. nov. Transverse section of zoarium, showing grouping of mesopores. Spec. 4405F. (x 18).
.. 8. *Fistulipora microscopica*, sp. nov. Vertical section of zoarium. Spec. 4405F. (x 78).
.. 9. Glaciated pebble of quartzite collected by Professor David from below the "Varve" Rocks in Browne's Creek, below the Middle Kuttung Main Felspathic Grit. Approximately natural size.
.. 10. Glaciated pebble of quartzite from the base of the Upper Kuttung rocks, immediately above the Main Felspathic Grit in Rocky Creek. (x $\frac{2}{3}$).

DESCRIPTIONS OF NEW SPECIES OF AUSTRALIAN COLEOPTERA.

Part xvi.

By Arthur M. Lea, F.E.S.

By courtesy of the late W. J. Rainbow, I was able to examine some of Macleay's and Olliff's types, belonging to the Australian Museum, and to make notes on synonymy, as given in some of the following pages.

STAPHYLINIDAE.

Pinophilus grandiceps Macl.

The type of this species is very close to a specimen in my collection identified as *P. trapezus*, but its prothorax is less dilated to the apex than on that specimen (this is possibly a sexual difference). It is very close to *P. mastersi* (the type of that species has lost its prothorax), but has the suture of the elytra raised (as on *trapezus*).

Philonthus aeneus Rossi.

(*Cafius amblyterus* Oll.; *Cafius laeus* Oll.)

The type of *C. amblyterus* agrees perfectly with specimens from New South Wales and Tasmania identified by Blackburn and myself as *P. aeneus*, and I am convinced belongs to that species; *C. laeus* also belongs to the species, the specimen from Adelaide (marked as the type) having the three conspicuous punctures (and a smaller apical one) on each side of the middle of the pronotum as on *laeus*, but in addition there are two irregular punctures on the right row, and one on the left. In comparing *amblyterus* and *laeus*, Olliff commented on the difference in the width of prothorax; the slight difference, however, appears to be sexual; the punctures at the base of the prothorax (one on each side) are exactly the same, and exactly as on *aeneus*.

Quedius ruficollis Grav.

(*Philonthus chalybeipennis* Macl.)

The type of *P. chalybeipennis* is a rather small female of *Q. ruficollis*.

Aleochara puberula Klug.

(*Oxypoda analis* Macl.)

Oxypoda analis has already been referred to *Aleochara* by Olliff, and from examination of the type I have now to record it as a synonym of the introduced *A. puberula*.

POLYLOBUS PALLIDIPENNIS Macl. (formerly *Homalota*).

(*P. pallidominor* Lea.)

The original description of *P. pallidipennis* is too short for identification of the species, as it would apply to many small *Staphylinidae*. There are two specimens mounted on one card with a type label, one is in quite unrecognisable condition, and the other is somewhat dirty but on comparison with the type of *P pallidominor* appeared to agree with it, except that the base of its head is not quite as dark as on the type of the latter species, but this may be due to its having somewhat faded. Olliff, on referring the species to *Polylobus*, and redescribing it, noted the elytra as having "a moderately large indistinct spot near the external apical angles," but I can find no trace of such a spot on either of the Gayndah specimens, so it is possible that Olliff's description may not have been drawn up from these, as he records the species also from New South Wales.

POLYLOBUS LONGULUS Oll.

(*P. tenuis* Lea.)

A specimen from Shelley's Flats bearing Olliff's label as *P. longulus* (but not marked as the type) agrees with the type of *P. tenuis*. It agrees with the description of the structure, but not of the colour, of *P. longulus*, as the elytra are twice noted as being "pitchy-black"; whereas on the specimen now before me they are scarcely darker than the prothorax, although in some lights appearing infuscated posteriorly. If the specimen in question is really the type of *longulus* the original description is misleading.

POLYLOBUS APICALIS Fvl.

(*P. fungicola* Oll.)

The type of *P. fungicola* agrees with two Tasmanian specimens that some years ago I identified from its description as *P. apicalis*, and on checking with that description again appear to agree with it. Fauvel notes the pronotum as having a rather wide basal foveole; on one of the Tasmanian specimens there is a fairly conspicuous transverse impression near the base, but on the other specimen, and on the type of *fungicola* the depression is scarcely evident.

PSELAPHIDAE.

RYBAXIS ATRICEPS Macl. (formerly *Bryaxis*).

(*R. acanthosterna* Lea.)

There were two males mounted on one card as the types of *R. atriceps*, and side by side these agree with the types of *R. acanthosterna*. Macleay did not mention the remarkable features of the sterna, abdomen, and front tibiae, and his description of the elytra is misleading "Elytra bistriated, one on each elytron" as there are two conspicuous striae on each elytron: a subsutural one, and a submedian one.

RYBAXIS ELECTRICA King, Var. A.

Mr. A. H. Elston took a specimen of this variety from the nest of a species of *Pheidole* on Kangaroo Island.

HISTERIDAE.

PLATYSOMA CONVEXIUSCULUM Macl.

There are three specimens mounted on a card as types of this species, but of these only two (those on the front of the card) agree with the description; their elytral striation is much as on *P. bipunctatum*, but they are considerably wider, larger, more convex and otherwise different from that species. The other specimen differs from the types in being smaller, narrower, and in having an additional short stria on each elytron, the medio-basal impression on the pronotum absent, etc., and belongs to *P. completum*.

PAROMALUS PLANICEPS Macl. (formerly *Platysoma*).

This species is a *Paromalus*, larger, wider, and more depressed than *P. umbilicatus* or *P. victoriae* and with considerably larger punctures.

TRIBALUS AUSTRALIS Macl. (formerly *Abraeus*).

(*T. leae* Lewis.)

The four types of *T. australis* agree perfectly with two cotypes of *T. leae*.

NITIDULIDAE.

HAPTONCURA OCULARIS Fairm. (formerly *Epuraea*).*

(*Haptoncus tetragonus* Murray†; *Carpophilus convexiusculus* Macl.)

Blackburn‡ recorded *Haptoncura ocularis* from Queensland and the Hawaiian Islands, pointing out Sharp's opinion§ as to its identity with *Haptoncus tetragonus*. The types of *Carpophilus convexiusculus* agree with the specimen he had named as *H. ocularis*, and one of them agrees well with Murray's figure of *H. tetragonus*; the other has elytral markings more extended. I have also taken the species in the Cairns district.

TROGOSITIDAE.

LEPERINA CIRROSA Pasc.

(*L. mastersi* Macl.; *L. burnettensis* Macl.)

Olliff commented upon *L. cirrosa* as being remarkable "for the great length of the white scales on the sides of the prothorax, and the large size of the elytral fascicles"; but the scales and fascicles are very easily abraded and I cannot look upon the type of *L. mastersi* as other than a large, partially abraded specimen of the species; I think also that *L. burnettensis* was founded upon small specimens of the species, as Olliff thought possible. It occurs from Northern New South Wales to Darwin.

SORONIA AMPHIOTIFORMIS Reitter.

(*Ancyrona resca* Oll.; *Ancyrona amica* Oll.)

The types of *A. resca* agree with specimens identified by Blackburn as *S. amphotiformis*, and I cannot regard the type of *A. amica* as other than a large, partially abraded specimen of the same species.

*Rev. et Mag. Zool., 1849, p.28.
†Mon. Nitid., 1863, p.401. Pl. xxxiii., fig. 7.
‡Trans. Roy. Soc. S. Aust., 1902, p.306.
§Tr. Dubl. Soc., 1885, p.231.

LATHRIDIIDAE.

HOLOPARAMECUS CAULARUM Aube.

Ann. Soc. Ent. Fr., 1843, p. 244, Pl. x., figs. 2, 5-10.

Mr. Froggatt and I obtained numerous specimens of this species in a stack of wheat at Peak Hill (New South Wales). I am indebted to Mr. G. J. Arrow for the name of the species, now first recorded as occurring in Australia.

SCARABAEIDAE.

OCNODUS LUGUBRIS Blackb.

A specimen from Coolgardie may represent a variety of this species; it differs from the typical form in being somewhat smaller, 9 mm., and almost entirely black.

OCNODUS TRIDENTATUS Lea.

A specimen from the Flora River (Northern Territory) in the National Museum may represent a variety of this species; it differs from the type in being somewhat larger, and by having the labrum more conspicuously notched, and the pygidium longitudinally carinated.

POLYSTIGMA VITTICOLLE Macl.

There are sexes of this species in the National Museum from the King River (Northern Territory) and they differ somewhat from the types in markings: on two males the small black subapical spot (of the types) on each elytron is joined to the suture, this being entirely black; on the female the subapical spot and postmedian fascia form parts of a complete but somewhat irregular ring, which encloses a conspicuous flavous spot on each elytron; on the males also there is a distinct, but not isolated, spot in each upper corner of the pygidium; the small humeral spot on all three specimens is also more angular than on the types. The male has a wide and rather shallow depression on the abdomen; its front tibiae have but two distinct teeth (on one male the third tooth of the female is feebly indicated, but not at all on the other); the hind tibiae are shorter and wider than those of the female, and on its under surface there is a dense fringe of golden hair commencing near the base and becoming denser to the apex.

EUCNEMIDAE.

NEMATODES PUBESCENS Macl. (formerly *Acroniopus*).

The type of this species is a female (its ovipositor is protruding) and it does not belong to the *Elateridae*, but to the *Eucnemidae*.* In Blackburn's table of the subfamily it would be referred to AA (the line marking off the pronotum from the prosternum is acutely carinated, and inwards of the carina is a shallow depression as in *Nematodes*, certainly not a conspicuous groove as in A), BB, C, D (the apical process is short and truncated), E- *Nematodes*, to which accordingly I refer it, although it certainly looks somewhat out of place in that genus. In general appearance, at first glance it strongly resembles *Fornax parvoniger*, but is somewhat narrower, the prothoracic punctures distinctly coarser, and the elytral ones somewhat stronger, the clothing also is uniformly pale; the sternal characters, however, are very different.

* *Acroniopus rufipennis* Macl., does belong to the *Elateridae*.

ELATERIDAE.

Monocrepidius minor Macl.

(*M. alpicola* Blackb.; *M. dolosus* (Cand. MS) Schwarz.)

The types of *minor* agree well with some cotypes of *M. alpicola*. A specimen of the species was sent to me some years ago by M. Candeze, as *M. dolosus* Cand., an MS. name subsequently published by Schwarz, whose description agrees with the types of *M. minor*, and also with the specimen sent by Candeze.

Monocrepidius eveillardi Le G.

(*M. breviceps* Macl.; *M. rubicundus* Macl.)

The type of *M. breviceps* agrees with specimens in the Blackburn and Lea collections identified by Candeze as *M. eveillardi*; its head has been forced upwards and backwards, so that it appears shorter than usual, and its median carina is concealed. The type of *M. rubicundus* is an abraded specimen of *eveillardi*, with the derm and punctures in consequence more clearly exposed; its head is in the normal position, the left hind angle of its prothorax has been broken off at the tip, but the right is as on the type of *breviceps*. The two discal spots of denser clothing on the pronotum, typical of *eveillardi*, are present on both of the Gayndah types.

Monocrepidius aphiloides Cand.

(*M. mastersi* Macl.)

The types of *M. mastersi* agree well with some specimens identified by Candeze as *M. aphiloides*, and with others standing under the latter name in the Blackburn collection. The species varies considerably in size, and occurs in Queensland, New South Wales, and Victoria.

Lacon variabilis Cand.

(*L. alternans* Macl.)

The type of *L. alternans* is quite an ordinary male of *L. variabilis*, of which there are specimens in the Blackburn and Lea collections, identified by Candeze.

Lacon guttatus Cand.

(*L. maculatus* Macl.)

The type of *L. maculatus* is a rather small specimen of *L. guttatus*, of which there are specimens in the Blackburn and Lea collections, identified by Candeze. Its derm, as well as the clothing, is mottled.

ANTHICIDAE.

Anthicus intricatus King.

(*A. ovipennis* Lea.)

This species is distinct amongst the Australian *Anthici* by its pronotum being densely and finely longitudinally strigose (or subreticulate); King speaks of the "intricate *markings*" of the prothorax, no doubt referring to its sculpture. In my own description the head and prothorax were incorrectly described as "shallowly punctate." Unfortunately with my type of *A. ovipennis*, I had two specimens of another species (obtained subsequent to its description) and I appear to have sent a specimen of this other species to Mr. Champion, who on it (and no doubt on my inaccurate description) recorded *ovipennis* as a synonym of his *A. inflatus*, but the latter name being already in use he suggested that *ovipennis* might stand; in size, colour and general appearance *inflatus* and *intricatus* are extremely close together; but Champion's description of the punctures of *inflatus* renders it quite certain that the two species are distinct.

ANTHICUS ALBANYENSIS Pic.

Bull. Soc. Ent. Fr., 1895, p. cccl.

(*A. inflatus* Champ.)

In M. Pic's Catalogue of the *Anthicidae*, *A. inflatus* and *A. ovipennis* are placed as synonyms of *A. albanyensis*; but as will be seen by the above correcting note, *inflatus* and *ovipennis* are not equal.

ANTHICUS HESPERI King.

(*A. mastersi* Macl.; *A. similis* Lea.)

Placing the types of *A. hesperi*, *A. mastersi* and *A. similis* side by side I am convinced that they belong to but one species; the sexes differ somewhat in the size of head and apex of prothorax; the punctures vary slightly in size, and the markings are extremely variable in extent, but these have been previously commented upon under notes on *mastersi*.*

ANTHICUS SCYDMAENOIDES King.

The type of this species *now* has the head no darker than the prothorax, and the "strong black setae" have been nearly all abraded; the sides of the prothorax are armed with small spines, from the hindmost one of which (almost in the exact middle) a pubescent line extends backward to the base.

A specimen taken in rotting leaves in the National Park (near Sydney) evidently belongs to this species, but differs from the type in being slightly smaller, the head entirely black, and the antennae with the first and seventh-tenth joints conspicuously darker than the others.

ANTHICUS IMMACULATUS King.

This species occurs in abundance at the roots of plants on the sand-dunes at Port Lincoln and Glenelg in South Australia; the head and prothorax (except for a slight difference in shade) appear to be constant in colour; but the elytra vary from entirely pale to entirely black (except that the base and suture are obscurely diluted with red), with or without a slight metallic-green gloss; on many specimens the dark parts consist of a large infuscation (scarcely a distinct spot) on each side. The subsutural striae are well-defined, and by this character alone entirely pale specimens may be distinguished from other pale species of the genus.

*Proc. Linn. Soc. N. S. Wales, 1894, p.620.

Anthicus rarus King.

A. krefftii King; *A. propinquus* Macl.; *A. australis* Champ. (*not* King).

Although placed in a different section of the genus by King, I cannot satisfy myself that the type of *A. krefftii* is other than a specimen of *A. rarus*, with the markings of the elytra almost obliterated; the shape of the elytra (including the conspicuous subsutural striae) and the lateral foveoles of the prothorax are identical, but the elytral punctures are not quite as strong as usual (I have, however, specimens with the typical markings of *rarus*, and with punctures no stronger than on the type of *krefftii*). Tasmanian specimens have larger and darker markings and somewhat stronger punctures than those on the mainland. The other synonymy has been already noted.

Anthicus myrteus King.

(*A. glabricollis* King.)

Specimens that some years ago were compared and agreed with the type of *A. myrteus*, structurally agree well with the type of *A. glabricollis*, although the former was referred to Group 4, and the latter to Group 10. The dark parts vary from moderately infuscated to deep black, the prothorax (as on the type of *glabricollis*) is sometimes of an uniform lurid-brown, but is usually paler at the base than in front, occasionally it is entirely black. The species occurs in abundance on flowers in New South Wales, Victoria, and South Australia.

Anthicus nitidissimus King.

In general appearance this species is very close to *A. xerophilus*, and the elytral markings of the type are practically identical, but it differs in being slightly wider, head darker (on some specimens, however, the head is not infuscated), prothorax more dilated in front, and elytra with distinct punctures only in front of the median markings; on *xerophilus* there are quite distinct punctures on the median markings, and beyond them to the apex (although becoming smaller posteriorly) and the punctures in front of the markings are also considerably denser than on *A. nitidissimus*. From *A. exiguus* it differs in being somewhat larger, elytra conspicuously wider, and with much smaller punctures; the elytral markings are also not quite the same.

The original description of the colour of the elytra is somewhat misleading: they are pale castaneous, with a blackish median fascia narrowed towards and not meeting at the suture, an infuscate spot on each side of the apex, the space between the spots and the median fascia paler than the basal half; a fairly large space about the scutellum is slightly darker than the rest of the basal half, but certainly not "piceous." The colour of the types has perhaps slightly altered since they were taken (over fifty years ago) but agrees well with some recently taken ones. The species occurs in Western Australia as well as in South Australia.

Mecynotarsus ziczac King.

Mr. J. S. Clark took numerous specimens of this species, about the Swan River, from nests of *Ponera lutea*.

CHRYSOMELIDAE.

Cadmus fasciaticollis Lea.

Mr. H. J. Carter and I recently took six specimens of this species, at Launceston and Cradle Mountain, in Tasmania, that agree in colour with the type, except that, on two of them, from four to six of the apical joints of the antennae are more or less deeply infuscated. Three other specimens, from Waratah and Wilmot, differ considerably, however; of these a female has the prothoracic fascia extended so as to occupy most of the disc, but not touching any of the margins; its elytra are blue-black at the base, with a wide extension along the middle to the summit of the apical slope, and a narrow extension from each shoulder, the tips of its antennae are lightly infuscated; a second female has the prothoracic fascia irregularly extended so as to touch the base in places and to leave but pale edgings at the sides and apex; its elytral markings are less extended than on the other female, and the antennae are entirely pale; the third specimen, a male, has the prothorax dark except for a narrow edging at apex and sides, the elytra are dark except for part of the apical slope, a narrow marginal strip on each side, and an obscure post-humeral spot, the two apical joints of its antennae and tips of several of the preceding ones are infuscated.

Ditropidus ochropus Er.

The type was described as having dark hind femora, and several specimens before me have them dark; but they are usually no darker than the others. The species occurs in South Australia (Mount Lofty, Adelaide and Moonta) as well as in Tasmania.

Ditropidus aurichalceus Suff.

Numerous specimens from New South Wales (Gosford, Sydney, and Tamworth) and Victoria (Dividing Range) agree with specimens identified by Blackburn as belonging to this species. They have the upper surface uniformly bronzy and the legs bright red; the pronotum densely and finely strigose at the sides and apex, but with punctures only on the rest of its surface; the eyes are rather close together on the male.

Ditropidus amabilis Baly.

Numerous specimens from Queensland (Bundaberg, Rockhampton, and Gayndah) probably belong to this species; they are close to *D. laevicollis*, but have the prothorax more metallic, with denser punctures (especially on the sides, but they are nowhere oblong as noted for *A. amabilis*) and the clypeus not in the form of a narrow transverse ridge; the abdomen is usually entirely pale in the female, largely infuscated in the male.

Ditropidus dimidiatus Baly.

Ten specimens before me, 2.25-3.25 mm. in length, probably belong to *D. dimidiatus*; they have the prothorax decidedly longer than is usual in the genus, its median length being fully two-thirds of the median length of the elytra, and with rather dense and sharply defined punctures, becoming more crowded on the sides; the prosternal process is deeply, on the male almost triangularly, notched. In the original description the prothorax was noted as "distinctly and somewhat closely punctured," a character which should at once distinguish it from *D. elegantulus*, and other species having the prothorax red and elytra black. The legs vary somewhat in colour, on some specimens being entirely pale, on others the hind ones, or the four hind ones being partly black or infuscated; but on all of them the head is entirely red. Two of the specimens, from Tamworth, have the prothorax, except for its narrow basal edging, entirely red, and elytra entirely black; two, from Brisbane, are similarly coloured, except that a pale spot is vaguely indicated on each elytron about the basal third; two, from Cairns and Charters Towers, have the prothorax red and the elytra with two reddish fasciae, the first commencing on each side at the basal third, and dilated so that near the suture, which it almost touches, it occupies about the basal half, the second fascia is apical; one, from Cairns, is like the preceding ones, except that the subbasal fascia appears as two large round disconnected spots; two, from Sydney, have a large black blotch occupying most of the pronotum, and the elytra are entirely black; the last specimen, from Cairns, is like the preceding ones, except that on each elytron a pale spot, as on the ones from Brisbane, is vaguely indicated. A specimen from Cape York, in the British Museum, has the elytra pale, except that the base and suture are very narrowly black, and that there are feeble infuscations on the sides.

Ditropidus odewahni Baly.

Specimens before me 1.75—2.25 mm. in length, appear to belong to this species; their prothoracic punctures are usually very feeble. They are from New South Wales (Whitton and Forest Reefs) and South Australia (Adelaide, Port Lincoln, Goolwa and Quorn).

Ditropidus antennarius Baly, 1877.

(*D. antennarius* Chp., 1878; *D. baccaeformis* Chp., var.)

This species, from the female, was described by Chapius as entirely pale, except that the five apical joints of the antennae were dark; there are six females before me that agree with his description, except that the junction of the prothorax and elytra is very narrowly black (apparently an invariable character in pale species); they are from Brisbane, Cairns and Bloomfield River, their antennae are of quite the ordinary type in the genus, but the male has very different ones, seven of the joints being dark, and all, after the second, being several times longer than wide, so that the tip of the eleventh joint actually passes the elytra; a character that, by his table, would generically separate the sexes.

Baly's description of colours differs from Chapius' only in six of the joints of the antennae being noted as black, and "Body beneath and legs more or less stained with piceous"; he notes the name as being "Suffr. MS," and probably Chapius also received his specimens with that manuscript name.

Var. A. Five females from Rockhampton, one from Bowen and one from Brisbane, differ in having the metasternum, abdomen and hind femora black, and sometimes other parts of the legs infuscated, the antennae have from four to six of the apical joints dark. A male from Rockhampton, and one from Bowen, are coloured as the females, except that seven of the joints of the antennae are dark, their antennae are almost as long as those of the typical form, extending exactly to the tips of the elytra. The Bowen female is rather larger, 4.5 mm., than usual, and its front legs are almost entirely dark; except in this variable feature, and for

.5 mm. in length, it agrees well with the description of *bacceformis* (the sex of the type of which was not noted), and that name appears to be varietal only; a female (without locality) apparently belonging to this variety is still larger, 5 mm., but its antennae and legs are all damaged.

A male, from Ooldea in South Australia (the only specimen I have seen, except from Queensland) also appears to belong to the species, but its antennae are slightly shorter, not quite extending to the tips of the elytra, and only six of its joints are entirely dark, its metasternum and abdomen, except for a median space at the base of each, and most of its middle and hind legs are black.

DITROPIDUS JACOBYI Baly.

A short, thick-set species with large eyes, almost touching in both sexes; the elytral striae are strong, and contain large punctures, the striae actually extend to the suture; on most species of the genus there are two or three well-impressed striae on each side, but towards the suture these are represented by rows of punctures. The prothoracic punctures are strong and rather dense on the sides, becoming more or less sparse on the middle; the seventh joint of the antennae (first of the club) is distinctly larger than any of the following joints in the male, and a trifle larger than any of them in the female. The upper surface is usually of a dingy testaceous, varying to obscurely piceous, or even black, with the apical portion of the elytra paler or not; occasionally there is a large infuscate blotch on the pronotum; the legs also vary from almost entirely pale, to almost entirely dark. There are specimens before me from many localities in New South Wales, Victoria, Tasmania and South Australia.

VAR. A. Some specimens from New South Wales (Tamworth), Victoria (Alps) and Western Australia (Pinjarrah and Mount Barker) differ from most specimens of the species in having the prothorax with dense punctures throughout, the elytral striae are deep throughout, with all the interstices strongly convex (on the typical form the elytral striae although distinct, are not as deep as on this variety, and the interstices near the suture are flat and wider than the striae), and the upper surface is of a uniform piceous-brown. A specimen from Victoria and another from Tasmania resemble the variety, except that the elytra are obscurely flavous at the tips.

VAR. B. A specimen from South Australia (Lucindale) is structurally like the preceding variety, but is flavous, except that the metasternum and abdomen are deeply infuscated.

VAR. C. Some specimens from Western Australia (Albany, Mount Barker and Darling Ranges) resemble the typical form, but the prothorax is without punctures, except for a few on the margins. One of them in colour resembles the preceding variety, but the others are darker.

DITROPIDUS ELEGANTULUS Baly.

Only the male of this species, from "Australia," was described by Baly, and his specimen was noted as having "Body beneath stained with piceous"; I have only seen one specimen agreeing with this character; on another the under surface, including the pygidium, is entirely red, and on another the pygidium is red but the rest of the abdomen is black; on all other males the metasternum and abdomen, including the pygidium, are deep black, although clothed with thin white pubescence. The female (there are several pairs taken *in cop.* before me) differs from the male in being slightly larger, the head, except for a small part of the muzzle, and prothorax of the same bronzy or brassy colour as the elytra, and the prosternum entirely black; its head is smaller, antennae, especially the joints of the club, thinner, prothorax more rounded in front and with more distinct punctures, distance across junction of prothorax and elytra less, abdomen more convex, and with a large apical fovea, and legs, especially the front ones, shorter and thinner.

The species occurs in New South Wales, Victoria and Tasmania, and is sometimes common on species of *Dilwynnia* and *Pultenaea*. In general appearance it is close to a specimen I have identified as *D. ruficollis*, but the elytra are not at all green, the head is densely punctured and obliquely strigose, with a conspicuous median line, eyes larger, etc.; the specimen of *ruficollis* has the inter-ocular space with sparse and small punctures, and is without an impressed median line there.

Ditropidus serenus Baly.

This species varies considerably in length, 2.25—3.5 mm., and the smaller specimens usually have a rather wide space at the apex of the elytra infuscated; on two small males the elytra are slightly infuscated throughout. It occurs in Victoria, as well as in South Australia.

Ditropidus ornatus Baly.

A specimen from Murray Bridge (South Australia) appears to belong to this species, but differs from an undoubted one of it (from Western Australia) in having the pubescence on the head very feeble, and the two pale parts on each elytron disconnected, owing to the black submedian fascia extending to both the suture and sides. Three other (old) South Australian specimens, also appear to belong to the species, but have the inter-ocular space glabrous; the prothorax has a dark green gloss and the dark parts of the elytra a purplish gloss, their markings, except for slight differences of detail, are as on the Murray Bridge specimen.

Ditropidus pulchellus Baly.

This species ranges 3.25—4.5 mm. in length; the pale elytral markings vary from bright flavous to a moderately dark red, but appear to be always paler than the prothorax; the latter is usually without discal markings, but occasionally has a black transverse median fascia, or there may be a series of spots representing the fascia. I cannot distinguish the species structurally from *ornatus*.

Ditropidus cornutus Baly.

A curious species readily distinguished by the armed muzzle of the male, the processes on the clypeus and mandibles, however, vary somewhat in size. The upper surface usually has a slight brassy-green gloss; on the elytra of the male there are usually four dark blotches, sometimes only two; on the female the blotches are usually scarcely in evidence; the male also has most of the under-surface black, on the female usually only the metasternum is infuscated. The types were from "Australia"; the specimens before me are from Western Australia (Warren River and Karridale).

Ditropidus fasciatus Baly.

(*D. canescens* Chp.)

On this species there is a short oblique carina on each side of the prothorax at the base, very distinct on the male, feeble on the female; the wide fascia on the elytra varies in extent, sometimes being continuous except for a very narrow interruption at the suture, at other times appearing as a large spot on each side; the legs are usually entirely dark or almost so. The clothing of the prothorax varies apparently in accordance with the elytral fascia, on specimens having this of great extent the pubescence is decidedly denser than on those whose fascia is greatly reduced in size; the elytra are usually entirely glabrous, but on an occasional specimen the sides are feebly pubescent towards the base.

Ditropidus fasciatus var. pictipes, n. var.

Six males, from Cue, differ from the typical form in having the prothoracic punctures somewhat coarser, and the legs red, except that the tarsi are almost black, that there is a black streak on the under surface of the front femora, and that the knees are slightly infuscated, the elytral fascia is wide and very narrowly interrupted at the suture, and the dark parts of the elytra, although brassy, are paler than the prothorax.

A specimen, from Port Lincoln, appears to represent another variety; it has the elytra entirely pale, except that a small amount of the base is dark and the suture is infuscated; the colour, however, is less flavous than usual; the front legs are dark, but with the coxae and part of the tibiae obscurely reddish, the other legs are red, except for the tarsi and knees. The outer half of each elytron is sparsely but rather distinctly pubescent.

A female, from Western Australia, may represent still another variety, it is unusually small (3 mm.) and at first glance the elytra appear to be entirely dark, but from some directions a fairly large space on each side about the basal third appears to be obscurely diluted with flavous; the legs are almost entirely dark, the prothorax has denser punctures than usual, with a tendency to become longitudinally confluent, and the latero-basal carinae are scarcely indicated.

Ditropidus doriae Chp.

Numerous specimens from Northern Queensland (Cape York, Cairns, Mackay and Bundaberg) probably belong to this species, but only two of them could fairly be noted as having both prothorax and elytra "nigro-cyaneis"; on most of them the elytra are purple, or deep purplish-blue, and the prothorax blue or black, with a slight greenish gloss; the elytra usually have some of the interstices obliquely strigose, but on some of them they are feebly strigose only near the apex. The eyes of the male are close together, about half the length of the basal joint of the antennae separating them; on the female the distance between them is about equal to the length of that joint.

Ditropidus tibialis Chp.

A small metallic species rather common in New South Wales; the typical form has legs pale, but hind femora dark; the prothoracic punctures are rather dense and sharply defined.

Var. A. Some specimens (from Sydney, Maitland and Armidale) differ in being of a darker and less coppery-green, and with the legs entirely dark; but I can find no structural differences from the typical form.

Ditropidus punctulum Chp.

This species ranges 1.25—1.5 mm. in length. The eyes are rather widely separated in the male, still more in the female. There was a cotype in the Blackburn collection and other specimens before me are from Queensland (Bribie Island), South Australia (Mount Lofty, Port Lincoln and Murray Bridge), and Western Australia (Swan River).

Ditropidus convexiusculus Chp. (formerly *Elaphodes.*)

Two specimens, from Bowen, appear to belong to this species, described, without the sex of the type being noted, originally as an *Elaphodes*. The antennae of the male are broken, but those of the female are slightly shorter and stouter than in *D. comans*, referred by Chapius to *Ditropidus*. The male has a conspicuous cross of white pubescence on the pronotum, on the female the cross is present but less distinct; the female has a conspicuous median fascia of white pubescence on the elytra, but on the male this is not distinct, owing to their clothing being almost entirely white. In appearance the species is fairly close to *comans*, but differs in having the prothorax scarcely gibbous, not shagreened, its punctures more sharply defined and not at all elongate, and the elytral striae distinct only near the sides.

Ditropidus comans Chp.

On this species there is usually, but not always, a distinct median fascia of white clothing on the elytra, the prothorax is gibbous in front, and at the middle is either glabrous or very sparsely clothed, allowing the dense punctures and finely shagreened surface to be clearly seen. The distance between the eyes is about equal to the length of the basal joint of the antennae in the male, considerably more in the female; the length ranges 1.5—3 mm. The species occurs from Dalby, in Queensland, to the Swan River, in Western Australia.

Ditropidus pubicollis Chp.

Recorded by Chapius without exact locality; specimens before me agreeing with his description are from New South Wales (Goulburn, Tamworth and Windsor) and South Australia (Quorn and Lucindale).

Ditropidus puberulus Chp.

A specimen from Geraldton (Western Australia) possibly belongs to this species; it is a male (the type was a female) and differs from the description in being slightly smaller (2.25 mm.) and in having the parts flavous that were noted by Chapius as ferruginous, except that the joints of the club are infuscated at their tips.

Ditropidus maculicollis Chp.

A specimen from Brisbane (the type was from Sydney) agrees well with the description of this species; its abdomen is more strongly convex than is usual in males, and the tip of the pygidium is not encroaching on the lower surface; but as it is nonfoveate I presume the specimen must be a male. Two other males, from Geraldton, appear also to belong to the species, one is slightly larger than the Brisbane specimen, and its prothoracic blotch is broken up into two spots; the other is still larger (2.5 mm.) and its prothorax is immaculate.

Ditropidus aciculatus Chp.

Two specimens from Victoria and South Australia (Mount Lofty) possibly belong to this species, but differ from the description in being smaller (1.75—2 mm.), and with the sides of the prothorax narrowly reddish; the differences are possibly sexual, as they are males, and the type was a female. They both have the shoulders slightly infuscated, and one at first glance appears to have a large scutellum, owing to the derm in its vicinity being deeply infuscated.

Ditropidus lentulus Chp.

Three cotypes of this species from Tasmania have the legs entirely dark, and there are many similar specimens before me, but the legs, especially the front and middle ones, are often obscurely reddish; the upper surface frequently has a greenish gloss, rarely a purplish one. There is a rather wide and shallow median line on the head, and the eyes are moderately widely separated on the male, more so on the female.

Ditropidus subaeneus Chp.

There were two females of this species in the Blackburn collection, one bearing a label "*Ditropidus subaeneus* Chp. Type" (no doubt it is a cotype), and I took one at Hobart. All three have the hind legs black with a metallic gloss, but the middle and front legs vary somewhat in colour. The head has a conspicuous median line (not mentioned in the original description) and the eyes are widely separated, but no doubt they are closer together in the male.

Ditropidus costatus Chp.

Two females from Dalby and one from Bowen possibly belong to this species (recorded from "Australia"), but they are brightly metallic (the types were described as "submitidus"). The Bowen specimen has the apical half of the abdomen brightly coppery, the others have most of it more or less red. They are close to *venustus*, but the prothorax has slightly smaller punctures, its sides could fairly be called strigose, and its colour is but little different to that of the elytra, the legs are also of a bright red.

Ditropidus laminatus Chp.

On the male of this species the clypeus has two subtriangular elevations, each side of the elytra has a large opaque patch (in striking contrast to the adjacent polished surface), and the front legs are stout and rather long. The female differs from it in being less dilated at the junction of the prothorax and elytra, the latter nowhere opaque, the tubercles on the clypeus much smaller, the front legs shorter and thinner, the antennae thinner, and the abdomen more convex, with a large apical fovea. On the male the eyes are separated about the length of the two basal joints of antennae, on the female about three. The specimens before me are all from Queensland (Cape York, Coen, Cairns, Bowen, and Charters Towers).

DITROPIDUS IMPERIALIS Chp.

Seven females, from Cape York, Coen, and Cairns, appear to belong to this species, the finest of its genus from Australia; only one agrees at all well with the type in colours, the others have the prothorax and scutellum coppery or coppery-red, and the elytra deep purple, or purplish-blue; on some of them the antennae have the basal joint no darker than the second, but on two it is partly infuscated; the distance between the eyes is about equal to the length of the two basal joints of antennae. Two males, from Cairns, differ in being smaller, 4—4.25 mm., the eyes larger and closer together, the distance between them less than the length of the basal joint, front legs stouter, abdomen smaller, sloping to base and apex, and non-foveate, and the clothing of the under surface denser; the prothorax and scutellum are coppery with a slight greenish gloss, the head is darker and the elytra are purple.

DITROPIDUS INSULARIS Lea.

(*D. chalceus* Lea; *D. lateralis* Lea.)

After reexamining the types and many other specimens I now believe that *D. chalceus* and *D. lateralis* can only be regarded as varietal forms of *D. insularis;* the upper surface is usually brassy, but varies to entirely blue, the legs vary from entirely dark to almost entirely red; the prothoracic punctures are always sharply defined, and are fairly dense. The species is evidently close to *D. distinguendus*, but all the specimens before me are larger, up to 3.5 mm. in length, than the type of that species, and the prothorax could not be regarded as "lateraliter strigero."

DITROPIDUS NIGRICOLLIS Lea.

A male, from Northern Queensland, probably belongs to this species, but differs from the type in being smaller, 1.75 mm., the head and prothorax reddish-flavous, and elytra flavous (except that there is a narrow black line at the junction of the prothorax and elytra); its under surface has a conspicuous black cross, the upright part of which extends from the prosternal process to the end of the first abdominal segment, and the cross-piece is on the metasternum, ending abruptly at the episterna. Another male, from Sydney, agrees with it, except that the cross-piece on the under surface is larger and less sharply defined, its sides including the metasternal episterna.

DITROPIDUS SUBSIMILIS Lea.

A female of this species, from the Blue Mountains, differs from the types in having a small, round, black spot, towards each side of the pronotum.

DITROPIDUS NIGRIPENNIS Lea.

On the male of this species the clypeus is depressed in the middle, and each side is elevated into a small subtriangular, slightly curved, black-tipped process, about half the length of the basal joint of the antennae; the armature is different from that of *D. cornutus*, and there are many other differences of sculpture and colour.

VAR. A. Three males, from Jenolan, agree so closely with the types that I cannot regard them as representing a distinct species, but the processes on the head are much longer (somewhat longer than the basal joint of the antennae) more strongly curved, and conspicuous from most directions.

Ditropidus laevicollis Lea.

This species occurs in South Australia (Luciudale and Port Lincoln) as well as in Western Australia. Its clypeus appears as a narrow transverse ridge, and in many other respects it agrees with the description of *D. submetallescens*, but all the specimens before me are somewhat larger, 2—2.75 mm., than the type of that species, $\frac{2}{3}$ lin., which was also noted as having "thorace subremote, tenuiter punctato"; the prothoracic punctures of *D. laevicollis* are certainly not subremote, being fairly dense, although not crowded.

Ditropidus striatopunctatus Lea.

A short compact species, the prothorax with sparse and small punctures on the disc, but the sides densely longitudinally strigose. Specimens from Sydney and Galston agree well with the type, except that the legs are entirely black; the eyes of the male are separated rather more than the length of the basal joint of the antennae, still more in the female.

Ditropidus sobrinus Lea.

Numerous specimens from South Australia (Petersburg, Quorn and Parachilna) belong to this species, but range in length 2.25—3 mm., the males usually being smaller than the females. The eyes are moderately widely separated in the males, more widely in the females; the punctures in the inter-ocular space are rather dense and sharply defined; there is usually a well-defined median line there, but occasionally it is almost absent; the discal striae of the elytra are very feeble; the labrum is reddish, and the red occasionally extends to the clypeus.

Ditropidus venustus Lea.

A specimen from Northern Queensland, and another from Mungar Junction, differ from the types in having the upper surface entirely purple, although the prothorax is of not quite the same shade as the elytra.

Ditropidus scitulus Lea.

Of two specimens from the Swan River one agrees well with the type, but the other has the elytra of a vivid coppery-green.

Ditropidus latifrons, n.sp.

♂.—Coppery-bronze, in places with a slight purplish gloss; labrum, antennae (the club infuscated) and palpi reddish, tips of tibiae obscurely reddish. Moderately densely clothed with white pubescence.

Head wide and flat in front; with rather dense, partially concealed punctures. Eyes widely separated. *Prothorax* about twice as wide as the median length, evenly convex, a feeble oblique carina on each hind angle, these acute; punctures rather dense and sharply defined, but not very large. *Elytra* with somewhat coarser punctures than on prothorax, the interspaces slightly rugose; striae well-defined on sides, but scarcely traceable elsewhere. *Legs* rather stout, the front ones somewhat longer than the others. Length (♂, ♀), 3.75—4 mm.

♀.—Differs in being rather more robust, head smaller, labrum less prominent, antennae somewhat thinner, with the club no darker than the basal joints, front legs no longer than the hind ones, more of the tibiae red, and in the abdomen.

Hab.—New South Wales: Condobolin, in October (W. W. Froggatt).

On the under surface the clothing is somewhat longer than on the upper; on the disc of the pronotum it has a somewhat rusty appearance, across the middle it forms a whitish line that is fairly distinct on the types, and on another specimen that was returned to Mr. Froggatt; but as a similar line is to be seen on occasional specimens of other species, it is probably not to be depended upon. The distance between the eyes of the male is about equal to the width of the clypeus, on the female it is slightly more. The species is close to *D. pubescens*, but the prothorax has a short oblique carina on each hind angle (somewhat as on *D. fasciatus*, but less distinct) the legs are darker, and the punctures are slightly coarser; the shape is more oblong than in *D. pubicollis* and *D. whitei*, and the clothing is denser.

DITROPIDUS GENICULATUS, n.sp.

♂.—Coppery-bronze; clypeus, labrum, parts of antennae, base of tibiae and usually parts of abdomen and elytral epipleurae red. Under surface moderately clothed with white pubescence, more sparsely on upper.

Head with a wide and rather shallow median line; punctures dense and rather sharply defined, becoming confluent in places. Eyes widely separated. *Prothorax* about twice as wide as the median length, rather strongly and evenly convex, scutellar lobe small; punctures rather small and not very dense in middle, becoming crowded and confluent, or substrigose, on sides. *Elytra* oblong, with dense and rather small but asperate punctures, the interspaces finely rugose (almost shagreened), striae distinct on sides but scarcely traceable elsewhere. *Legs* moderately stout, front ones scarcely longer than the hind ones. Length (♂, ♀), 3–4 mm.

♀.—Differs in being rather more robust, head slightly smaller, the median line deeper and almost foveate in the middle, antennae somewhat thinner, legs slightly shorter, and in the abdomen.

Hab.—Western Australia: Geraldton (A. M. Lea).

A sub-oblong species, not very densely but almost evenly clothed on the upper surface. The third, fourth, and fifth joints of the antennae, and the lower parts of the first and second are reddish, the others being blackish; the red of the clypeus varies in extent and intensity; the sides of the three or four basal segments of abdomen and the tip of the pygidium are usually, but not always, reddish (the variation is not sexual); the elytral epipleurae are of a rather bright red on some specimens, obscure on others; the red of the tibiae sometimes extends to the tips of the femora. The distance between the eyes is about equal to the width of the clypeus on the male, rather more on the female. From above the hind angles of the prothorax appear to be acute, but from the sides they are seen to be rectangular; the sides are not evenly strigose, the punctures there being dense and frequently confluent, but as the derm is partially concealed by the clothing, the surface at first glance appears quite conspicuously strigose. On the apical segment of the abdomen of the male there is a vague depression, but on the female this is increased to a large round fovea. In general appearance it is fairly close to *D. pubicollis* but is somewhat narrower and the elytra are not glabrous; from *D. gymnopterus*, to which it is closer in shape, it differs markedly in the finer sculpture of both prothorax and elytra, as well as in the latter being clothed; *D. intonsus* is much smaller and more rounded; *D. whitei* is larger, more rounded, and with the finer sculpture different. The antennae are somewhat longer than is usual, but the joints of the club are not sufficiently long and loose to warrant the species being referred to *Elaphodes*.

DITROPIDUS MIRUS, n.sp.

♂. Coppery-bronze; elytra flavous, shoulders, base, and suture infuscated, six basal joints of antennae (except upper surface of first), knees and trochanters reddish, rest of antennae and of legs infuscated or black. Head, prothorax, under surface and legs with white pubescence.

Head large and wide, obliquely flattened between eyes, shagreened and finely punctate; clypeus large, rounded in front, less shagreened and with stronger punctures than between eyes; labrum wide and feebly bilobed; mandibles large and strongly curved. Eyes prominent and widely separated. *Prothorax* about twice as wide as the median length, base not much wider than apex; with small and sparse punctures on middle, becoming more numerous, but not crowded, on sides. *Elytra* slightly longer than the basal width, sides moderately narrowed posteriorly; with rows of small but distinct punctures, on the sides set in distinct striae; interstices subopaque or very inconspicuously shagreened. Front *legs* much longer than the others. Length, 4—4.25 mm.

Hab.—New South Wales: Moree (W. W. Froggatt's 107 L).

A remarkably distinct species, with mandibles suggestive of those of the male of *Elaphodes vulpinus*, although the antennae are of normal length; the eyes are unusually wide apart, and the canthus of each is rather feeble; the great length of the front legs is due partly to the tarsi, but mostly to the tibiae, the latter being at least half as long again as the others. I know of no closely allied species, although the colour of the elytra is at first suggestive of *D. fasciatus*; on the male of *D. mandibularis* the jaws, although very powerful, are of different shape, the eyes are closer together (although widely separated) with the canthus larger, and the prothorax entirely glabrous.

DITROPIDUS BIMACULATUS, n.sp.

♂. Black; muzzle, basal half of antennae, palpi, a large spot on each elytron, and parts of front legs flavous or reddish-flavous. Head, under surface and legs with sparse, whitish pubescence.

Head with rather small and dense but sharply defined punctures; median line feebly defined. Eyes moderately separated, the distance between them about equal to the length of two basal joints of antennae. *Prothorax* not quite twice as wide as the median length, base almost twice as wide as apex; punctures about as large as on head, but not quite as dense. *Elytra* slightly narrowed posteriorly; with rows of rather small but distinct suboblong punctures, becoming larger and set in strong striae on the sides, interstices with minute punctures. *Legs* rather short. Length, 2.6 mm.

Hab.—Queensland: Dalby (Mrs. F. H. Hobler), unique.

The non-metallic upper surface, with two large red spots on the elytra, render this a very distinct species, to which I know no closely allied one; each spot is tear-shaped, and extends from the middle of the disc (where it is narrowest) almost to the inner apical angle, where it occupies about two-thirds of the width; the red of the muzzle extends to slightly beyond the ocular canthi, the front femora are almost entirely red, the under surface and apex of the front tibiae and the tips of the others are also more or less reddish. The median length of the prothorax is slightly more than the apical width.

DITROPIDUS LATICOLLIS, n.sp.

♀.—Black; labrum, basal half of antennae (the club infuscated) and palpi rather obscurely flavous; elytra with sides and apex widely flavous, elsewhere infuscated; legs in parts obscurely diluted with red. Under surface and legs slightly pubescent.

Head shagreened and with dense, fine, aciculate punctures, more distinct on clypeus than elsewhere. Eyes rather widely separated. Antennae short. *Prothorax* more than twice as wide as the median length, apex scarcely half the width of base; shagreened and with dense, fine, aciculate punctures, becoming crowded in front angles. *Elytra* scarcely as long as wide, sides moderately rounded; with rows of distinct but not very large punctures, becoming larger and set in deep striae on the sides; interstices with dense and very fine punctures, or feebly shagreened. *Abdomen* with a large, round, deep, apical fovea. Length, 2.75—3 mm.

Hab.—Queensland: Duaringa (G. Barnard).

A curious round species of which I know no close ally. On two specimens the elytra have the sides widely flavous, from the base to and across the apex (but there is a slight infuscation on the sides above the abdomen), thus bounding on three sides a large, subquadrate, deeply infuscated patch; on a third specimen the infuscation is extended so that the flavous parts (which are considerably reduced in intensity) are confined to the vicinity of the shoulders and apices; on the third specimen the median line of the head is very distinct, on the others it is feeble. The distance between the eyes at their nearest is about equal to the length of the three basal joints of the antennae, but it would be less in the male. The pronotum has a vague bronzy gloss, but it could hardly be regarded as metallic; from some directions it appears to be very finely pubescent, but under a compound power it is seen to be quite glabrous; the hind angles from above appear to be quite sharply acute, but from the sides they are seen to be rectangular; the notch of the scutellar lobe is very feeble. The intercoxal process of the prosternum is almost twice as wide as long, truncated in front, and feebly incurved behind.

DITROPIDUS IMPUNCTICOLLIS, n.sp.

♀.—Black; labrum, basal half of antennae (the club infuscated), palpi, abdomen, legs, and a variable amount of elytra flavous. Under surface and legs very feebly pubescent.

Head shagreened and subopaque; median line feeble. Eyes widely separated. *Prothorax* about thrice as wide as the median length, sides strongly narrowed to apex; impunctate. *Elytra* about one fifth longer than wide, sides moderately rounded; with rows of rather small but distinct punctures, on the sides set in distinct striae. *Abdomen* with a large, round, deep, apical fovea. Length, 1.75—2 mm.

Hab.—Western Australia: Karridale (A. M. Lea).

A minute species without punctures on the prothorax, even on the sides. The hind end of the prosternal process is almost truncated, but as the scutellar lobe is notched, the scutellum minute, and club five-jointed the species was referred to *Ditropidus* without hesitation. Of the two specimens under examination the larger one has the elytra flavous, except for a narrow black basal edging, and a short infuscation of the suture at the base; but the smaller one has about half of the elytra black or infuscated, the dark part not sharply defined on its edges, but extending from each shoulder to the suture beyond the middle, so that the sides and apex are widely flavous.

DITROPIDUS METALLICUS, n.sp.

♂.—Coppery, prothorax sometimes with a greenish gloss; labrum, basal half of antennae (the club infuscated), tips of elytra, abdomen (except part of base), legs (the claws infuscated) reddish-flavous. Head, under surface and legs sparsely pubescent.

Head with crowded and more or less obliquely confluent punctures; median line rather shallow. Eyes widely separated. *Prothorax* at apex about as wide as the median length, sides increasing in width to base; with dense and rather strong punctures, the sides conspicuously strigose. *Elytra* oblong; with rows of rather large punctures, at the sides set in rather deep striae. Length (♂, ♀), 2—2.5 mm.

♀.—Differs in being somewhat more robust, eyes more widely separated, prothorax and legs slightly shorter, and abdomen larger, with a large, round, deep, apical fovea.

Hab.—Tasmania: Sheffield (H. H. D. Griffith's No. 1204).

The prosternum is usually coppery, the mesosternum and metasternum bronzy; the dark part of the abdomen is sometimes semicircular, and almost confined to the intercoxal process; the pygidium is entirely pale. The median line of the head is rather shallow, but is very conspicuous on account of the converging punctures; the front legs of the male are no longer than the hind ones. The description of *D. apiciflavus* (from "Nouvelle Hollande") agrees in most respects with this species, except that of the prothorax, which is noted as "parce et subtiliter punctulato, lateraliter substrigoso." Specimens from New South Wales (Gosford, Sydney, and Jenolan) agree in all respects with its description (except that some of them are larger); the present species differs from these in having the prothorax with dense, and, for the genus rather strong punctures, with the sides densely strigose; it has also larger elytral punctures, is narrower and more coppery (almost golden) than brassy. It is the only species now known from Tasmania, with the elytra tipped with red, although the red is not always sharply limited; *D. viridiaeneus* has the prothorax wider and very differently sculptured.

DITROPIDUS INSIGNIS, n.sp.

♀.—Deep violet-blue, labrum, palpi and part of antennae red. Under surface and legs with sparse pubescence.

Head with crowded and sharply defined punctures, becoming rugose on clypeus, median line shallow and irregular. Eyes widely separated. *Prothorax* at base scarcely twice as wide as the median length, sides strongly rounded; with crowded, longitudinally confluent punctures, except on scutellar lobe, where they are separately impressed. *Elytra* briefly suboblong; with rows of not very large but deep punctures, becoming larger and set in fairly deep striae on the sides; interstices with sparse punctures, except posteriorly, where they are moderately dense and rugose. *Under surface* with rather dense and coarse punctures; abdomen with a large, round deep apical fovea. Length, 4.25 mm.

Hab.—Western Australia: Mullewa (Miss J. F. May), unique.

A beautiful deep-blue species, very distinct from all others known to me by the sculpture of the prothorax; at first glance this appears to be densely longitudinally strigose, but it is really densely punctate, the punctures everywhere confluent except on a small part of the scutellar lobe. The elytra are of the same shade of colour as the prothorax, but owing to their smoother surface they appear brighter; the antennae are rather long for the genus, and the second-fourth joints are partly or entirely red, the others being more or less deeply infuscated. The pygidium is glabrous, and its punctures are quite as sharply defined as those on the head.

Ditropidus pygidialis, n.sp.

♂.—Black; three basal joints of antennae obscurely reddish. Under surface and legs with sparse pubescence.

Head with dense punctures at base and on clypeus; median line wide, shallow, and with smaller and sparser punctures than on the adjacent surface. Eyes moderately separated. *Prothorax* at base not twice as wide as the median length, sides strongly rounded; with sparse and minute punctures, the front angles finely strigose. *Elytra* briefly suboblong, with rows of not very large punctures, at the sides set in deep stria; interstices faintly wrinkled. Length (♂, ♀), 2.6—3 mm.

♀.—Differs in being slightly more robust, prothorax shorter, legs somewhat shorter, and in the abdomen.

Hab.—New South Wales: Sydney (A. M. Lea).

There is a single specimen of each sex before me; on the male the elytra have a slight bluish or bluish-green gloss, but this is absent from the female; the distance between the eyes of the male is about equal to the length of the three basal joints of antennae, in the female of the five basal joints; on the male the front angles of the prothorax are densely and finely strigose, but the strigae are so very fine that the surface at first appears to be slightly shagreened, on the female they almost reach the vanishing point; the hind angles from above appear to be acute, and to slightly embrace the shoulders, but they are really almost rectangular; the punctures on the pygidium are dense and subreticulate.

Ditropidus carinaticeps, n.sp.

♀.—Blue; labrum, palpi, and second-sixth joints of antennae red. Under surface and legs with sparse, inconspicuous pubescence.

Head large; with rather small but sharply defined punctures, becoming crowded and irregular in front; median line well-defined; clypeal suture marked by a bisinuate carina. Eyes very widely separated. *Prothorax* about twice as wide as the median length, sides strongly rounded, lateral gutters well-defined; punctures small but sharply defined. *Elytra* sub-oblong; with rows of fairly large punctures, on the sides set in deep striae; interstices with sparse and minute punctures. *Abdomen* with a large, round, deep, apical fovea. Length, 4.5 mm.

Hab.—New South Wales: Forest Reefs (A. M. Lea), unique.

The side of each elytron is gently incurved between the base and the sudden deflection before the middle, the dilated part being unusually deep, and the sublateral interstice curving around on to it; the clypeus has two small transversely-oval, impunctate areolets, each bounded behind by a narrow carina, and in front by a more obtuse elevation (it is probably very different in the male); these characters at once distinguish the species from *D. armatus*, *D. vigilans*, *D. abdominalis* and the blue variety of *D. concolor;* from the variety, it is also distinguished by its red labrum, longer elytra, different inter-ocular space, non-strigose sides of prothorax, and punctures of metasternum notably coarser and sparser towards the sides. In *D. coelestis* the sides of the elytra are almost the same, but the punctures of the head and prothorax are considerably larger and denser, and the head has a circular inter-ocular fovea. The head and parts of the under surface have a greenish gloss, the elytra a purplish one; the tip of the abdomen and middle of the metasternum are obscurely diluted with red, but from most directions the red is invisible, parts of the coxae are also obscurely reddish. The prothoracic punctures, although small, are sharply defined, on the sides they are slightly elongated, but not at all confluent.

DITROPIDUS SUBARMATUS, n.sp.

♂.—Bronzy, labrum, basal half of antennae, palpi, and under surface of front femora and tibiae reddish. Head, under surface and legs with white pubescence.

Head with rather distant punctures; median line lightly impressed; clypeus subtuberculate at each end. Eyes rather close together. *Prothorax* at base not twice as wide as the median length, sides strongly narrowed to apex; with small but sharply defined punctures in middle, becoming larger and crowded on sides. *Elytra* not much longer than basal width, sides rather strongly narrowed posteriorly; with rows of rather large punctures, interstices with dense but faint punctures (almost shagreened). Front *legs* slightly longer than hind ones. Length, 2.75 mm.

Hab.—Western Australia: Swan River (A. M. Lea), unique.

This species has been placed amongst those having dark legs, as, although the under surface of the front ones is reddish, their upper surface is blackish; the elytra have a vague greenish gloss. The distance between the eyes is hardly more than the length of the basal joint of antennae; the rows of punctures on the elytra, even the short subsutural ones, are set in shallow striae; as a result the interstices are gently separately convex; on the sides, however, the striae are much deeper, and the interstices are acutely costate; although the type is a male, the third abdominal segment is distinct across the middle. The sides of the clypeus denote an approach to some of the armed species, as they are slightly elevated and shining, with the intervening space depressed; this character at once distinguishes the species from *D. cognatus*, *D. quadratipennis*, *D. indistinctus*, *D. congenitus* and others, to which at first glance it seems close; in general appearance it is like a small *D. concolor*, but the jaws and clypeus are very different.

DITROPIDUS LOBICOLLIS, n.sp.

♂.—Black, upper surface with a slight bronzy gloss, labrum and basal half of antennae (upper surface of first joint infuscated) reddish. Head, under surface, pygidium and legs with white pubescence.

Head with rather small, dense, partially concealed punctures; median line vague. Eyes as far apart as the length of two basal joints of antennae. *Prothorax* at base almost twice as wide as the median length, sides strongly rounded, with small and sharply defined but not crowded punctures in middle, becoming larger and denser on sides. *Elytra* short; with rows of not very large punctures, becoming larger and set in deep striae on the sides; interstices with fairly dense but very minute punctures. Front *legs* slightly longer than hind ones. Length, 3.25 mm.

Hab.—Queensland: Brisbane (A. J. Coates), unique.

The three apical joints of the club are missing from the type, but the two basal ones are of normal appearance, the scutellar lobe is acute, slightly elevated and not notched. The type at first looks like a small female of *D. concolor*, but has very different punctures and jaws; the prothorax is less narrowed in front than *D. subarmatus*, the eyes are slightly more distant, and the clypeus is not subdentate on the sides; the prothoracic punctures differ, both on the middle and sides, from those of *D. puncticollis* and the labrum is reddish, etc.; the elytra are not shagreened as in *D. costatus*.

Ditropidus caeruleus, n.sp.

♂.—Deep blue, under surface almost black, front of clypeus, labrum and basal half of antennae (upper surface of basal joint infuscated) reddish. Under surface and legs sparsely clothed, head almost glabrous.

Head with dense, sharply defined punctures. Eyes widely separated. *Prothorax* more than twice as wide as the median length, sides strongly rounded; with fairly dense and rather small, but sharply defined punctures, becoming slightly smaller on sides. *Elytra* briefly suboblong, sides gently narrowed posteriorly; with rows of small punctures, becoming slightly larger and set in distinct striae on the sides; interstices faintly wrinkled, and with very small punctures. Front *legs* slightly longer than hind ones. Length (♂, ♀), 2.75–3 mm.

♀.—Differs in being more robust, eyes slightly more apart, elytra less narrowed posteriorly, front legs no longer than hind ones, and abdomen with a large, round, deep, apical fovea.

Hab.—Western Australia: Rottnest Island and Vasse River; New South Wales: Sydney (A. M. Lea).

A beautiful, deep blue species, with unusually small seriate punctures on the elytra: the head occasionally has a slight greenish or coppery-green gloss, and two specimens have the sides of the elytra, from some directions, distinctly coppery, occasionally the upper surface is almost purple; the tips of the tibiae and the extreme base of the front femora are sometimes reddish. It is more conspicuously blue than *D. tropicus*, eyes (sex for sex) more widely separated, prothoracic punctures larger, seriate ones of elytra much smaller and the interstices faintly wrinkled; structurally it is close to *D. clypealis*, which also has the clypeus red, but the colour and punctures are different; it has the sharply defined inter-ocular punctures of *D. frontalis*, *D. melasomus*, *D. seminulum* and *D. sobrinus*, but differs from all of these in being shorter and broader, prothorax with sides more strongly narrowed in front, and punctures denser and stronger. The median line of the head is very feeble at the base, and on some specimens is represented by a shallow, almost circular depression in the middle, but from some specimens it is altogether absent.

Ditropidus coriaceus, n.sp.

♂.—Black, with a slight bronzy gloss, basal half of antennae obscurely reddish. Glabrous. Upper surface shagreened.

Head with very minute punctures, median line very feeble. Eyes rather widely separated. *Prothorax* about thrice as wide as the median length, sides strongly rounded; punctures very minute. *Elytra* short, sides beyond middle strongly rounded. Length, 1.2—1.3 mm.

♀.—Differs in the usual particulars of eyes, legs and abdomen.

Hab.—Western Australia: Geraldton and Swan River (A. M. Lea), Dirk Hartog Island (Dr. Michaelsen).

In general appearance very near *punctulum*, but slightly narrower and elytra shagreened, on that species the head and prothorax, but not the elytra, are shagreened, the shagreening is not so pronounced as that of the head and prothorax, but is quite distinct; from some directions vague lines representing series of punctures may be seen on the discal parts, and even the lateral striae are very feeble, on several specimens only the marginal stria on each side is present; an inconspicuous depression traverses the base of the scutellar lobe; the median line of the metasternum is dilated at the base so as to form a fairly large but shallow fovea.

DITROPIDUS TRANQUILLUS, n.sp.

♂.—Black, labrum, basal half of antennae (club infuscated) palpi and parts of legs more or less reddish or flavous. Glabrous.

Head evenly convex; with small, but rather sharp punctures; median line scarcely traceable. Eyes rather widely separated. *Prothorax* more than twice as wide as the median length, sides strongly rounded; with rather dense and small, but sharply defined punctures. *Elytra* subquadrate; with series of small punctures, on the sides set in deep striae. Length (♂, ♀), 1.75—2 mm.

♀.—Differs in the usual particulars of eyes, legs and abdomen.

Hab.—New South Wales: Sydney and Como (A. M. Lea).

Slightly larger and more compact than *D. vagans*, and elytral punctures almost the same, but prothoracic punctures slightly smaller, and all parts of the upper surface shining and nowhere shagreened or opaque; the prothoracic punctures are much smaller than on *D. rotundiformis*, and the legs are paler. There are dense and sharply defined punctures on almost the whole of the under surface. The knees, tarsi, and hind femora are usually darker than the rest of the legs, sometimes the hind femora are only partly dark, occasionally the tibiae are scarcely paler than the tarsi.

DITROPIDUS RUFIMANUS, n.sp.

♂.—Black; clypeus, labrum, most of inter-ocular space, basal half of antennae (the club infuscated) palpi, front legs (knees infuscated), middle and hind tarsi, more or less red. Under surface and legs with very sparse pubescence.

Head subopaque; with small and fairly dense punctures; median line lightly impressed. Eyes rather widely separated. *Prothorax* about twice as wide as the median length; with very small but sharply defined punctures. *Elytra* briefly suboblong, with rows of rather large punctures, becoming much smaller posteriorly, and set in deep striae on the sides. Front *legs* slightly longer than hind ones. Length (♂, ♀), 2—2.25 mm.

♀.—Differs in being more robust, eyes more apart, inter-ocular space, clypeus and front femora black, seriate punctures of elytra smaller, front legs no longer than hind ones, and abdomen larger, more convex, and with a large, apical fovea.

Hab.—South Australia: Mount Lofty (A. M. Lea).

In some respects fairly close to the description of *D. facialis*, but middle tibiae dark, on the head of the female only the labrum is pale, the sides of the metasternum are not pale, and five joints of the antennae are dark; the clothing and punctures also do not agree with the description. Only one specimen of each sex was obtained, and it is probable that the colours of the legs are variable.

DITROPIDUS SCULPTIPENNIS, n.sp.

♂.—Black; muzzle, basal half of antennae, palpi, and parts of legs more or less flavous. Under surface and legs very feebly pubescent.

Head opaque and with small punctures; median line lightly impressed. Eyes large and close together, the distance between them hardly more than half the length of the basal joint of antennae. *Prothorax* more than twice as wide as the median length, sides strongly rounded; with rather small but sharply defined punctures in middle, becoming larger and crowded on sides. *Elytra* short; with rows of rather large punctures, on the sides and apical half in distinct striae. *Abdomen* with a vague apical depression. Front *legs* slightly longer than hind ones. Length, 2.1 mm.

Hab.—Western Australia: Geraldton (A. M. Lea), unique.

Approaching the *D. jacobyi* group, but the punctures on the medio-basal half of the elytra, although in quite distinct rows, are not in deep striae, on the sides the interstices between the striae are carinated. The tarsi, trochanters, front tibiae and base of front femora are paler than the other parts of the legs, which are more or less deeply infuscated; the pygidium is of a deep black, and the elytra in its vicinity seem dark brown, although from above they seem to be polished black throughout. From above the scutellar lobe seems to be entire, but from behind it is seen to be slightly notched.

DITROPIDUS SUBSUTURALIS, n.sp.

♂.—Black, upper surface with a vague metallic gloss; labrum, basal half of antennae, palpi, tarsi, front legs (knees excepted) and parts of middle and of hind tibiae more or less flavous. Glabrous.

Head shagreened and with minute punctures; median line lightly impressed. Eyes moderately separated, their distance apart slightly more than the length of basal joint of antennae. *Prothorax* about thrice as wide as the median length, sides strongly rounded, scutellar lobe shorter than usual; punctures very small. *Elytra* short, rather strongly narrowed posteriorly; rather strongly striated, the striae becoming smaller towards suture, and towards the base near the suture represented by rows of punctures. Length, 1.75 mm.

Hab.—New South Wales: Tweed River (A. M. Lea), unique.

The elytral striae are much as in the preceding species, but their contained punctures are much smaller, the eyes are also more apart, so that the divergence from the *D. jacobyi* type is still more apparent; at first glance the species seems close to *D. brevicollis* and *D. vicarius*, but the striae occupy the whole of the apical half of the elytra, instead of being confined to the sides. The basal segment of the abdomen, and the whole of the metasternum, have dense and small, but sharply defined punctures.

DITROPIDUS BRUNNEIPENNIS, n.sp.

♂.—Black, in places with a slight metallic gloss, but head distinctly coppery; elytra dark brown, becoming paler at apex and sides, the suture narrowly black; labrum, basal half of antennae (club infuscated) and legs more or less flavous. Glabrous.

Head shagreened but with fairly distinct punctures; median line faint and becoming feebly foveate between eyes. Eyes moderately separated, the distance between them about equal to the length of three basal joints of antennae. *Prothorax* more than thrice as wide as the median length, sides strongly rounded, median lobe unusually short; punctures very small but from some directions rather sharply defined. *Elytra* about as long as the basal width, apical half rather strongly rounded; with series of punctures of moderate size, set in deep striae on the sides, and lighter ones posteriorly. *Abdomen* with a shallow apical depression. Front *legs* slightly longer than hind ones. Length (♂, ♀), 1.5—1.75 mm.

♀.—Differs in having eyes more apart, front legs no longer than the hind ones, and abdomen with a large apical fovea.

Hab.—Western Australia: Swan River and Karridale (A. M. Lea).

A short rounded species, with elytral striation approaching the species of the *D. jacobyi* group, but the striae on the medio-basal portion giving place to rows of punctures, the eyes are also more apart than in any species of that group. The intercoxal process of the mesosternum is larger than usual, and with punctures much as on the prosternal process.

ELAPHODES RHIZOBIOIDES, n.sp.

♀.- Black, elytra with a purplish gloss; labrum, antennae (club more or less infuscated), palpi, abdomen, and parts of coxae and of tarsi reddish-flavous. Moderately densely clothed with somewhat golden pubescence, becoming shorter and sparser on under surface and legs.

Head with dense and sharply defined punctures; median line fairly distinct. *Prothorax* more than twice as wide as the median length, sides strongly narrowed in front; punctures about the size of those on head, but less crowded. *Elytra* rather short; punctures larger and less crowded (although still fairly dense) than on prothorax, only the marginal stria on each side distinct. *Abdomen* with a very large apical fovea. Length, 3.25 mm.

Hab.- New South Wales: Dalmorton, in March (A. M. Lea), unique.

The pubescent body and fairly long club seem to indicate that this species is a member of *Elaphodes* rather than of *Ditropidus*, to which in consequence it has been referred. At a glance it resembles *Rhizobius ventralis*, of the *Coccinellidae*.

ELAPHODES HAEMORRHOIDALIS, n.sp.

♀. Black; muzzle (including a subtriangular space to between the eyes), antennae (club infuscated), tips of elytra, abdomen and legs red. With moderately dense and comparatively long white pubescence, becoming sparser and shorter on under surface and legs.

Head shagreened and with dense punctures, many of which are obliquely confluent; median line feeble. *Prothorax* more than twice as wide as the median length, sides strongly rounded; punctures dense and sharply defined. *Elytra* oblong; with rows of fairly large punctures, on the sides set in striae; interstices each with a row of distinct punctures. *Abdomen* with a large apical fovea. Length, 3.75—4 mm.

Hab.—Tasmania: Hobart (A. M. Lea).

Structurally and in appearance like the preceding species (and as with that species it might almost as well have been referred to *Ditropidus*), but clothing not quite the same, legs and tips of elytra red, and punctures of elytra larger and seriately arranged, those on the interstices are almost as large as those in the regular rows, although not so closely placed, as a result the series appear to be very numerous.

ELAPHODES HALTICOIDES, n.sp.

♂.—Head and prothorax reddish with a coppery gloss; muzzle, basal joints of antennae (the others blackish) prosternum, mesosternum, part of abdomen and legs reddish-flavous, elytra pale flavous (almost ivory-white), with darker markings and punctures, extreme base, scutellum, metasternum, and part of abdomen black or blackish. Moderately clothed with short, whitish pubescence, but elytra glabrous.

Head with crowded punctures; median line feeble. *Prothorax* more than twice as wide as the median length; with dense but not very large punctures, becoming crowded on sides; with remnants of an impunctate median line; scutellar lobe scarcely visibly notched. *Elytra* suboblong; with rows of rather large punctures, in distinct striae throughout; interstices with very sparse punctures. Front *legs* slightly longer than hind ones. Length (♂, ♀), 2.25—2.5 mm.

♀.—Differs in being larger and more robust, under surface entirely pale, and in the usual particulars of the eyes, legs and abdomen.

Hab.—Western Australia: Bridgetown (A. M. Lea).

As the antennal club is but five-jointed this species cannot be referred to *Polyachus;* as the prothorax is clothed and the joints of the club rather lax I have therefore referred it to *Elaphodes;* at first glance it appears to belong to the Halticides, the resemblance to some of the pale species of *Plectroscelis* and to some small ones of *Arsipoda* being quite striking. The markings on the elytra are somewhat the colour of the prothorax, except that in some lights they have a purplish gloss; they are not exactly the same on both specimens; on the male on the left elytron they form an irregular *j* (reversed on the right) and a spot on the shoulder, on the female they are more diffused and connected together; the punctures at first appear to be infuscated, but are really slightly metallic. On the male the eyes are larger than on the female, and the distance between them is slightly less than the width of one, on the female their distance apart is more than the width of one.

COENOBIUS LONGICORNIS, n.sp.

♂.—Black; muzzle, basal joints of antennae and parts of legs obscurely paler. Under surface and legs scarcely visibly pubescent.

Head with a few large punctures in front. Eyes almost touching. Antennae considerably longer than usual in genus. *Prothorax* not twice as wide as the median length, sides strongly narrowed in front, with a fairly deep oblique impression on each side about the basal third; without punctures except on the margins. *Elytra* short; with rows of fairly large punctures, becoming larger posteriorly and on the sides, and on the latter set in deep striae. Front *legs* slightly longer than hind ones. Length, 2 mm.

Hab.—Queensland: Cairns (Dr. E. W. Ferguson), unique.

The eyes are as close together as on *C. parroniger*, but the antennae are decidedly longer and thicker, and the oblique impressions on the prothorax are fairly deep and distinctive; these characters also distinguish the species from *C. inconstans.* The antennae, when at rest, pass the base of the abdomen, the first joint is slightly longer than the second and third combined, the sixth-eleventh are subequal, and each is about twice the length and twice the width of the fifth. The elytra have a vague bluish gloss.

COENOBIUS SPISSUS, n.sp.

♂.—Black or blackish; muzzle, five basal joints of antennae and legs (parts of tarsi infuscated) more or less flavous. Under surface and legs scarcely visibly pubescent.

Head with rather coarse punctures. Eyes large and close together. Antennae moderately long. *Prothorax* at apex scarcely as wide as the median length, a distinct oblique or slightly curved impression on each side of the base, in front of which the surface is rather strongly gibbous; with rather coarse punctures throughout, dense in the middle, crowded on the sides. *Elytra* slightly longer than wide; with rows of large punctures, in distinct striae throughout. Length (♂, ♀), 1.75—2 mm.

♀.—Differs in being more robust, most of prothorax, elytra and under surface pale, eyes more apart, antennae and legs smaller, and abdomen with a large apical fovea.

Hab.—New South Wales: Sydney (A. M. Lea).

A small species very variable in its colours, but readily distinguished from all others of the genus by its dense and coarse prothoracic punctures, and by the rows of elytral punctures all being in distinct striae, of which the lateral ones, however, are deeper than the others. There are seven males before me and six females; of these the males scarcely differ in colour, except that the tip of the abdomen is reddish on some specimens, but not on others; but no two females are exactly alike, one is not much paler than the males, but they usually have the prothorax dull red, except for a narrow black basal margin, and elytra flavous with the suture and a variable extent of the base (on one specimen a narrow black basal margin only) black, the metasternum and middle (transversely) parts of abdomen are more or less deeply infuscated, the rest of the under surface being flavous. On most of the specimens the second joint of antennae is distinctly darker than the first and third.

COENOBIUS INSULICOLA, n.sp.

♂. Black with a metallic gloss, more distinct on head and prothorax than elsewhere; elytra piceous-brown, the tips paler, antennae (a variable number of joints of the club infuscated) and legs (femora more or less deeply infuscated) of a rather dingy flavous or testaceous. Under surface and legs minutely pubescent.

Head with rather dense and sharply defined punctures. Eyes large and close together. *Prothorax* about twice as wide as the median length, sides strongly narrowed to apex, with a shallow oblique impression on each side directed to the middle of the scutellar lobe; punctures dense and sharply defined, but not very large in middle, becoming coarse and crowded on sides. *Elytra* briefly sub-oblong; with rows of distinct punctures in rather narrow striae, but on the sides striae deeper and wider. Length (♂, ♀), 2—2.5 mm.

♀.—Differs in being larger and more robust, much paler, eyes more apart (the distance between them almost equal to the length of the basal joint of antennae), punctures smaller, antennae and legs shorter and abdomen more convex and with a large apical fovea.

Hab.—Western Australia: Pelsart Island (A. M. Lea).

As the antennae have a six-jointed club, the eyes are close together, and the scutellar lobe not notched I have referred this species to *Coenobius*, despite the shape of its prosternal process: its posterior end is outcurved instead of slightly incurved to the middle. From the preceding species (whose prosternal process is normal) it differs in being metallic, in having the prothorax less gibbous in front, with much smaller punctures, although the discal ones are sharply defined, and elytral punctures distinctly narrower than the interstices instead of wider, as on at least the males of that species. Six males before me are practically identical in colours except that on two of them the median interstice on each elytron is slightly paler than the adjacent ones; four females have the elytra (except the shoulders and extreme base) and legs entirely pale, and the prosternum, mesosternum and two basal segments of abdomen obscurely reddish; two of them also have parts of the prothorax and of the muzzle obscurely reddish.

ORDINARY MONTHLY MEETING.

29th September, 1920.

Mr. J. J. Fletcher, M.A., B.Sc., President, in the Chair.

Mr. Herbert Charles Furst, Linwood Avenue, Killara, and Dr. Edwin Theophilus Jesse Ick-Hewins, Dunedoo, were elected Ordinary Members of the Society.

The President made regretful reference to the death of the Rev. W. W. Watts.

The Donations and Exchanges received since the previous Monthly Meeting (25th August, 1920), amounting to 6 Volumes, 89 Parts or Nos., 4 Bulletins, 2 Reports, and 1 Pamphlet, received from 36 Societies and Institutions and one private donor, were laid upon the table.

NOTES AND EXHIBITS.

Miss Hynes exhibited a very symmetrical concretion from Natal Downs Station, about 90 miles inland from Charters Towers, Q.

Mr. E. G. Jacobs exhibited specimens of *Epacris purpurascens* showing perfectly doubled flowers. The plant from which these specimens were collected is growing naturally beside one or two plants showing single flowers only, on a stony ridge at Ryde.

Mr. E. Cheel exhibited two living plants of *Erigeron*, which had been regarded as forms of one species, namely, *E. linifolius*, as recorded in these Proceedings, xliii., 1918, p. 610, but which on investigation seem to be identical with specimens in the National Herbarium labelled *Conyza Naudinii* Bonnet (Bull. Soc. Bot. Fr., xxv., 1878, p. 208). Another specimen from the Eastern Pyrenees labelled *Conyza altissima* Ch. Naud. et. O. Debx. seems to be scarcely distinguishable from *C. Naudinii*, but as the works describing these species are not available in our libraries, the differences between the two species cannot be settled.

He also exhibited specimens of a wild strawberry, *Fragraria indica* Andr., from Summer Hill, which is also spreading rapidly on the Bellingen River in Paspalum paddocks. Specimens from the latter place were brought in for determination by Mr. D. Boland.

Mr. W. F. Blakely exhibited specimens from the National Herbarium of a supposed hybrid form of *Boronia serrulata* Sm., × *B. floribunda* Sieb., and a variety of *B. serrulata*, both from the Hornsby district. The leaves of the hybrid closely resemble those of *B. serrulata*, and are nearly all simple; some, however, are binate, others ternate on the same branch. The inflorescence is axillary and terminal, while the flowers are solitary and cymose, but do not vary essentially from those of *B. serrulata*. As most of the important characters agree with those of *B. serrulata* the evidence points to it being the seed bearer. This form is almost identical with the one exhibited by Mr. J. H. Maiden, on behalf of Mr. T. Steel (these Proceedings, 1906, p. 566), but differs from the specimen exhibited by Mr. A. A. Hamilton (these Proceedings, 1915, p. 419) in the majority of the leaves being simple.

Boronia serrulata Sm. var., a virgate plant about 18 inches high; young shoots minutely tomentose; leaves lanceolate, acute, slightly crenulate, 12 mm. long, 3-4 mm. broad; bracts, sepals and petals more acuminate than in the normal *B. serrulata* Sm. It differs from *B. serrulata* Sm. in the narrow lanceolate leaves and relatively smaller flowers. He also exhibited a white form of *Boronia floribunda* Sieb., which, as far as he could ascertain, had not been previously recorded.

Mr. C. Hedley gave a short account of the work of the Pan-Pacific Science Congress held at Honolulu in August.

THE GEOLOGY AND PETROLOGY OF THE GREAT SERPENTINE BELT OF NEW SOUTH WALES.

Part IX.—The Geology, Palaeontology and Petrography of the Currabubula District, with Notes on Adjacent Regions.

By Professor W. N. Benson, B.A., D.Sc., F.G.S., W. S. Dun, and W. R. Browne, B.Sc.

Section C.—Petrography.

By W. R. Browne, B.Sc., Lecturer and Demonstrator in Geology, The University of Sydney.

(Plate xxv.)

Introduction.

The igneous rocks of the Currabubula district are of interest, both on account of the variety in type and in mode of occurrence which they present, and because of the striking resemblance which many of them bear to the volcanic rocks of Carboniferous age in other parts of the State, and particularly to the extensive series which form so important a part of the Carboniferous area at Clarencetown, Paterson, Seaham and elsewhere in the Hunter River basin, about 100 miles away to the S.S.E. of Currabubula.

Igneous activity appears to have begun in this area during the Burindi epoch, and was confined, so far as is at present known, to explosive outbursts: no outcrops of massive volcanic rock have been found, but fine-grained tuffs occur at the top of the Burindi Beds. The display of igneous activity, however, culminated during the laying down of the Kuttung Series and continued apparently right to the close of the Carboniferous period.

The chronological sequence of the igneous rocks can never be determined with the same accuracy and definiteness with which it can be established in the more southern areas, for the reason that the series is partly extrusive and partly intrusive, and so mutual relationships can often not be observed. This must also render the precise stratigraphical position of some of the rocks a matter of uncertainty: for example, the great series of pyroxene andesite sills, which are so important both physiographically and petrologically in the area, have been found intrusive only into the Burindi Beds and the overlying "grits," so that their exact time-relations to the conglomerates and glacial beds of the Kuttung Series cannot be established, except indirectly through the fact of the Martin's Creek type of andesite (which presumably is closely connected with the pyroxene andesite) being found at Werris Creek Gap among the conglomerates.

The earlier and more acid portions of the series appear to have been ejected largely in fragmental form, and are now represented by the tuffs which occur so abundantly at the base of the Kuttung Series, and resemble very closely those found in the Hunter Valley. This tendency of certain of the acid rocks to form pyroclastic material has been noted and commented on by Flett (47) and others. It is exhibited in this State at the base of the Devonian at Taemas, near Yass, and it appears as a constant feature of our Carboniferous vulcanicity. Probably it is in some way connected with the viscosity of the highly alkaline magmas.

At intervals during the deposition of the tuffs (which continued during most of the Kuttung epoch) small flows of basalt were poured out, and there were also local eruptions of soda rhyolite and associated tuffs.

The most important and definite manifestation of volcanic activity took place subsequent to the deposition of the Kuttung Series, when there were extensive outpourings of basalt, with tuffs and agglomerates, succeeded by widespread intrusions, and probably extrusions, of magma. Of these we have evidence in the sills and dykes of dolerite, hornblende and pyroxene andesite, and, lastly, of trachytoid keratophyres.

It is here assumed that the sills, dykes, and other intrusions which are found so extensively about the district were closely connected if not actually synchronous with the igneous activity of which the Warragundi volcano was one expression; the field evidence, as well as the petrological study of the rocks, tends to justify this assumption.

The petrological examination of the rocks has been carried out on material, the bulk of which was collected by Benson during the progress of the field-work, and the field-relations as determined by him have been accepted.

Extrusive Rocks.

Tuffs of the Burindi Beds.

A comprehensive study of these has not been made, but specimens have been collected and examined from the railway cutting in Portion 34, about 1½ miles north-east of the railway bridge over Currabubula Creek. Here the mudstones and tuffs have been invaded and indurated by a sill of glassy andesite, and an interesting though complicated section is exposed.

The tuff itself is an extremely hard, compact, siliceous-looking rock with a short and subconchoidal fracture. Under the microscope it is seen to be a keratophyric tuff, consisting of a microfelsitic or cryptocrystalline matrix thickly set with angular chips of felspar. These are of pure albite and vary much in size, the bulk of the fragments being very minute indeed, while the largest are not more than .5 mm. long. This felspar is a good deal kaolinized and the rock as a whole is slightly stained with limonite. Quartz could not be detected with certainty, and ferromagnesian minerals are absent. There has been some silicification, indicated by little aggregates of chalcedonic quartz-granules. Just where the andesite has invaded it, the tuff grades into a type crowded with angular fragments of a hard buff or cream-coloured porphyritic rock. These grade from pieces about 1½ inches in diameter down to the minutest chips. It is evident, on examination with the microscope, that the rock has undergone a certain amount of contact metamorphism. Angular aggregates composed of tiny chalcedonic quartz-granules are numerous, and the rock is crossed with veinlets of the same material, while many of the rock-fragments included in the tuff have been devitrified. These fragments include examples of a trachytic rock, as well as the porphyritic rock already mentioned. This latter proves to be keratophyre, the only phenocrysts recognisable microscopically being albite; a few aggregates of chlorite and quartz may possibly represent original pyroxene. In the larger fragments the glassy base has been completely kaolinized and is characterised throughout by well-marked perlitic cracking with traces of devitrification: in the smaller fragments the base has completely devitrified into spongy-looking felspathic material with a lower R.I. than Canada Balsam.

Underlying the andesite sill there is a tuff (1455) of rather unusual constitution, consisting as it does for the most part of albite, pyroxene and fragments of trachytic rock. The felspar is generally fragmental, but in some cases shows almost perfect square sections. It often contains inclusions of apatite needles and of chloritic material, which at times assumes the rounded outline characteristic of inclusions of glassy base. The pyroxene, which is mostly augite, with a little hypersthene, still retains in a large measure its stout prismatic habit, although a good deal cracked and somewhat altered. The rock fragments are small, none being more than 3 mm. in diameter. Almost all of them have trachytic fabric and are porphyritic in columnar albite. A few are partly glassy. The interstices of the rock are filled mostly with chlorite, but some parts of the matrix appear to consist of an extremely fine-grained trachytic hypocrystalline rock, and here and there are evidences of silicification. The rock may be termed a pyroxene-bearing keratophyre tuff.

In view of the fact that the albite of many basic rocks is secondary and that many keratophyres must be regarded as albitized porphyrites (49), it is proper to inquire into the possibility that the albite in the rocks under discussion may be secondary. As far as can be observed there is no positive evidence that albitization has occurred. Neither are there traces of still unaltered basic felspar (50), nor does the albite exhibit a suspicious clearness (51), nor yet is it crowded with epidote and other alteration products, such as one might expect in the endogenic albitization of a basic felspar. The albite then may fairly be considered a primary mineral.

Felspathic Tuffs of the Kuttung Series.

These form an extensive series of gritty-looking rocks constituting much of the Kuttung Beds and intercalated with the conglomerates. Megascopically, a typical specimen obtained from the Main Felspathic Grit is pinkish-grey in colour, composed mostly of small felspar chips and crystals, both pink and white, and subordinate quartz, with a few dark minerals, all embedded in a greyish matrix. In thin section the tuffaceous character of the rock becomes apparent. The dominant mineral is orthoclase, in crystals and fragments averaging about 1 mm. and much kaolinized; there is a minor amount of plagioclase, mostly albite. Quartz, of the type found as phenocrysts in volcanic rocks, is fairly abundant, mostly as fragments but often retaining traces of crystal form and showing corrosion and stony inclusions. A few small pieces of augite, hornblende and ilmenite are also seen. Of lava fragments there are many, mostly glassy and often pumiceous, sometimes possessing fluidal or spherulitic fabric.

All these constituents are compacted together and set in a brown-stained unresolvable matrix containing numerous tiny chips of quartz, felspar and pumiceous glass.

Interbedded Flows and Tuffs in the Kuttung Series.

(*a*) *Soda rhyolites and tuffs.* Interbedded with the Kuttung Series are what appear in the field to be rhyolitic flows or tuffs. These form a series of striking outcrops on the right bank of Rocky Creek in Portion 322. Three specimens have been sectioned and examined, and they prove to be soda rhyolites or soda rhyolite tuffs. The rocks are fragmental wholly or partly, but it is not clear from a microscopic examination whether they should be classed as tuffs or essentially massive volcanic rocks with a great deal of tuffaceous material included.

1493 from the east end of Portion 273, Currabubula, is in hand-specimen a light greyish-green rock with a dull felspathic-looking groundmass containing small phenocrysts of felspar and quartz. Under the microscope the quartz is seen to be fragmental and much corroded, as is also the felspar which is pure albite of the variety known as checker-albite. The groundmass is largely cryptocrystalline, is free from flow-structure, and in addition to little grains of felspar and quartz, contains large numbers of remains of collapsed pumice in the shape of little cuspate bodies now devitrified and represented by strings of chalcedonic quartz granules and little prisms of clear albite. There are also little irregular pockets consisting mostly of granules of clear secondary albite. A few very small rounded vesicles are filled with the chalcedonic quartz and chlorite.

1534 from Portion 322 is a green, hard, dense lithoidal rock recalling in appearance some of the Pokolbin rhyolites. There are phenocrysts of quartz up to 1 mm. in length, originally idiomorphic but now much shattered and corroded, and with inlets and inclusions of groundmass; also fragments of pure albite up to 2 mm. long and a good deal shattered. The groundmass consists of small chips of quartz and felspar and numberless pumice fragments, set in a cryptocrystalline base in which there are occasional streaks of glassy material. A little apatite is present. The groundmass of the rock contains inclusions of rhyolitic rock, the largest being of fluidal fabric, and poryphyritic in quartz, orthoclase, and albite.

Specimen 1535 (Pl. xxv., fig. 1), described as a "flow breccia from Portion 322, Currabubula," looks more distinctly like a tuff than either of the others in hand specimen; it has a hard stony base of pale green colour, in which can be seen tiny fragments of quartz and of white and pink felspar, as well as larger dark-coloured inclusions of rock. The microscope shows it to be composed of abundant small fragments of quartz and felspar and devitrified pumice with chips of fluidal and spherulitic rhyolite, set in a cryptocrystalline base containing little nests of secondary quartz. The quartz fragments are angular and corroded; felspar comprises albite and orthoclase, the former predominating and both a good deal decomposed. The rhyolitic inclusions are sometimes much chloritized, and the flow-lines are indicated by strings of secondary quartz granules. What appear to have been cavities are now lined with tiny prisms of clear quartz and filled with a colourless zeolitic (?) substance stained in patches with haematite.

(*b*) *Basaltic Rocks.* In Portions 57 and 59, Currabubula, there is a small flow (1497) of peculiar type (Pl. xxv., fig. 7). In hand-specimen the rock is dark greyish-brown and aphanitic, with a very few small felspar phenocrysts showing. Microscopically felspar is the only fresh constituent, in laths about 6 mm. long, with frayed ends. Measurements indicate acid andesine, about $Ab_{68}\ An_{32}$. There is a second crystallization of microlitic felspar giving approximately straight extinction, which would point to oligoclase. This forms a kind of mesostasis of sub-variolitic aspect. The spaces between the felspars are filled with a confused mass of chlorite, some of which is pseudomorphous after a mineral giving rectangular sections, possibly pyroxene, while the rest is just interstitial and may represent original glass. It is sprinkled with rod-like microlitic iron-ore. Carbonates are present in fair amount, both as little interstitial patches and also, with quartz, filling a few vesicles. The rock may provisionally be termed an andesine basalt, though probably more acid than normal basalt.

Specimen 1446, collected from Portion 57, a little south of the andesine basalt just mentioned, is possibly from another interbedded flow. It is typically basaltic in appearance, bluish-black, very compact and with a rather hackly fracture.

In thin section it is hypocrystalline intersertal and very fine grained. Laths of bytownite, varying from a length of .75 mm. down to microlitic dimensions, and slightly altered, are distributed through a matrix composed of pyroxene and magnetite. The pyroxene is a bright yellow-green colour and occurs in dense masses of extremely tiny, rounded, and almost equidimensional granules and crystals. Some of these are distinctly pleochroic and have straight extinction, indicating hypersthene, but the bulk of the pyroxene is augite. There is abundance of magnetite as tiny crystals and locally as clouds or patches of fine dust.

The relative proportions of the different constituents vary very much from point to point in the slide, but on the whole felspar probably predominates, with pyroxene and magnetite in the order given. There are fairly frequent irregular small patches of altered brown glass into which felspar and pyroxene crystals protrude, and in the neighbourhood of these patches minerals may be rather larger and more idiomorphic than usual. Minute apatite needles are scarce. Occasional aggregates of magnetite with some indeterminate material, up to 2 mm. in length, appear to be pseudomorphs, possibly after olivine. This may be called a hypocrystalline intersertal basalt.

Basalts of the Werrie Series.

For the most part the rocks are very decomposed, and only one specimen (1510) was available for sectioning (Pl. xxv., fig. 9). This was obtained from a well in Portion 239, at the head of Anstey's Creek. It is a rather weathered, grey, fine-grained rock, amygdaloidal in structure, the vesicles being filled sometimes with calcite and sometimes with white or colourless zeolites. Under the microscope the rock is seen to have suffered considerably from surface alteration. The principal constituent is a plagioclase, in laths averaging about .8 mm. long which are at least as basic as labradorite. There are occasional traces of parallel orientation, and the interspaces between the felspars are filled largely with augite which is interstitial rather than ophitic. It is of a greyish-brown colour, very faintly pleochroic, and has magnetite plentifully distributed through it. What were probably small crystals of olivine are now represented by aggregates of serpentinous material always rimmed with translucent haematite. Evidently the original olivine, if such it was, was highly ferriferous. Further alteration of the rock is indicated by interstitial patches of fibrous radial green chlorite. The amygdules are filled with quartz crystals and calcite, or with calcite and a zeolite which may be chabazite.

INTRUSIVE ROCKS.

Trachytoid Quartz Keratophyres.

The rocks described in the account of the field-geology as felsites, trachytes, etc., forming sills, dykes and other intrusions, fall, with few exceptions, into the keratophyre class, although varying among themselves in details of texture and mineral constitution. The variations are fairly regular, so that subdivision is rather difficult, and it will be best perhaps to mention the general mineralogical features of the series before proceeding to more detailed description.

The series as a whole has been called the trachytoid quartz keratophyres to distinguish them from the soda rhyolites, from which they differ in texture, mode of occurrence and most probably also chemical composition.

As no essential differences were found between the rocks composing the dykes directly emanating from the Warragundi volcano and those forming the sills and dykes cutting through the Kutting Series elsewhere in the area, all have been grouped together.

Megascopically the rocks are fairly compact, occasionally slightly vesicular, and varying in colour through buff, pink and pinkish-grey to dark greenish-grey. The majority of the specimens have phenocrysts of pink or white felspar ranging up to 6 mm. in length; in other cases the phenocrysts are small, while in certain types they are entirely absent.

Microscopically the rocks are all holocrystalline; the grain-size is fine to very fine, and the fabric may be trachytic or orthophyric, with or without fluxion structure, or again no definite fabric may be recognisable. Of the minerals present acid plagioclase is by far the most abundant and important. Accurate determinations of composition were generally most difficult and sometimes quite impossible owing to alteration and fineness of grain, but there appears to be a variation from pure or almost pure albite in certain members of the series to oligoclase in others. The felspar may be zoned, with apparently an oligoclase kernel and an albite rim. It is possible that the variation in habit of the felspars is to some extent a function of their chemical composition, the slender, almost acicular, crystals of oligoclase being contrasted with the stumpy prisms of the more albitic rocks. The extent to which orthoclase enters into the rocks is doubtful. In some it is certainly present, in others, especially those containing the more acid plagioclase, it is undoubtedly absent, while in others again its presence cannot be definitely determined. It is probable, of course, that orthoclase molecules exist to a small extent in solid solution in the plagioclase.

Quartz is perhaps the mineral next in importance after felspar; it is almost always interstitial, but in two cases its occurrence is peculiar and gives the impression of early crystallisation. Rarely it encloses the felspar in micropoikilitic fashion. The proportion of quartz varies very much in the different rocks, but does not appear to be correlated with the fluctuation of any other constituent save possibly the iron ore. The latter varies considerably in amount, both magnetite and ilmenite being present.

Primary ferro-magnesian minerals are comparatively scarce; certain of the rocks must have been entirely devoid of them, while in others the occurrence of chlorite and other secondary material indicates that some dark minerals were once present. In a few rocks the original biotite, hornblende or pyroxene still remains. The presence of the last two points to a genetic connection with the andesites. Apatite in small amounts is a fairly constant constituent.

Many of the more albitic types are characterised by orthophyric fabric. We may take as an example 1498, from a dyke in Duri Creek, S.E. of Duri Peak, cutting through the Kuttung grits and conglomerates. Phenocrysts of albite up to 3 mm. long, sometimes aggregated in glomero-porphyritic fashion, are set in a matrix of stumpy prisms of albite averaging about .25 mm. long and at least as acid as $Ab_{90}\ An_{10}$ in general composition. The spaces between these are filled with quartz, which composes about 10 % of the rock. The felspar is much kaolinized and stained with haematite, and displays a narrow clear him round a decomposed kernel. Tiny crystals of magnetite are fairly plentiful and little apatite needles and biotite flakes are infrequent.

Another rock (1499) resembles 1498 except for the presence of definite ilmenite much leucoxenised, and that the biotite is chloritized (Pl. xxv., fig. 4). This rock occurs as a sill which passes into the dyke from which the previous specimen was taken. Another specimen (1530) from the same dyke differs in the higher proportion of iron ore and in the smaller amount of biotite, which is represented by a little chlorite.

A dyke which occurs in Portions 240 and 178 may be connected with the Warragundi volcanic centre, and belongs to the orthophyric type, differing from the rocks just described only in having slightly coarser texture and having more interstitial chlorite.

A much more basic though allied type is 1528, from a dyke 24 yards wide, half a mile north of Portion 1. This has a much higher proportion of iron ore than the others, while ferro-magnesian minerals are represented by abundant augite. The grain-size is coarser, too, the felspars averaging about .6 mm. long, and the rock is non-porphyritic. Felspar ($Ab_{95}\ An_5$) is slightly zoned, and has the usual clear rim round a decomposed kernel. The interspaces between the felspars are filled chiefly with abundant pale granular augite, iron ores and very subordinate quartz. Augite and magnetite are also included in felspar. Tiny apatite needles are fairly numerous, while chlorite is quite common, often filling cavities.

In 1494 (dyke crossing Rocky Creek) and 1496 (dyke in the S.E. of Portion 11), the texture is finer than that of 1498, and there is rather more elongation of the felspars of the base, although their general composition is still very acid, about $Ab_{95}\ An_5$. Ilmenite is fairly plentiful, and may appear among the phenocrysts. The felspars are much replaced by carbonates, but the rocks were evidently devoid of ferro-magnesian silicates. Vesicles in 1496 are filled with calcite, and partially lined with little quartz prisms.

These two rocks may very probably represent dykes radiating from Warragundi. A dyke (1511) from the N.E. corner of Portion 70, Werrie, has much in common with them, but has rather more iron ore and retains chloritic pseudomorphs after (?) hornblende.

There are a number of very fine-grained rocks (1437, 1514, 1529) consisting mostly of lath-shaped or acicular felspars, apparently oligoclase, and exhibiting a more or less perfect trachytic habit. Orthoclase is sometimes associated with the other felspar, generally in subordinate amount, but its presence is not always recognisable. In all of these there is practically no evidence of the former presence of ferro-magnesian constituents, though magnetite is plentifully dusted through the rock. Small phenocrysts of oligoclase are present, and there is much alteration to kaolin and carbonates. Cavities are filled with chalcedonic quartz.

Primary quartz is very sparingly present, and is practically absent in 1437. Rock 1515 is a very fine-grained porphyritic type without trachytic arrangement of the felspars, and is notable as being the only one of the series containing hornblende. In hand-specimen this is seen as fairly abundant rod-like phenocrysts up to about 6 mm. in length. In thin section it is of a light brown colour and strongly pleochroic. In addition to the predominant oligoclase of the rock, there is probably a little orthoclase as small shapeless interstitial grains. Quartz is fairly abundant.

The rock (1448) from the Church Hill railway cutting at Currabubula presents some unusual characters. It consists largely of lathy oligoclase showing trachytic fabric, with subordinate orthoclase. Locally the grainsize of the felspar may increase slightly and its habit may alter to a stout prismatic or to a granular form; this may be due to local variation in the water-gaseous content of the crystallizing magma. A large square-shaped section of labradorite, comparable with that found in the andesites, may be a xenocryst. The abundant iron-ore is in minute octahedra, rods and grains, some of it being titaniferous, judging by the frequent coronas of secondary sphene. Apatite is very scarce. The interesting feature of this rock is in the habit and disposition of the quartz, which is present as optically continuous patches, enclosing the felspars in micropoikilitic fashion. It also fills what have evidently been drusy cavities, giving a pseudo-porphyritic appearance to the rock (Pl. xxv., fig. 2). In this case the quartz, which may consist of two or more grains of different orientations, has its boundaries determined by the felspar-laths forming the original walls, which often project into it. This quartz is to be regarded as of primary crystallization; it often contains tiny inclusions and may pass out with optical continuity into the poikilitic quartz. A few of the druses have been filled with opal or with chalcedony, associated with little rosette-shaped bundles of chlorite needles growing on the walls of the cavity. One grain of opal includes a granule of ilmenite completely surrounded by a rim of secondary sphene.

This rock, being the freshest in the collection, was selected for chemical investigation, and the result of an analysis by Mr. H. Yates, B.Sc., is given in the first column of the table.

	I.	II.	III.	IV.
SiO_2	67.71	69.20	71.52	75.06
Al_2O_3	15.24	15.00	11.76	14.21
Fe_2O_3	1.48	1.57	1.52	1.31
FeO	1.89	1.83	3.44	0.27
MgO	0.46	0.69	1.18	0.09
CaO	3.00	1.88	2.72	0.42
Na_2O	5.87	5.87	5.05	6.88
K_2O	1.81	1.81	0.26	0.58
H_2O+	1.89	0.67	1.25	0.62
H_2O-	0.39	0.90	0.14	0.56
TiO_2	0.47	0.52	0.28	abs.
P_2O_5	tr.	0.10	0.20	0.03
MnO	—	0.15	0.04	0.04
CO_2	abs.	abs.	0.38	—
FeS_2	—	—	0.12	SO_3 0.11
	100.21	100.19	99.86	100.18

I. Trachytoid quartz keratophyre, Church Hill, Currabubula. Analyst, H. Yates.

II.* Rhyolite, Ancon Hill, Panama Canal Zone. Analyst, G. Steiger.

III.† Quartz keratophyre, Portion 175, Par. Nemingha, N.S.W. Analyst, W. N. Benson.

IV.‡ Soda rhyolite, Paddy's Sugarloaf, nr. Raymond Terrace, N.S.W. Analyst, W. A. Grieg.

The analysis indicates the sodic character of the rock, although the CaO percentage is rather high. It also points to the presence of about 10 % of orthoclase, either as a definite mineral or in solid solution in the oligoclase. The correspondence of this analysis with that of the rhyolite from the Panama Canal Zone is very striking. Analyses III. and IV. have been inserted for contrast rather than comparison; there are evidently important differences between the Carboniferous rock and the Devonian quartz keratophyre from Nemingha, while the Paddy's Sugarloaf rock, which is probably to be correlated, chemically as well as petrologically, with the soda rhyolites of Rocky Creek, emphasises the difference between these rocks and the trachytoid quartz keratophyres.

This Church Hill intrusion is an offshoot from or prolongation of a laccolitic mass invading the Werrie basalt and forming a small hill about a mile west of Currabubula. The rock composing the intrusion differs but little from that just described, but shows some additional features of interest. The cavities in the rock have not always been filled completely with quartz, and open spaces may be left, into which project felspar crystals. These spaces may, however, be filled with calcite or more frequently with what appears to be a zeolite, having a R.I. of about 1.49, complex twinning, and a birefringence about the same as that of quartz. This mineral has evidently formed after the consolidation of the quartz, which it occasionally enwraps. Embedded in both quartz and zeolite are isolated little crystal aggregates of felspar and an occasional flake of rather pale-coloured biotite. The conclusion seems warranted that the zeolite represents the last and the quartz the penultimate stage in the continuous process of rock-crystallization.

The rock (1520, 1526) composing the laccolitic mass S.W. of Soma has some features which mark it off from the foregoing types. It is very fine-grained, with a few small phenocrysts of oligoclase, and a groundmass composed mainly of little albite laths and quartz, with probably some orthoclase. In contrast to its usual habit, the quartz is characterised by distinctly squarish outlines, sometimes with corrosion embayments, as though it was of early crystallization. It makes up about 40 % of the slide. Bleached and ragged biotite and a little ilmenite are seen.

An interesting rock is that found in a kind of sill cutting through a mass of felsite on Werrie's Creek. The phenocrysts include, in addition to oligoclase and (?) orthoclase, infrequent chloritized crystals of augite and hypersthene. The groundmass is of stumpy oligoclase with some orthoclase, abundant magnetite, a little pyrites and apatite, and a good deal of quartz and biotite.

The presence of both rhombic and monoclinic pyroxene links up this rock with the andesites.

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*Washington's Tables (United States Geol. Surv., Prof. Paper 99), p.231.

†These Proceedings, xliii., 1918, p.602.

‡Washington's Tables, p.163.

Quartz Trachyte.

The only potash trachyte is 1506 from the S.E. corner of Portion 167. It is very sparingly micro-porphyritic in orthoclase, which also predominates in the fine-grained groundmass. The felspar is in ill-formed laths, much spangled with alteration-products, and is accompanied by a little acid oligoclase. Quartz forms an imperfect micro-poikilitic setting to the felspars and iron ore is fairly abundant with a little apatite. A small amount of chlorite probably represents original biotite.

Quartz Latite.

Only one specimen (1495) of this rock type has been encountered, occurring as a dyke near the centre of Portion 273, Currabubula. It is distinguished from the other felsitic rocks, from which it does not differ noticeably in appearance, by the presence of a more basic plagioclase. In thin section the rock is slightly porphyritic, the phenocrysts being felspar, probably andesine; a few crystals with only simple twinning or with straight extinction may be orthoclase. In the groundmass, zoned andesine ($Ab_{60}\ An_{40}$) predominates, but there are indications of the presence of orthoclase as well, though the relative proportions are impossible to tell. The felspar laths of the groundmass average about .6 mm., and there is at times a tendency to trachytic fabric. Iron ores are fairly abundant, while interstitial quartz is less important. A few remnants of a pale monoclinic pyroxene are seen, but much altered to carbonates, and tiny apatite needles are scattered about. Chlorite is present in good amount, and there is a small proportion of interstitial carbonates.

Andesites.

These are of two distinct, though probably related types, characterised by the presence of hornblende and pyroxene respectively. The former type is the more acid, and this is reflected in the composition of the felspar.

(*a*) *Hornblende Andesites.* Rocks belonging to this type have been found occurring as sills: (*a*) in Portion 117 of the eastern limb of the syncline and (*b*) at the Werris Creek Gap, on the western limb. We have also been supplied by Mrs. Scott with a specimen of the same type of rock from a mass occurring near "Allanbank," which lies about 13 miles slightly W. of N. from the Gap. This rock-type is fairly constant in its main characteristics, and is identical with one phase of the well-known Carboniferous lava in the Hunter River district quarried at Martin's Creek, near Paterson.

The rock in hand specimen is purplish-grey in colour, and is studded with small phenocrysts of felspar and hornblende, the former predominating. A characteristic megascopic feature of the felspars is the existence in them of kernels of dark-coloured material, presumably chlorite. In thin section the Werris Creek Gap specimen (1491) is seen to be hypocrystalline. The plagioclase phenocrysts are tabular, fairly well-formed, and slightly zoned, the general composition being about $Ab_{55}\ An_{45}$ (andesine). The felspar is much cracked and resorbed and is considerably altered to kaolin, with occasional patches of carbonates. Inclusions of the groundmass are not infrequent. Hornblende is, as usual in such rocks, much resorbed, and is surrounded by a dark rim composed largely of magnetite granules. Magnetite is also beginning to separate out along the cleavage planes from without inwards. The hornblende is green, but looks bleached at times and exhibits occasional carbonate alteration. Ilmenite shows hexagonal and irregular plates. Tiny apatite prisms are quite abundant either in the groundmass, or as inclusions in the phenocrysts, notably in the felspars. Little zircon prisms, too, sometimes appear. There is a fair amount of chlorite in rosette-shaped aggregates, often pseudomorphous after what appears to have been felspar, judging by its outlines, and by the abundant enclosed apatite needles. The groundmass is largely cryptocrystalline, with irregularly sinuous aggregates of secondary quartz and chlorite. Magnetite dust may be fairly abundant locally. An important feature of the groundmass is the presence of numerous irregular patches of brown glass showing marked fluidal fabric, and with streaks of cryptocrystalline material through it. These patches pass rather quickly into the ordinary groundmass, and it is hard to say whether they represent remnants of a once completely glassy base, or whether the present texture as a whole is due to heterogeneity in the original magma.

Specimen 1441, from the centre of Portion 117, evidently represents a slightly different phase of the same type. There is a much greater proportion of glass in the groundmass, the felspar phenocrysts are rather more numerous and more altered, while hornblende is also more abundant. Further there is another ferromagnesian mineral present, which is now represented by clusters of magnetite granules, with or without an indeterminable greyish or brownish substance. The sections are idiomorphic and very elongated, almost rod-like, and the original mineral appears to have been biotite. Apatite is less abundant than in 1491 and zircon is infrequent. This rock corresponds rather more closely to the Martin's Creek type than does 1491.

A rock of somewhat similar habit to the hornblende andesite outcrops in Portion 88, about half a mile east of Rocky Creek, but the place of hornblende is taken by biotite, and a single phenocryst of corroded quartz was observed in the slide examined.

(*b*) *Pyroxene Andesites.* These present many variations in texture, as regards both crystallinity and fabric, and in composition are evidently more basic than the hornblende andesites.

The rocks may be conveniently subdivided into the lithoidal, vitrophyric, and pilotaxitic types, the first of these terms being applied to those rocks of which the groundmass, as seen under the microscope, consists of a mosaic of spongy-looking felspar grains.

The first two types are closely associated in the field, combining to form the great series of sills which have invaded the tuffaceous grits at the base of the Rocky Creek Series, whereas it is rather significant that all the pilotaxitic rocks of which specimens are available have quite a distinctive appearance, and occur as dykes connected with the Warragundi complex. It is quite possible that, although all three types are linked together by mineralogical similarities, there are chemical differences between them, but the data available do not warrant a positive statement on this point. It is difficult to say whether the mosaic groundmass of the lithoidal type is primary, or results from devitrification of an original pitchstone. Anderson and Radley have put forward the suggestion for certain pitchstones of Mull, that the stony types have been derived from the glassy by devitrification due to the escape of some of the chemically combined water. This suggestion is based on field observations supplemented by determinations of the water present in the rocks (24). In the case of the Currabubula rocks special field-examination of the relations of the glassy and stony types has not been made, but they are known to be at times associated in the same sill. A similar close association has been observed in the Hunter Valley area, and it is possible that the question of the origin of the stony groundmass will eventually be solved in the field rather than in the laboratory. It is to be noted, however, that in none of the slides examined does the stony type contain any traces of glassy base, or *vice versa*, although in the hornblende andesite the association of glassy and crystalline patches appears to be the rule.

Lithoidal Type. The rocks belonging to this type exhibit a hard stony base of a purplish-grey colour, with very numerous and conspicuous tabular felspar phenocrysts up to 4 mm. in length and smaller and subordinate pyroxene phenocrysts, without any definite arrangement. The rock weathers to a very characteristic, soft reddish crust which is pitted by the alteration and removal of the felspars.

Microscopically, in specimen 1444, from near the summit of Duri Peak, the felspar phenocrysts prove to be basic labradorite, zoned, but not conspicuously so, and showing well-marked albite and occasionally carlsbad and pericline twinning. The crystals are somewhat cracked and altered, sometimes zonally, and are often crowded with tiny pyroxene and magnetite inclusions, with a few apatite needles. The pyroxene phenocrysts comprise both augite and hypersthene, the former being the more abundant; both occur in well-formed stout prisms, the augite being occasionally twinned. Hypersthene is notably pleochroic, and shows a disposition to alteration along the periphery. Ilmenite is fairly plentiful. The groundmass at first sight appears cryptocrystalline, but really consists of an ill-defined mosaic of spongy-looking, untwinned felspar, of indeterminate composition, but with a refractive index apparently higher than that of Canada Balsam. This groundmass is plentifully dotted with iron ore and less abundantly with pyroxene granules, and is microporphyritic in plagioclase.

Specimen 1503, from the Summit of Duri Peak, is exactly similar to the foregoing except that the rock has been more weathered, while in 1454, from the lower portion of North Cobla, the only differences are that the proportions of the pyroxenes are approximately equal and that the groundmass is but sparsely microporphyritic.

Vitrophyric Type. When fresh the rock is a brownish-black colour, very compact, with a resinous or pitchy lustre, and porphyritic in felspar. Sometimes the phenocrysts show marked flow structure, but mostly this is absent. In common with the lithoidal type, the pitchstones have typically a rather smooth fracture.

For the microscopic features we may take as a type specimen 1531, from the west face of Duri Peak (Pl. xxv., fig. 6). The porphyritic felspar is basic labradorite (Ab_{35} An_{55}) or even acid bytownite; it is tabular prismatic in habit and may be up to 2.5 mm. in length. The crystals are much fresher than in any of the lithoidal andesites examined, but are much corroded and cracked. Twinning on albite and carlsbad laws is present, and zoning is very marked in some crystals. There are very abundant inclusions of pyroxene and to a less extent of magnetite granules, as well as of the groundmass, the latter sometimes having a schiller-like arrangement, while the mineral grains may be disposed in a rude zonal fashion. Hypersthene and augite are fairly abundant, the former perhaps being in excess, in much cracked prisms up to about 1.5 mm. long. Occasional parallel intergrowths of the two are seen. Slight alteration is noticed in the hypersthene, but the augite is quite fresh. Irregular grains of magnetite or ilmenite are fairly numerous. The groundmass is hypohyaline and microporphyritic, small grains and crystals of plagioclase and pyroxene being set in a base composed of greyish-brown glass with much microlitic augite, felspar and magnetite. Round the microlites there is often exhibited the characteristic border of glass of lighter colour than normal.

The chemical composition of the pitchstone may be gathered from the analysis of a specimen from Portion 116.

	I.	II.	III.	IV.
SiO_2	60.26	58.79	61.17	59.48
Al_2O_3	16.46	17.51	17.74	17.38
Fe_2O_3	1.15	2.11	1.78	2.96
FeO	4.87	3.87	3.51	3.67
MgO	3.09	2.23	2.76	3.28
CaO	5.25	6.18	5.90	6.61
Na_2O	4.23	4.84	3.79	3.41
K_2O	0.98	0.68	1.71	1.64
H_2O+	2.22	2.61	0.83	0.74
H_2O-	0.22	0.71		
TiO_2	0.84	1.21	0.45	0.48
P_2O_5	0.29	—	0.14	0.20
CO_2	abs.	tr.		—
S	0.03	—	—	—
Cr_2O_3	abs.		—	—
MnO	0.08		0.12	0.15
BaO	abs.		0.06	—
SrO	abs.		—	—
	99.97	100.74	99.96	100.00

I. Andesitic pitchstone, portion 116, Currabubula. Anal. W. N. Benson.
II.* Andesitic pitchstone, Pokolbin. Anal. W. R. Browne.
III.† Hypersthene andesite, Lassen Park, California. Anal. Hillebrand.
IV.‡ Osann's Average of hypersthene andesite.

It will be seen that there is a very close correspondence between the Currabubula and Pokolbin rocks, quite sufficient to place their consanguinity beyond all doubt. In magnesia and lime both rocks are somewhat lower than usual, and though the total of the alkalies is normal, soda is conspicuously high and potash correspondingly low.

The pitchstone from the small intrusion revealed in the railway cutting in Portion 34 differs from that of the larger masses in having a certain amount of perlitic cracking, while the phenocrysts are smaller and less numerous. In some parts of the sill a certain amount of alteration has occurred, rendering the rock lustreless and giving it a purplish-grey colour. In thin section this peculiarity is seen to be due in part at least to the separation of haematite from the base.

*See (52), p.404.
†Quoted by Iddings.—Igneous Rocks, Vol. ii., p.443.
‡Quoted by Daly.—Igneous Rocks and Their Origin.

The Pilotaxitic Type. In hand-specimen this is readily distinguished from the lithoidal type by its short, hackly fracture and by the fact that phenocrysts are as a rule less abundant. A specimen (1439) collected in the hill in the S.W. part of Portion 100, Werrie, is porphyritic in basic labradorite distinctly zoned, but exhibiting rather less resorption than the felspar of the other types. The phenocrysts are generally fresh and contain rare needles of apatite. A very little pyroxene is present, both hypersthene and augite being represented. The proportion of pyroxene among the phenocrysts is notably smaller than in the lithoidal and vitrophyric types. Little fibrous, pleochroic, purple-brown prisms with feeble birefringence may represent bastitic alterations of the pyroxene. Some ilmenite may be included among the phenocrysts. The groundmass consists of a felted mass of microlitic felspar, either untwinned or simply twinned, with a R.I. greater than that of Canada Balsam, and approximately straight extinction. This is probably oligoclase. There is flow structure developed, and interstitial minute granules of pyroxene and iron ore occur, so that the fabric is typically pilotaxitic. The groundmass is mottled or blotched with ovoid and irregular patches of chlorite enclosing the felspar microlites (Pl. xxv., fig. 5).

Other examples of the pilotaxitic type showed a general similarity to this rock with occasional minor variations such as the absence of flow structure in the groundmass.

Lamprophyre.

One rock (1450), described as a "felsitic extension of an andesite dyke" in a branch of Upper Currabubula Creek, 5 miles S.E. of Currabubula, belongs to the lamprophyres (Pl. xxv., fig. 3). It is pinkish-grey and felsitic, with a spangled or frosted appearance due to the presence of countless, tiny, rod-like, hornblende crystals never more than 3 mm. in length. Under the microscope these are seen to be fresh well-formed crystals and microlites, light brown in colour, showing a characteristic cross-fracture and often broken at the ends. Pleochroism is weaker than usual, and there is occasional simple twinning. Some of the larger crystals might be considered phenocrystic; the smaller ones show traces of parallel orientation. A few grains of almost colourless pyroxene appear, and others are probably pseudomorphed by carbonates. The groundmass contains, in addition to hornblende, much-altered acid felspar, with a plentiful sprinkling of magnetite and a little apatite. A very abundant constituent is a zeolitic mineral, similar to that found in the quartz keratophyre of Church Hill, which acts as a kind of matrix to the other minerals over irregular small areas, and fills the central portions of cavities, which may sometimes be lined with tiny quartz-prisms.

This rock is possibly allied to the keratophyres, but the habit of its constituent minerals would place it rather in the lamprophyre group.

Basic Intrusive Rocks.

There is a great variety of basic intrusive rocks developed in the Currabubula district. They occur for the most part widely distributed throughout the area as dykes intrusive into the Kuttung Series. An interesting series of basic dykes is also found in close connection with the Warragundi centre, intersecting the Werrie Series. So great is the amplitude of the textural and mineralogical variation in these rocks that it is difficult to conceive how they all emanated from the same magma reservoir. The majority of the types are normal dolerites, but the collection also includes some containing albite or oligoclase, and there is a single example of a teschenitic dolerite. The normal dolerites, though differing much among themselves in texture, may quite probably conform to a common chemical type and may have affinities with the Werrie basalt, and the albitic rocks may have resulted from albitization. The teschenite, however, stands apart from the others, and its mineralogical characteristics are closer to those of the Tertiary alkaline intrusives of the State than to anything of Carboniferous age with which we are acquainted. However this fact is hardly sufficient in itself to justify any conclusion as to the geological age of the intrusion and the field-relations shed no great light on the matter.

(*a*) *Normal Dolerites.* These comprise most of the dykes around Currabubula, as well as those actually in the Warragundi complex. The rocks are all holocrystalline, with or without phenocrysts, and vary considerably in grainsize.

Specimen 1502, cutting through the basalt in Portions 302 and 307, is a porphyritic rock. The phenocrysts, roughly prismatic zoned crystals of basic labradorite (near Ab_{30} An_{70}) up to 4 mm. in length, are much cracked and carbonated, the cracks being often filled with what appears to be clear secondary albite. There are also long streaky inclusions of devitrified glass. The felspar of the groundmass is zoned acid labradorite in rather stumpy laths about .25 mm. long, without any definite arrangement. Augite is plentiful in small prisms, occasionally slightly ophitic towards the felspar. It is pale reddish-brown and faintly pleochroic. Ilmenite is almost as abundant as augite and is much leucoxenised. Apatite is rare. Chlorite is interstitial but may also be associated with calcite as pseudomorphs after some unknown mineral.

A somewhat similar rock in many respects is 1527, from a dyke in Rocky Creek, in Portion 287, Currabubula. The plagioclase phenocrysts appear slightly less basic than those of 1502, and are much altered to carbonates, with inclusions of what appear to be devitrified base. Slight zoning is noticed. The felspars of the groundmass are andesine, about Ab_{55} An_{45}, about 3 mm. long and slightly zoned, and there is abundant well-crystallized magnetite, with very tiny apatite needles. Ferro-magnesian minerals are represented only by interstitial chlorite, and by small amounts of carbonates. There is a small amount of interstitial primary quartz.

The medium-grained rock forming the central part of a dyke in the railway cutting in Portion 34, Currabubula, is a felspathic dolerite (1509). It is non-porphyritic. The felspar, tabular-columnar in habit, ranges in length from .3 to 3 mm. It is strongly zoned, the variation being from bytownite to andesine. Alteration is a very marked feature, the crystals being seamed with irregular veins of what appears to be secondary albite. The subordinate augite, of a pale greyish-brown colour, is partially idiomorphic and partly ophitic to the felspar. It is altering to brown, strongly pleochroic hornblende. Ilmenite is fairly plentiful, and long apatite needles are included in the felspar. Interstitial chlorite and calcite are fairly plentiful, and a zeolite, (?) chabazite, occurs in places.

The basic rocks in immediate association with the Warragundi volcanic centre occur as sills and dykes intersecting the basalt, tuffs and other products of eruption. They have not been exhaustively studied in the field and will accordingly be only briefly referred to here. The specimens that have been examined exhibit many textural variations. Some of the rocks are porphyritic and a few exhibit flow structure, while others are more or less ophitic. Grain-size is medium to fine. Mineralogically they consist of plagioclase, augite and iron ores, but there is much variation in the relative proportions of these constituents. In the porphyritic rocks the felspar of the phenocrysts is usually a zoned basic labradorite, while that of the groundmass is acid labradorite to andesine. The felspar of the non-porphyritic types is labradorite about Ab_{40} An_{60}. Most of the rocks have suffered considerable alteration, which is best exhibited by the ferro-magnesian minerals, now largely represented by uralite, chlorite (pennine), epidote and carbonates. Iron ores are plentiful, both ilmenite and magnetite having been identified, while in one rock a little pyrites was noticed. Primary quartz is a very minor constituent in a few of the rocks.

One type should be noticed, although its field relations have not yet been completely determined. It occurs as a dyke in the Warragundi complex, and is unusually coarse in grain, the felspars often attaining a length of 12 mm. Unfortunately the specimens so far obtained have proved very difficult to section, but still the rock has been determined as belonging to the granophyric diabases or quartz dolerites, a small amount of interstitial micropegmatite being visible here and there, the felspar of which is an acid plagioclase in optical continuity with the zoned large crystals. Normal augite, much uralitized, is apparently the only pyroxene. Skeletal ilmenite and some apatite complete the list of constituents. The occurrence of this quartz dolerite is interesting, inasmuch as a sill or other intrusion of granophyre occurs not far away, which microscopical examination proves to be composed almost entirely of quartz and albite. The association of quartz dolerites and granophyres or aplites, particularly of sodic type, has been noted in various parts of the world, and a genetic connection has in many cases been proved. This fact adds to the interest as well as to the complexity of the Werrie volcanic series.

(*b*) *Dolerites characterised by Acid Plagioclase.* Two specimens of this type were collected, the first (1451) from the narrow dyke through the conglomerates in C.L. 3,000, Currabubula. A close-grained, dark greenish-brown rock, in thin section it is fine-grained and non-porphyritic, and of distinctly basaltic aspect (Pl. xxv., fig. 8). It is composed of subidiomorphic laths of albite averaging about .3 mm., clear and fresh, tiny augite prisms, and magnetite in crystals and skeletal forms. The interspaces are occupied mostly by brownish chloritic material forming at least 30% of the section, and possibly representing an original intersertal glassy base. The suspicious clearness of the felspar might be taken to point to albitization. The rock may be termed a fine-grained *Albite Dolerite*.

Of a generally similar character is specimen 1492, from "a dyke through the Church Hill felsite in the railway cutting 1½ miles west of Currabubula." This is a dark-coloured, compact, basaltic-looking rock. Under the microscope there are seen to have been two periods of crystallisation, the older felspar being in elongated laths averaging about .6 mm. These are very much clouded with decomposition products, so that optical determinations are difficult, but there is a symmetrical extinction of 10° and the R.I. appears to be a little less than that of Canada Balsam, so the mineral is probably acid oligoclase. No ferro-magnesian minerals are present, but there is a good deal of chlorite, and there are abundant tiny granules of secondary sphene. Ilmenite and magnetite are very plentiful in little octahedra, and in rod-like and skeletal forms. There is in places a mesostasis consisting mostly of microlitic plagioclase with magnetite dust and chlorite.

Patches of calcite are sporadically distributed and tiny vesicles are filled with calcite, or with chlorite, chalcedonic quartz and a hexagonal (?) zeolite.

(c) *Teschenitic Dolerite*. An interesting rock, and the only one of its kind so far discovered in the area, is that forming the sill or dyke about half a mile S.E. of Currabubula Railway Station. It is megascopically fine and even-grained, with felspar apparently constituting a little less than half of the entire rock. Microscopically it is subophitic in fabric. The augite is titaniferous, purplish-brown and pleochroic, and occurs in two ways: (1) as largish subidiomorphic to allotriomorphic individuals, often ophitic towards felspar, and (2) as nests or clusters of small stout well-formed prisms. Felspar is in elongated laths up to .8 mm. in length, slightly decomposed, and is labradorite bordering on bytownite. Olivine, usually enclosed in augite, is fairly abundant, sometimes as large regular grains, but generally in small rounded prisms, much cracked and altering peripherally to a brown-green serpentine. Fresh subidiomorphic ilmenite is plentiful, often surrounded by tiny flakes of biotite, and apatite is very abundant. There is a mesostasis composed of analcite which makes up at least 25 % of the rock and often completely encloses tiny crystals of most of the other minerals, particularly augite and apatite. Indeed the bulk of the apatite is found in the analcitic mesostasis, which recalls the fact recorded by Dr. Elsden in regard to certain of the quartz dolerites of St. David's Head (53) that the interstitial quartz contains over 70 % of the apatite present in the rock, indicating a very high solubility for this mineral under the conditions obtaining in the magma. The analcite is always interstitial, never forming definite crystals. It is in some places quite clear, but elsewhere is quite turbid, and flecked with highly birefringent alteration products. Occasionally its place may be taken by calcite.

It is now generally agreed that the analcite of teschenitic rocks is often to be regarded as belonging to the period of primary rock crystallization, and to represent the consolidation of the last watery soda-rich magmatic fraction (54) (55). In the present instance the analcite has all the appearance of a primary mineral of late crystallization. It has attacked the felspars to a very slight extent, but the augite inclusions present well-marked and unaltered boundaries, and there is no development of a soda-rich border (55). The serpentinization of the olivine may possibly be, as Bailey has suggested, due to the action of residual magma or "juvenile" waters (54*a*).

General Remarks.

The foregoing investigation establishes the essential correspondence between the rocks of the Warragundi complex and those of the intrusions at a distance from that centre. Some points of difference have been noted, but the conclusion of a close mutual relationship seems inevitable.

If we consider the series as a whole, tuffs, flows and intrusions—and this seems a reasonable thing to do—a curious association of alkaline and calcic types is revealed. On the one hand there are the typical calcic andesites and dolerites, and on the other the soda rhyolites and keratophyric rocks, the albitic dolerites and the tuffs, both sodic and potassic—an assemblage of distinctly alkaline facies. The two groups are of equal importance in the series, and, as we have seen, are linked by intermediate types, so that there can be no doubt of their derivation from a common stock-magma, a conclusion with which the field evidence is in complete agreement. What was the nature of the original magma we can only conjecture. In dealing with the rocks of the Seaham-Paterson-Clarencetown area

(4) the present writer took the view that possibly the hornblende andesite might represent the original undifferentiated magma, but a thorough chemical investigation of the whole series is needed before any definite opinion can be formed.

Comparison With Other Carboniferous Areas in the State.

The Currabubula rocks show many analogies with those of other Carboniferous areas further to the south. One of the localities whose rocks have been petrologically studied in any detail is Pokolbin (52), and many points of similarity are noticed with the rocks under discussion, although the sequence of eruption appears to have been different, a point which, however, may not be of any great significance.

A re-study of the slides of some of the Pokolbin rocks reveals a closer relationship to the Currabubula types than the published descriptions would indicate. For example, though Mingaye's analysis proves the existence of a strongly potassic rhyolite, yet slides of other rhyolites show a dominance of albite among the phenocrysts, linking these rocks with the soda rhyolites of the Kuttung Series.

The Pokolbin rocks described as trachytes also contain considerable albite in addition to the orthoclase (indeed the soda-felspar occasionally predominates) and although there are slight textural differences, these do not obscure the similarity to the quartz keratophyres of Currabubula. The chemical similarity of the andesitic pitchstones from the two localities has already been commented on. In addition, certain of the Pokolbin andesites are pilotaxitic and are strikingly similar to those from Warragundi, except for the almost complete absence of pyroxene phenocrysts.

The present writer has recently been privileged to examine a series of rocks collected by Mr. C. A. Sussmilch during his investigation, in conjunction with Professor David, of the Carboniferous sections at Paterson, Seaham, Clarencetown and Eelah (4). The series comprises soda rhyolites, toscanites, dellenites, dacites, hornblende andesites, hornblende mica andesites and pyroxene andesites and pitchstones. The hornblende andesite of the Martin's Creek type and the pyroxene andesite and pitchstone are absolutely identical with the corresponding Currabubula rocks. The soda rhyolites usually contain biotite, but some of them are quite comparable with the Currabubula rocks. There is, however, a complete absence of trachytoid keratophyres in the southern area, if we except the trachytic fragments present in the tuffs, while the extensive series of toscanites, dellenites, and dacites is wanting at Currabubula. It may be, of course, that these two groups are chemically equivalent. Nothing more basic than pyroxene andesite has been discovered by David and Sussmilch among the rocks definitely known to be Carboniferous in the area examined by them. Dr. Walkom and the present writer, however, considered that the natrolite basalt of Pokolbin, which was regarded as forming contemporaneous flows in the Lower Marine conglomerate, might represent the last phase of the vulcanicity initiated in Carboniferous times (52, p. 394) and Professor David has recently suggested that the Werrie basalt may be the equivalent of the natrolite basalts which are so extensively developed in the Hunter River Valley at the base of the Permo-Carboniferous (4).

A noteworthy fact in connection with the Currabubula area is the great importance and extent of the intrusive rocks in it as contrasted with the southern areas, where intrusions are comparatively insignificant. The elucidation of the causes of this difference belongs to tectonic geology rather than to petrology, and will involve a close comparative study of the tectonic conditions attending the vulcanicity.

The present study has shown that Benson's suggested correlation of certain rhyolite flows in the Rocky Creek Series (48, p. 508) with the Pokolbin rhyolites can be considerably extended. In the present incomplete state of our knowledge of the Carboniferous rocks of New South Wales any hasty attempt at detailed correlation is inadvisable, but there is every reason to hope that ultimately this great series of rocks, so widespread in occurrence and so uniform in characteristics, will be of the greatest stratigraphical importance.

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EXPLANATION OF PLATE XXV.

Fig. 1. Soda rhyolite tuff (1535); × 16½. Ordinary light.

Fig 2 Trachytoid quartz keratophyre (1448); × 16½. Ordinary light. At the top is a quartz-filled cavity with felspar prisms projecting into it. The light-coloured patch underneath is quartz poikilitically enclosing felspar.

Fig. 3. Hornblende lamprophyre (1450); × 16½. Ordinary light. Showing irregular patches of zeolite.

Fig. 4. Trachytoid quartz keratophyre with orthophyric fabric (1499); × 23½. Crossed nicols.

Fig. 5. Pilotaxitic pyroxene andesite (1439); × 16½. Crossed nicols.

Fig. 6 Vitrophyric pyroxene andesite (1351); × 15. Ordinary light

Fig. 7. Andesine basalt (1497); × 15. Ordinary light.

Fig. 8. Albite dolerite (1451); × 15. Ordinary light.

Fig. 9. Basalt of Werrie Series (1510); × 15. Ordinary light.

THE CHEMICAL EXAMINATION OF *MACROZAMIA SPIRALIS*.

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Historical.—The family of the Cycadaceae are all tropical or subtropical plants. The genera have a very limited distribution, and are few in number, but these represent the remnants of a once extensive flora which covered the earth in the Palaeozoic and Mesozoic Eras. Scott, in his "Evolution of Plants," says that in the Secondary Floras about one plant in every three was a Cycad, and they stretched from the Equator to the Poles. They were the dominant class; there was nothing above them; they were the best thing in the way of flowering plants that their age had produced. Though these in giving rise to the Angiosperms gradually became extinct, yet from some less progressive and therefore less highly organised cycadean forms, we may trace through the Tertiary Era the plants which linger on to our present day. In the descendants of this ancient race of plants we still find those primitive functions and primitive structures which closely resemble those indicated in the fossils of the Carboniferous Period, and which give to the Cycads a history and an interest unique among plants.

The fossil cycads make their first appearance with the genus *Pterophyllum* in the Upper Carboniferous formations, and reach their maximum towards the end of the Triassic and the beginning of the Jurassic Periods. Of these ancient forms Schimper recognised 34 genera which include 278 species.

Distribution.—The Cycadaceae of the present day, according to Engler and the Index Kewensis, include only nine genera and 75 species. Four genera, including *Zamia*, belong to tropical America, two are confined to the African continent, and three are found in Australia. The last include *Cycas* which is widely distributed from India to Japan and through the Islands to Australia, one Queensland genus, and *Macrozamia* which is limited to Australia.

There are fourteen species of *Macrozamia*, four of which belong to New South Wales, and four to Queensland; four are common to both States, and two are found in Western Australia. They are confined to the coastal regions of our Continent, and on the Eastern side are not found beyond the Dividing Ranges. There are no native cycads in Victoria, nor in the great central deserts of Australia. *Macrozamia spiralis* has a geographical coast range of over 800 miles extending from north of Brisbane to the Victorian border.

Evidence of Poisonous Character.

Nearly all the cycadaceous plants are believed to contain some poisonous principle in their sap, and it is said to be concentrated in the seeds. This fact seems to be well known to all the native races in the lands where cycads are used for food. We find that they uniformly pursue an elaborate course of preparation to destroy the poisonous properties. This consists in crushing the seeds with large stones, in washing the pulp in bags laid in running water for a certain time, and lastly, in drying the mass and heating it over a fire. This method of washing and baking the pulp, as used by the Australian aborigines, is almost identical with that used by the natives of Brazil in preparing the arrowroot from the poisonous cassava—*Manihot utilissima*.

In this connection also, Greshoff describes how the natives of the Malayan Archipelago eat the seeds of the poisonous cyanogenetic plant, *Pangium edule*, but never without submitting them to the same treatment.

Cycas revoluta, a Japanese tree, and *Cycas circinalis*, a tropical East Indian cultivated plant, are both described as having poisonous properties. In preparing the starch or sago for food their seeds are first roasted, and then washed in running water for a long period to remove an astringent emetic substance. The aqueous extract is described as fatal to chickens. Van Dongen (23) examined the latter plant in 1903, and mentioned an amorphous glucoside, pakoein, as the poisonous principle, but apparently nothing further was done with it.

Cycas media of Queensland, the largest of all cycads, is also poisonous (7), and produces a kind of paralysis of the hind limbs in cattle, sheep, and horses [Pammel (28), Ewart (29)].

In Banks' Journal (1770) there is an incident recorded, where some of Captain Cook's men found the hulls of the nuts round a deserted camp fire of the aborigines on the coast of Eastern Australia. They were thus assured that these nuts were used as food. They found them growing in the bush and ate one or two, after which they became very ill and were violently affected with vomiting. Some of his pigs died and many others after showing very severe symptoms just recovered (1). Leichhardt also described this cycad and how the natives prepared food from it (16).

Zamia integrifolia of tropical Florida is also used in a similar manner for the preparation of arrowroot. American chemists have attempted to isolate the poison, but without success.

Zamia muricata and *Z. Fraseri* have the same poisonous seeds, which are treated in a similar manner for the preparation of their starch. The tuberous bulbs also are poisonous.

Xanthorrhoea, the Australian grass-tree, though a monocotyledonous plant and therefore far removed from the cycads, is reported to cause the same poisonous symptoms as the latter, when the young shoots or green buds are eaten by cattle.

Macrozamia.—All the species of this are reputed poisonous plants, and the records of their harmful nature extend from the earliest days of the colonies. Governor Phillip, in 1789, gave an account of *M. spiralis* having formed part of the diet of the Port Jackson aborigines, and of its having caused La Perouse's sailors to become very ill with vomiting and diarrhoea after eating the nuts or kernels of the seeds (16).

In Grey's Journal of his two Expeditions in 1837 we have a detailed account of the use of the seeds by the natives, of the careful treatment in order to remove the poisonous constituent, and of the evil effects produced by eating these seeds without this preparation. Grey found *M. Frazeri* on the Gairdner Range and Mount Horner. Several of his men ate the nuts and were taken violently ill with vomiting, vertigo and other distressing ailments, but all recovered next day (3). This "By-yu" nut of the natives he describes as a violent emetic and cathartic. The natives soak it in water, bury it in the earth till the pulp is dry, then roast it for food (2).

Mr. J. H. Maiden records the poisoning of three boys at Springsure in Queensland through eating the nuts of *Macrozamia Perowskiana* (16).

Baron von Mueller was quite convinced that all the cycadaceous plants are pervaded by a virulent poison principle, which becomes inert or is expelled by heat (6).

Moore, in describing the methods of the aborigines in preparing the starch for food, says that in the fresh state the seeds are dangerously acrid (8).

Macrozamia spiralis was first examined chemically by Norrie (a Sydney pharmacist). His report was published in Dr. Milford's paper (5), which was read before the Royal Society of New South Wales in 1876. Norrie stated (*a*) that the kernels of the seeds contained much starch and gluten; the soluble portion had an acid reaction, and lime water precipitated calcium oxalate; (*b*) that he had isolated potassium binoxalate which he stated was the poisonous substance in these nuts; and (*c*) that he had also observed microscopic crystals of an alkaloid in small quantity. He believed that when the nuts were heated by the natives the potassium binoxalate would be converted into carbonate, and thus rendered innocuous. Dr. Milford, in his paper, described the effects on human beings after eating the nuts, viz., the severe suffering like sea-sickness, diarrhoea, and cramps in the abdomen.

On the other hand, Dr. Bancroft stated in a Government report that the kernels contained no poison, and that extracts of the nuts produced no deleterious effect when injected into frogs and guinea-pigs. He observed that when fowls and ducks were fed at one time with a large quantity of the kernels death frequently ensued after 1 or 2 days from gastro-enteritis, caused by the indigestibility of the material. He stated that all parts of the plant are indigestible (9).

Mr. F. Turner, in 1893, described the poisonous properties of the two species *M. Miquelii* and *M. spiralis*, and the methods of the aborigines in preparing the starch for food (11)

In 1894, Govt. Vet. Surgeon Edwards, of Western Australia, wrote a report describing his experiments on feeding cattle with *Macrozamia*, and the disease produced known as rickets or "wobbles." This is the most detailed account we have. He says the disease has been known since 1865, and is peculiar to Zamia districts. It is characterised by partial paralysis of the hind limbs, the diminished muscular power giving rise to a wobbling gait. The symptoms occurred after a definite period according to the amount eaten. A one year calf ate 6 lbs. of leaves per day with other food, and showed symptoms on the seventh day; another ate 4 lbs. per day with wheat chaff, and became ill on the eleventh day. The author could thus induce the disease at any time and had no doubt as to the cause. After the second week the disease became thoroughly established. It did not produce death, but resulted in starvation. Edwards fed cattle with the leaves, nuts, the mucilaginous secretion, and aqueous extracts of all parts of the plant. These mucilaginous juices and extracts produced, in cattle, congestion of the fourth stomach, intestines, liver and kidneys. He concluded that the deleterious effects were due to the extremely indigestible nature of the plant, and not to any organic poison (12, 13).

Lauterer, who was experimenting in a similar way in Queensland, doubted the conclusion of Edwards, and set out to prove his assertion of the existence of a direct poison in the *Macrozamia*. In 1898, he published his results, and described the symptoms he observed of spinal meningitis or progressive paralysis (18).

Bancroft, after many trials in searching for micro-organisms in the animals affected with "wobbles," obtained invariably negative results. He described the disease as Zamia paralysis.

Lauterer stated that the leaves of *M. spiralis*, at certain times of the year, contained a considerable amount of a poisonous resin, soluble in ether. The time corresponded to the period of flowering and fruiting. The resin existed in greatest amount in the nuts, and was also present in the half subterranean stems or bulbs and the leaves.

In guinea-pigs and cats the feeding produced gastro-enteritis and death. The author could not produce "wobbles" in any animals, but stated that enteritis, through inanition, might lead to it.

Lauterer and Pound then continued their experiments, by feeding calves with chaff mixed with the cut-up leaves of *Macrozamia* in the flowering stage. The first calf ate 8 lbs. of *Macrozamia* leaves per day for 3 days, then refused to eat more, and died on the fifth day. The second calf refused to eat *Macrozamia* on the fifth day, ate lucerne for 2 days, and died on the tenth day. The third calf ate for 6 days before refusing, and lived on green pasturage till the tenth day, when it, too, died. All these animals walked slowly, and staggered from weakness. Post-mortems revealed symptoms of gastro-enteritis only, with inflamed membranes of stomach and alimentary tract (18).

Lamb, in 1895, recorded the death of a great number of cattle in North Queensland from paralysis of the hindquarters, attributed to the eating of young shoots of *M. Miquelii* (17).

Poisoning by *M. Fraseri* is recorded by Crawley in Western Australia, 1898. Twenty-four bullocks died after eating the leaves. Owing to a gradual loss of vitality, the animals lay down for a few days in a helpless and semi-paralysed condition, and finally died. On post-mortem examination, the contents of the omasum were found impacted with ingesta, which were abnormally dry. The abomasum and intestines were empty. The spinal cord and meninges were in an abnormal condition (19).

Dr. Hunt, of Queensland, carried out a series of feeding experiments in 1899. He observed that cattle fed on leaves, stem, bulb, and male and female fruits, became affected after 14 days, the ration being 2 to 4 lbs. per day. Of these animals suffering with Zamia paralysis, some being recent acute, others old chronic cases, the author took blood, spinal and synovial fluids, and emulsion of cord, and injected these into other healthy cattle. He failed in all cases to infect the latter. He remarked that no case of disease had ever been produced by injecting hypodermically, or by internal dosing with any substance extracted or isolated from Macrozamias, but only by feeding with the plant itself. After long persistence in feeding with the plant, the practical permanence of symptoms was associated with peripheral neuritis (20).

Similar conclusions were arrived at by Professor Smith, of Sydney University, as a result of his experimental work.

Mr. J. H. Maiden described a convincing instance of cases of poisoning in 1895-1898. In a paddock in which *Macrozamia* plants were growing, stock were badly affected. The cattle were removed and the cycads cut down completely, but left lying in the paddock. Next year the stock were put back, and in six weeks were again suffering badly. Their stomachs were filled with the dried *Macrozamia* leaves. In 1897, the paddocks were closed again, till after one year cattle were admitted. They ate the dried withered leaves and all became ill. In 1898 the withered leaves had all disappeared, and only the roots were left, which had been dried for over 3 years. Cattle, when put in again, ate the roots, and became ill as before (16).

Professor J. D. Stewart, in 1899, then chief Veterinary Officer for New South Wales, conducted an enquiry into an outbreak of the disease at Moruya. A hundred head of cattle of all ages were affected. The symptoms were observed in all stages, and were described in detail and illustrated by photographs. Post-mortem examinations also were conducted. These led to the conclusion of the existence of partial motor-paralysis of the hind extremities, due to loss of nervous control over the actions of the muscles of the parts affected (21).

In the following year, Professor Stewart carried out feeding experiments on cattle. He gave each 2 lbs. per day mixed with chaff. Symptoms of the disease were indicated on the 23rd day, and the condition thoroughly established in all its manifestations 8 days later. This condition was shown to be permanent, and for all practical purposes incurable (22).

In 1906, Mann and Wallas analysed *Macrozamia Fraseri*, the Western Australian species, and concluded that the effects upon cattle induced by eating the plant are caused by potassium oxalate [confirming Norrie's result on *M. spiralis* (5)]. The authors referred to the plant but did not say whether leaves or nuts were used (24).

In 1912, Inspector Marks was sent to the Tabulam district, New South Wales, where in 1900 over 400 cattle had died. Heavy losses had been experienced each succeeding year till at last the leases had been given up. Zamia eaters with the confirmed habit had taught the whole herd, though plenty of green fodder was available. After some years, this neglected land was again leased for grazing and the herds were at once affected, there being many fatalities (25).

Dr. Cleland carried out feeding experiments on Milson Island in 1912 and 1913. The leaflets of *M. spiralis* were cut up small and mixed with chaff, 1 to 2 lbs. per day being given to each animal which was then well fed with other nourishing food. These experiments were of 5 months' duration, and no signs of any poisoning effects were discovered. The author's comment is that if

Macrozamia contained any actual poisonous constituent, some signs of its action would have been manifest in 5 months. Cattle in the poor *Macrozamia* country, however, would eat the plant in sufficient quantity to keep alive, but were not being supplied with vitamine (26).

The dietetic deficiency theory put forward by Dr. Cleland was not accepted by Professor Stewart, who has since conducted further feeding experiments. These eliminate any suspicion of lack of vitamines being the cause of the disease. He has obtained positive results in so far as the disease was established in animals receiving a "sufficient" diet, with an allowance of *Macrozamia*. It is understood that the details of these later feeding experiments will be published shortly.

In 1917, Mr. F. B. Guthrie analysed the nuts and leaves of *M. spiralis*, and the following results were published (27).

	Kernel	Leaves.
Water	81.79	76.67
Ash	1.07	.99
Ether extract	.18	.40
Fibre	4.74	6.18
Albuminoids	.03	2.64
Carbohydrates	12.19	13.31
	100.00	100.00

It is important to note from these figures for the kernels, after deducting the water and calculating the dry substance, that two thirds of this is starch and one quarter fibre.

Experimental Work.

Macrozamia spiralis Miq. grows in great abundance in certain districts, north and south of Sydney. A large stock of the leaves obtained from Bateman's Bay on the south coast of New South Wales, was made available by Professor Watt in connection with the investigation of this plant as a possible source of raw material for the manufacture of commercial alcohol.

The sample consisted of the entire rachis and leaflets, each about six feet long. Through the kindness of Mr. G. Wright, these were air-dried and put through a disintegrator in the School of Agriculture at the University. The fine dry powder thus obtained weighed 10.4 kilograms.

Proximate Composition of the Leaves.

A portion of the leaf-powder was dried at 100° C. for water content, then incinerated to obtain the amount of crude ash. Another portion was completely extracted successively with various solvents, in a Soxhlet extractor; the extracts were evaporated, and the residues dried at 100° and weighed. There was left an insoluble powder containing the cellulose, fibre, and other indefinite substances. The following results were obtained for the air-dried leaf-powder, and have been also calculated for the fresh and completely dried leaves.

	Fresh leaves.	Air-dried.	Dried at 100°
Water	60.0 %	9.6 %	—
Crude ash	1.7	3.8	4.2 %
Extd. by solvents	12 9	29.2	32.3
Insol. residue	25.4	57.4	63.5

The various organic solvents removed in solution the following amounts:—

		Air-dried leaves.
1. Petroleum spirit (b.p. under 50°)	extracted	1.19 %
2. Ether	„	1.26
3. Chloroform	„	6.04
4. Ethyl alcohol	„	13.08
5. Water	„	7.60
Total soluble substances		29.17 %

A portion of the leaves was specially tested for alkaloids by extracting with chloroform-ether-alcohol mixture. The extract, after removal of the solvents, was heated with dilute acid, and on applying the characteristic tests for alkaloids gave entirely negative results.

Another portion of the leaf-powder was treated specially for the isolation of oxalic acid or oxalates, and these were proved to be absent.

Proximate Composition of the Nuts.

The bright red ovules or seeds were collected and used in the fresh condition. One average ovule consisted of:—

Soft red outer cover	10 gms.
Hard shell	2 „
Soft white kernel	6 „
Total weight	18 „

These kernels contained a harder core in the centre, and were easily cut like a potato. When they were grated down they became a sticky pulp, resembling thin dough, mixed with much mucilage. Exposed to the air, the pulp soon became dry and brittle, and was then easily powdered in a mortar. A portion of this was extracted with alcohol, which dissolved out a small amount of fixed oil, and then extracted with water. The insoluble residue from this extraction was dried and weighed. In a second portion the nitrogen was estimated by Kjeldahl's method. In a third portion a careful examination was made for salts of oxalic acid. This was subsequently repeated with a much larger sample, and the minute precipitates carefully examined under the polarising microscope, but in none of these were any of the characteristic calcium oxalate crystals seen.

A large sample was washed in a muslin cloth under cold water, after which the white starch which deposited was dried and weighed, likewise the insoluble fibrous residue in the cloth was separated and weighed. The aqueous solution contained a considerable amount of a thick gelatinous slime, or mucilage.

Composition of the Kernels or Seeds of the Macrozamia Nuts.

	Calculated on Fresh Kernel.	Dried at 100°
Water	42.6 %	—
Ash	1.0	1.7 %
Extracted by alcohol (oil)	4.25	7.4
„ hot water	4.2	7.3
Insoluble residue	48.0	83.6
	100.0	100.0
Nitrogen	1.8 %	3.2 %
Starch	39.0	68.0
Residue left in cloth (fibre)	15.1	26.3

Complete Chemical Examination.

Extraction.—For the purpose of a detailed investigation of the constituents of the leaves, 6 kilograms of the air-dried plant powder were extracted with 80 % alcohol, by maceration and percolation at room temperature. Three large percolators were employed. The fresh spirit was added to the first, the percolate from this run into the second, and the percolate from the second added to the third, thus making one complete extract. Each complete extract was assayed for total solids contained in it; in this way the progress of the extraction was ascertained.

1st	extract, 3	litres, contained	285	gms. solid matter.
2nd	,, 3	,,	246	,,
3rd	,, 3	,,	171	,,
4th	,, 3	,,	114	,,
5th	,, 3	,,	63	,,
6th	,, 3	,,	36	,,
7th	,, 3	,,	24	,,
8th	,, 4	,,	24	,,
9th	,, 3	,,	12	,,
	28 litres		975 gms.	

The total solid matter, soluble in alcohol, thus obtained, represents 16 % of the air-dried leaf-powder. The 28 litres of alcoholic extract consisted of a dark brown fluid, and were distilled under diminished pressure to a thick syrup. The temperature of distillation did not exceed 40° C. After removing the solvent in this way there remained in the still a thick, black, tarry product.

Distillation of the Extract in a Current of Steam.—The semi-solid mass was then distilled in a current of steam, when there was obtained 2.5 litres of aqueous distillate, and in the still an insoluble resinous mass with a large volume of hot aqueous liquid. The latter was filtered hot, the solid portion boiled in water, and decanted many times till the washings were colourless. This substance, insoluble in hot water, when dry weighed 392 gms. The filtered solution and washings were set aside to cool, and after a few days a quantity of a brown solid deposit separated, which was washed with cold water, and when dry weighed 64 gms. The following portions were obtained:—

A. Volatile steam distillate	2.5	litres
B. Aqueous solution	7	,,
C. Chlorophyll and insoluble resins	392	gms.
D. Brown deposit on cooling the aqueous soln.	64	,,

The insoluble substances in C and D, weighing 456 gms., made up 47 % of the whole alcoholic extract.

Examination of the Volatile Portion, A.

The distillate, measuring 2.5 litres, and showing a distinctly acid reaction to litmus, was shaken out with ether many times.

(1). The remaining aqueous fluid was first examined: it was still acid in reaction to litmus When boiled with Fehling's solution it produced a slight reduction. It also reduced mercuric oxide and silver nitrate when boiled, indicating the presence of a small amount of formic acid. A little of the solution was evaporated with sulphuric acid, when the pungent vapours of acetic acid were recognised, and on addition of alcohol, the odour of ethyl acetate was very marked.

The whole fluid was neutralised with baryta water and evaporated to dryness. This left a residue of barium salts of the organic acids weighing 0.93 gm., which was converted into barium sulphate.

0.93 gm. Ba salt yielded 0.847 gm. $BaSO_4$=91.1 %
Acetic acid requires „ =91.3

The barium salt represents 0.54 gm. of acetic acid in the aqueous solution, with a trace of formic acid.

(2). The ether extract of the volatile distillate was agitated successively with ammonium carbonate, sodium carbonate, and sodium hydroxide until nothing further was removed in solution by each solvent. These alkaline fluids were then acidulated and extracted with ether, the solvent distilled off, and the residue converted into barium salt by titration with decinormal baryta solution. The latter was decomposed by sulphuric acid, and the barium sulphate weighed.

The ammonium carbonate extract was too small in amount for analysis, but the sodium carbonate solution gave 0.226 gm. of barium salt.

0.0465 gm. Ba salt yielded 0.032 gm. $BaSO_4$=68.80 %
Valerianic acid, C_4H_9 .COOH, requires „ =68.73

By titration the sodium carbonate extract was found to contain 0.3 gm. of valerianic acid.

The sodium hydroxide extract was neutralised by 0.5 cc. of baryta. It left a small residue on evaporation, which possessed the odour of cresol.

The ethereal solution remaining after the treatment with alkaline liquids was dried and distilled at a low temperature. There was obtained in this way a pale yellow limpid essential oil weighing 2.15 gms. This oil possessed a strong fragrant odour like camphor, and when kept in a desiccator over sulphuric acid, it was nearly all lost by evaporation in 3 days. This exceedingly volatile oil left about 0.25 gm. of a yellow solid on spontaneous evaporation.

The volatile constituents in the steam distillate were thus identified:—

trace of formic acid	CH_2O_2
0.54 gm. acetic acid	$C_2H_4O_2$
0.30 gm. valerianic acid	$C_5H_{10}O_2$
2.15 gms. essential oils.	

For comparison with these acids we may mention the historic work of Chevreul on another plant survival from the past, *Ginkgo biloba*, the maiden-hair tree of China and Japan. This is the sole representative now existing of the very ancient branch constituting the second Order of the Gymnosperms, and has much in common with the cycads. Chevreul and Béchamp* isolated a complete series of acids from C_1 to C_7, viz., formic, acetic, propionic, butyric, valerianic, caproic and caprylic acids. The second, fourth and sixth predominated. This result was obtained after many trials, and only after extracting a large amount, 30 kilos, was sufficient of the third, fifth and seventh acids obtained to enable them to be identified. It is quite probable that small amounts of the other acids are present in *Macrozamia* also, but if so they can be recognised only

*Comptes rendus de l'Acad. des Sciences, 53, 1861, 1225; Annales chim. et de phys., i., 1864, 288.

by taking a much greater quantity of material, and making this a special object of research.

Examination of the Aqueous Solution, B.

The aqueous solution:—The voluminous washings and aqueous solutions were concentrated at a low temperature, and freed from a small amount of oil by shaking with petroleum spirit. The solution was then treated with an equal volume of 10 % lead acetate solution, and the brown precipitate removed by the centrifuge and washed. The filtrate was next treated with basic lead acetate solution, and a white precipitate separated in the same way. The lead was removed from the solution by sulphuric acid and hydrogen sulphide, and the solution concentrated at 60° C. The hydrogen sulphide was removed by an air current passed through the warm solution. The black solution was shaken up repeatedly with (1) ether, (2) chloroform and (3) amyl alcohol. Ether removed about 2 gms. of a viscous resinous substance, chloroform removed only a trace, and amyl alcohol a dark brown syrup. These substances yielded nothing of a crystalline nature. They were dissolved in ether and shaken out successively with ammonium carbonate, sodium carbonate and sodium hydroxide, neutralised and again agitated with ether, but nothing could be obtained in this way.

Each of these extracts was carefully tested for alkaloids but only negative results were obtained.

The aqueous solution remaining after treatment with the above organic solvents, was distilled in a current of steam till free from amyl alcohol, and set aside. After some time crystals separated, and these were found to consist only of potassium salts. No tannin was present in this solution, and saponins were absent.

Picric acid gave a large precipitate of needle crystals of potassium salt. When boiled with potash, much ammonia was evolved, and Fehling's solution showed an immediate and strong reduction.

The osazones were next prepared from the solution, and when the product was examined under the microscope it was identified as the characteristic yellow crystals of phenyl glucosazone. These were purified by six recrystallisations from dilute alcohol, and then showed a melting point of 206° C. (corrected).

The melting point of the osazone of glucose is given as 205°. The predominating sugar is therefore glucose.

The solution also gave strong reactions for furfuraldehyde.

The total solid content of this aqueous fluid was 350 gms. or 36 % of the alcoholic extract.

Examination of the lead acetate precipitates.—These lead deposits were treated with sulphuric acid and hydrogen sulphide to remove the lead, and the hydrogen sulphide boiled off. The solutions were treated with animal charcoal till nearly colourless and then concentrated. They showed no reactions with ferric chloride or sulphuric acid. When neutralised with sodium hydroxide, heavy gelatinous white precipitates were obtained, and Fehling's solution was strongly reduced.

The fluid was shaken out with ammonium carbonate, sodium carbonate and sodium hydroxide, then agitated with ether and acid, but nothing was obtained from any of these extracts in this way. The remaining solution from the normal lead precipitate, after standing some time, deposited a considerable amount of anhydrous calcium sulphate, in masses of white, needle-shaped crystals, matted together.

Examination of the Resins, C.

The resinous mass insoluble in hot water, which was left in the still after the removal of the volatile constituents by steam distillation, when dry weighed 392 gms., or 40 % of the total contents of the alcoholic extract.

This substance was a dark brown powder. It was dissolved in the smallest amount of alcohol, mixed with purified sawdust and completely dried to constant weight. The dried mass thus rendered porous was transferred to a Soxhlet apparatus, and extracted successively and completely with petroleum spirit (b.p. below 50° C.), ether, chloroform, and alcohol. After each of these extracts was distilled to remove the solvent, and the residues dried at 110° and weighed, the following results were obtained:—

1. Petroleum spirit extract	35 gms.	8.9 %
2. Ether extract	38 "	9.7
3. Chloroform extract	4 "	1.0
4. Alcohol extract	60 "	15.4
Left unextracted	255 "	65.0
Total	392 "	100.0

This table shows that although 392 gms. of this mixture originally were in alcoholic solution, being extracted from the leaves with this solvent, 255 gms. had now become insoluble in that liquid, forming nearly two-thirds of the original extract.

Two factors may explain this anomaly:—The petroleum spirit extract contains all the oils and fats. Certain substances are intimately associated in the plant with these oils and are soluble in them alone. They are removed together with the oils in the extraction of the leaves by alcohol. When subsequently the oils and fats are removed by petroleum spirit these other constituents, having lost their special solvent, are now rendered completely insoluble in alcohol. In the second place the leaves were originally extracted with 80 % alcohol (containing 5 % wood-spirit), and in the resin analysis 98 % ethyl alcohol was used.

i. *Petroleum spirit extract of the Resins.*—The solvent was removed by distillation, and the residue of 35 gms. was dissolved in ether leaving a small amount of insoluble brown residue, which weighed 0.2 gm. The ethereal solution was then agitated a number of times with (1) ammonium carbonate, (2) sodium carbonate, (3) sodium hydroxide, (4) water, for the separation of organic acids. The alkaline extracts were rendered acid with sulphuric, and shaken back with ether, the solvent distilled off, and the residue examined. In this way (1) ammonium carbonate yielded 0.25 gm. of a grey amorphous residue. (2) The sodium carbonate extract yielded a small quantity of a dark brown oil. At the same time there was precipitated by sulphuric acid about 10 gms. of a brown solid substance. The latter with the acid fluid was distilled in a current of steam, but from the distillate only a trace of volatile acids was obtained. The acid liquid remaining in the still, however, when titrated with baryta solution and evaporated, yielded the barium salt of acetic acid.

0.460 gm. Ba salt gave 0.410 gm. $BaSO_4$ = 89.2 %
Barium acetate requires " = 91.3

The amount was equal to about 0.76 gm. of acetic acid. The brown solid substance mentioned above, of 10 gms. weight, was treated with petroleum spirit in which 3.3 gms. dissolved, ether dissolved 1 gm., and the remainder was soluble in alcohol only. These residues appeared to be complex mixtures of acids, and were not further examined. (3) The sodium hydroxide extract contained much chlorophyll. When acidified and shaken out with ether 0.2 gm. of substance was obtained. (4) The water extract after caustic soda treatment yielded to petroleum spirit 6.6 gms. of a white fatty substance, which was filtered and washed with cold alcohol. On recrystallisation a number of times from petroleum spirit, it showed a melting point of 47.5° C., and solidified at 46° C. The solution of this substance possessed an acid reaction.

0.155 gm. required 4.85 ccs. of decinormal alkali to neutralise it to phenolphthalein. This gives for a monobasic acid, the molecular weight of 320. The iodine-value by Hubl's method was determined:—

(1). 0.1097 gm. absorbed 0.058 gm. of iodine=52.9 %
(2). 0.1012 " 0.054 " =53.1

The iodine-value corresponds to 59 % of oleic acid, and leaves 41 % with a molecular weight approximating 374, as probably one of the higher homologues of stearic acid.

Isolation of Phytosterol.

The ethereal solution which remained from the last section, after extraction with alkalis and water, was distilled off. This residue consisted of a mixture of fats and oils, with certain unsaponifiable substances, and weighed 10 gms. It was hydrolysed by boiling for 6 hours with an alcoholic solution of potassium hydroxide, and the products of saponification brought into aqueous solution by heating on the water-bath. In this way there were separated a black insoluble unsaponified portion, and a strongly alkaline aqueous solution. The whole was cooled and agitated with ether many times until nothing further was brought out in solution.

The unsaponified portion.—The ethereal solution, dark brown in colour, contained 0.5 gm. of solid, and was distilled off leaving a residue of impure, much discoloured crystals. The latter were dissolved in alcohol and digested with animal charcoal. They were then obtained in a fairly pure condition, and were redissolved and recrystallised twice from dilute alcohol.

The crystals were pure white with glistening surfaces, but under the microscope appeared of two kinds—a few broad rectangular flakes with dome ends, and the greater portion consisting of lath-shaped forms with pointed ends.

The broad flaky crystals presented the appearance of cholesterol, with low refractive index, and with the characteristic bites out of the sides.

The lath-shaped forms resembled some phytosterol crystals.

The crystals were exceedingly soluble in chloroform, and the following specific tests were applied:—

Salkowski's reaction—A chloroform solution and concentrated sulphuric acid were mixed, when the former assumed a blood-red colour and the acid a deep-green fluorescence; the red solution when removed and evaporated slowly changed colour, through purple, violet, blue and finally colourless; on again adding sulphuric acid the original crimson colour was restored.

Liebermann's reaction—acetic anhydride and a drop of sulphuric acid added to a chloroform solution gave a rich rose-red colour.

Iodine and sulphuric acid gave a violet colour, changing to blue and green.

Schiff's reagent gave a reddish violet residue.

These positive reactions place the substance in the group of phytosterols.

Purification and physical properties of the phytosterol.—After five recrystallisations from 95 % alcohol the greater portion of the substance was obtained in one fraction which, under the microscope, showed crystals of a uniform kind, laths with pointed ends. A second small fraction contained a mixture of the phytosterol with some few crystals like cholesterol. The first fraction was used for the following determinations:—

Estimation of water of crystallisation.

0.3301 gm. heated in the oven at 110° C. lost 0.015 gm.

Loss in weight	4.54 %	water
$C_{27}H_{46}O.H_2O$ contains	4.46	„

Formation of acetate.

.2657 gm. of the anhydrous crystals was boiled with acetic anhydride; the product evaporated and weighed, gave .2937 gm. of phytosterol acetate.

Increase in weight	10.6 %
$C_{27}H_{46}O(CO.CH_3)$ requires	10.9

Melting points.—The first fraction of the phytosterol containing its water of crystallisation showed a constant melting point of 132° C. (corrected). The second fraction gave a melting point of 135° C. The phytosterol acetate crystals melted at 120° C. (corrected).

Optical properties.—A polarimetric determination of the substance was made with a Schmidt and Haensch polarimeter. A solution of .2657 gm. of the phytosterol crystals in 15 ccs. of ether, and equivalent to a 1.7714 % solution, was used in a 1 dcm. tube. A laevo-rotation was recorded of −0.61° at a temperature of 16° C.

The specific rotatory power, $\left[\alpha\right]_{D}^{16} = -34.5$.

This biochemical group, of which cholesterin is the best known, has been called by Abderhalden the sterins (Lehrbuch der physiol. Chemie). These appear to be intimately associated with the fats and oils in all living cells, and have certain well defined properties. Their physical constants, however, are found to vary within certain limits, showing that not one substance but several closely related compounds exist.

Cholesterin of animal tissue has been known for fifty years, but of the analogous compounds in plants, the phytosterins, our knowledge is very recent. They occur both in the free state and as esters. Chemically, they are unsaturated alcohols of high molecular weight, having the constitution of cyclic polyterpenes.

In the literature available to the author the investigation of 66 different plants includes the isolation and identification of their phytosterins. In the English literature the term phytosterols is adhered to throughout. In ultimate composition they are found to range from C_{20} to C_{30}, but two-thirds of the number have the formula $C_{27}H_{46}O$ and the great majority possess the general formula $C_nH_{2n-8}O$. These 44 phytosterols have—

a melting point	between	130°	and	138° C.
optical rotation	„	—30	„	—41
2 groups of acetates (1) m.p.	„	118	„	122
(2) „	„	125	„	128

Those possessing the latter constants for their acetates were distinguished by Burian as sitosterols

The phytosterol of *Macrozamia spiralis* possesses the following physical constants:—

melting point.	132.0° C.
optical rotation.	—34.5
acetate m.p.,	120.0° C.

It therefore falls in the first of the two groups.

Separation of Hydrocarbons.

The alcoholic mother-liquors, left after crystallising out the phytosterols, were united, and on further concentration a small quantity of cream-coloured fatty solid was separated. This substance, when purified by digesting with animal charcoal and several crystallisations, possessed the properties of a saturated hydrocarbon, and a constant melting point of 65° C. The weight was insufficient for analysis, and was not further examined. The melting point of the paraffin triacontane, $C_{30}H_{62}$, as observed by Tutin, is 65° C.

There now remained of the unsaponified substances only an uncrystallisable dark yellow oil, weighing about 2 gms.

Something of the nature of this oil was ascertained by treating a portion with a small piece of sodium, when only a few micro-bubbles of gas were produced, even on heating to 75° C. The substance therefore was not an alcohol. This point was confirmed by acetylation of the substance: when boiled with acetic anhydride and the products separated, no gain in weight was observed. The substance therefore did not contain a hydroxyl group.

The yellow oil was next distilled under a pressure of 30 mms.; the first drop collected at 180° C., and the greater part passed over at about 220°. The distillate was a pale yellow fluid which solidified on cooling in microcrystalline needles. This clear distillate was quite solid at 16° C., and when carefully warmed became a viscous fluid at 20°; the melting point lay between 17° and 19° C. By careful bromination of the substance in solutions of carbon bisulphide, it was observed that the bromine decolourised but almost no hydrobromic acid was formed,—evidence that only addition products were present. The absence of substitution of bromine points to the absence of paraffins.

The olefine hydrocarbon, octodecylene, $C_{18}H_{36}$, possesses the melting point of 18° C., and boiling point 182° C., under a pressure of 30 mms.

The Saponified Oils.

The strong alkaline solution obtained by hydrolising the petroleum spirit extract of the resins, and after removal by ether of the unsaponified substances, was now treated for fatty acids by adding sulphuric acid and distillation in a current of steam.

The distillate was faintly acid, and contained a small amount of a greenish solid, which was filtered off and examined. The substance was recrystallised from alcohol a number of times, and then consisted of 50 mgs. of nearly white crystals in small globular masses. The melting point was 45° C. The neutralisation equivalent was determined in alcoholic solutions, the titration ended sharply and required 20 ccs. of centinormal alkali to neutralise 40 mgs., which is equivalent to a neutralisation value of 200.

Lauric acid, $C_{12}H_{24}O_2$, requires 200 and possesses a melting point of 43.6° C.

The titrated sodium salt in alcoholic solution was then precipitated by baryta, and the barium compound converted into sulphate.

0.0383 gm. Ba salt yielded 0.0162 gm. $BaSO_4$.
equivalent to $BaSO_4$ 42.3 %
Barium laurate requires 43.5 %

The substance was therefore lauric acid, $C_{12}H_{24}O_2$

The aqueous distillate, from which the above solid lauric acid had to be filtered, was treated by shaking out with ether; but nothing was removed in solution except a trace of an acid too small to identify. The aqueous distillate was titrated with decinormal barium hydroxide, and required 42 ccs. The solution was evaporated to dryness and weighed. During the heating the strong odour of acetic acid was detected.

0.3973 gm. Ba salt yielded 0.3671 gm. $BaSO_4$=92.4 %
Barium acetate requires " 91.3

The substance is therefore acetic acid, $C_2H_4O_2$.

The acid liquid remaining in the distillation flask was shaken out with petroleum spirit. This removed a dark coloured solid mass which weighed 3 gms., and consisted of the higher fatty acids including stearic and oleic acids; they were not further examined.

The same acid liquid after treatment with petroleum spirit was agitated with ether. This solvent removed about 1 gm. of solid substance in solution, which consisted of resins and resin acids.

ii. *The ether extract of the Resins*:—The ether extract weighing 38 gms. was examined in the following manner.

A portion of the extract was dissolved in alcohol and poured into a large volume of water, when a dark green insoluble mass separated and was deposited. The aqueous portion was a pale green colloidal solution which did not settle. The resinous contents could not be induced to separate either by spinning in a high-speed centrifuge, filtering by the suction pump, allowing to stand several weeks, or by addition of such reagents as sodium citrate, magnesium sulphate, ether or alcohol. When agitated, however, with a little dilute sulphuric acid, instant separation took place, light green resins were deposited, which were filtered off from a clear aqueous fluid, and washed with water till acid-free.

The total deposited resins were dried and extracted with prepared sawdust in a Soxhlet extractor (1) with chloroform, (2) with alcohol. From each of these extracts the solvent was removed by distillation, dried and weighed.

27 gms. soluble in chloroform.
5 gms. insoluble in chloroform, soluble in alcohol.
6 gms insoluble in chloroform, insoluble in alcohol.

Each of these portions was examined separately in great detail. Their solutions in ether were agitated with sodium carbonate, sodium hydroxide, and water. Each solution was carefully purified by animal charcoal and evaporated spontaneously, but in no case could any crystalline substance be isolated. Amorphous residues were obtained in all cases.

The portion insoluble in chloroform but soluble in alcohol was a black brittle resinous substance; when its alcoholic solution was poured into water it assumed a brilliant pale green and bright blue fluorescence.

iii. *The chloroform* and iv. *the alcohol extracts of the original resin.*—These, following the petroleum spirit and ether extractions, were treated in the same manner as the ether soluble portion, but only amorphous resins were obtained.

The Resins deposited from Cold Water, D.

The light brown resinous powder obtained by settling the original aqueous solution of the resins, and weighing 64 gms., was dissolved in a little alcohol and mixed with prepared sawdust. The whole was then thoroughly dried, and extracted in a Soxhlet apparatus, successively with organic solvents. The yield obtained was:—

Extracted by ether	10 %
,, chloroform	1
,, alcohol	21
Insoluble	68

The brown resin contained 1.2 % of inorganic salts. From each of these extracts the solvent was distilled, and the residual substance examined. Nothing crystalline was obtained from any portion, and they seemed to be composed of amorphous resins.

FEEDING EXPERIMENTS WITH MACROZAMIA SPIRALIS.

The animals used were white rats. They were kept singly in metal cages, and their normal food consisted of bread, or dog-biscuit, and water.

(i.) *With the fresh leaf-powder.*—The powdered leaves were mixed with bread or biscuit into a paste with water. 10 gms. of leaves were thus given daily to each of four rats. In most cases the ration was finished, but at the end of two weeks they ceased to eat any more, and after starving for a number of days they were put back on normal diet.

These animals were very lively and active, showing no ill effects at the end of the experiment, nor after some weeks.

(ii.) *With the constituents of the ether extract.*—It has been stated in the historical part above (p. 427), that Lauterer, of Queensland, separated from the leaves of *Macrozamia* by extraction with ether, a quantity of resin, to which he attributed the poisonous effects.

For the purpose of testing these resins a quantity of the leaves were treated in a special manner.

A quantity of the air-dried leaf-powder weighing 2.5 kilos was thoroughly extracted in large percolators with ether. After distilling off the solvent, there remained a viscous residue weighing 94 gms. (dry weight), which consisted of oils, fats and resins. Instead of using this entire extract it was further analysed by dissolving in a little alcohol, mixing with prepared sawdust, and completely drying the mass. This was extracted in a Soxhlet successively with (*a*) petroleum spirit, (*b*) ether, (*c*) alcohol.

The petroleum spirit extract was found to be the greatest in amount: it was further subdivided by shaking out successively with (1) sodium carbonate, (2) sodium hydroxide.

The weights of these different portions finally obtained were:—

(*a*) Petroleum spirit extract—	
Sodium carbonate solution	15 gms.
Sodium hydroxide ,,	30 ,,
Petrol. spirit ,,	20 ,,
(*b*) Ether extract	24 ,,
(*c*) Alcohol extract	5 ,,
	94 ,,

These various portions were divided into small amounts for feeding purposes, to last about two weeks. Each portion, mixed as before with about 10 gms. of bread or biscuit, was fed to a rat. Water also was given in each case.

All these extracts were readily and completely eaten. The rats apparently enjoyed the rations and remained throughout the period of two to three weeks very active and well. These experiments show that nothing of the nature of Lauterer's poisonous resins was present.

(iii.) *With the aqueous extract of the nuts.*—About 1 kilo. of the seeds was made into a pulp, and extracted with 2 litres of water and 1 cc. of toluene. After 3 days, with frequent stirring, it was filtered through cloth into a tall cylinder, to allow the greater portion of the starch to deposit.

The solution thus obtained was given to two rats, the ration for each being made up of 30 ccs. of the fluid, with bread and biscuit soaked in it. This was given daily for 22 days, at the end of which period the two rats appeared quite normal and active.

The supposed poisonous principle said to be removed from the nuts by washing with water, and which would have been in the above solution, was not found in these experiments

(iv.) *With the fresh nuts.*—Nuts were fed to two rats, with no other food, but with plenty of water. Both animals died of impaction within three days, and no other abnormal symptoms were detected.

In the historical record given above (p. 425), it will be noticed that animals were affected in two different ways. (1) Symptoms were rapidly manifested within the first three or four days after eating the *Macrozamia*. The animals became slow in their movements, dragged the hind limbs, and finally died of impaction. This condition would include the gastro-enteritis mentioned by certain authors. (2) Symptoms were gradually produced after three or four weeks' feeding. The condition was entirely different from the former, and was said to produce peripheral neuritis, and partial paralysis, etc. The animals, though incurable, might live on if cared for but if not, they usually died of starvation.

The results of the experiments with the white rats were positive for the former, but entirely negative for the latter condition.

The symptoms described for the real *Macrozamia* poisoning are characterised by the slow onset of the disease, but when fully established, the disease has not been associated with any very definite pathological changes. These symptoms, in a general sense, have also been observed after animals have fed for long periods on certain other plants, for example, the Grasstrees, the Darling Peas, *Lathyrus*, Loco weeds, etc., and in none of these has any active poisonous chemical compound been identified.

This chemical investigation has shown that the *Macrozamia* contains no active poisonous principle which could be isolated or identified, or any individual constituent which could be associated with the disease.

Summary.

Macrozamia spiralis, which grows abundantly along the East Coast of New South Wales, has been regarded as a poisonous plant from the earliest days of the Colony.

A complete summary of its poisonous record is given.

The chemical composition of its leaves is characterised by a large amount of amorphous resins.

The following constituents were identified:—

Formic, acetic, valerianic and lauric acids.

Oleic, stearic, and higher fatty acids.

A very volatile essential oil.

A phytosterol with m.p. 132°, opt rot. — 34.5, and m.p. of acetate 120° C.

A paraffin, with the properties of triacontane $C_{30}H_{62}$, and an olefine having the properties of octodecylene.

The nuts contained 39 % of starch, and much mucilage.

In the feeding experiments, white rats were given, with their ordinary food, (1) the crushed fresh leaves, (2) the grated seeds, (3) the rich, fatty, and resinous components extracted from the leaves by ether, and which Dr. Lanterer stated contained the poisonous principle, (4) the aqueous extracts of the leaves, and the seeds, by which the aborigines believed the poison was removed.

The animals showed no signs of being affected after three weeks' feeding; the material was apparently not poisonous to white rats. With careless feeding the animals are easily killed by impaction, which is due to the fibrous nature of the material.

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TWO NEW HYMENOPTERA OF THE SUPERFAMILY PROCTOTRYPIDAE FROM AUSTRALIA.

By Alan P. Dodd.

(Communicated by W. W. Froggatt, F.L.S.)

Among a small collection of Micro-Hymenoptera kindly lent me by Mr. W. W. Froggatt, Government Entomologist of New South Wales, the two species described herein were picked out as new; of these one is of special interest, being a primary parasite of the Sheep-Maggot Flies.

I am very much indebted to Mr. Froggatt for the loan of the specimens, and also for the data and information contained in his letters.

Family DIAPRIIDAE.

Hemilexomyia, n.gen.

♀.—In Kieffer's table of genera (Genera Insectorum, 1911), running to *Hemilexis* Foerster, *Paramesius* Westwood, and *Spilomicrus* Westwood; closely related to all these genera and combining many of their characteristics, but at once differing in the incised base of the body of the abdomen, and the very long stigmal vein; *Hemilexis* and *Spilomicrus* possess a more or less truncate abdomen at the apex, but in both these the base of the body of the abdomen is distinctly raised from the petiole, whereas *Paramesius*, which does not possess the latter character, has the apex of the abdomen narrow and pointed. The detailed generic characters are given in the description of the species.

Type, *Hemilexomyia abrupta*, n.sp.

Hemilexomyia abrupta, n.sp.

♀.—Length, 5.5 mm. Shining black; legs, including the coxae, bright red; antennae red, the apical half more or less dusky; tegulae red.

Head normal; smooth and shining, except for scattered small punctures each bearing a long fine seta; viewed from above, sub-rectangular, about twice as wide as long; viewed from the side, the frons triangular, the antennal prominence distinct; cheeks broad; eyes moderately large, giving off a few long setae; ocelli large, close together. Antennae inserted on a prominence in centre of frons, 13-jointed; scape long and slender; pedicle and flagellar joints with scattered long pubescence; pedicel twice as long as its greatest width; flagellum without a distinct club, the apical seven joints a little thickened; joint 1 cylindrical, one-half longer than pedicel (in two specimens from Marsden longer and twice as long as pedicel); joint 2 one-half as long as 1; joints 3 and 4 subequal, a little shorter than 2, joints 5-10 subequal, subglobose, about as long as wide; apical joint conical, one-third longer than preceding. Thorax normal, twice as long as its greatest width; pronotal neck short and stout, the pronotum itself hardly visible from above; scutum and scutellum smooth and shining, with a few small setigerous punctures; scutum almost as long as its greatest width, broadly rounded anteriorly, the parapsidal furrows very deep, complete, and foveate; scutellum longer than its width at apex, subquadrate, at base with two large deep almost circular foveae, situated slightly obliquely to each other, each traversed by two or three more or less obscure carinae, their inner margins carinate, the narrow area between appearing as a shallow fovea (sometimes there are two of these shallow foveae); lateral margins of scutellum without a fovea, the posterior margin finely foveate; postscutellum conspicuous, carinate; median segment long, rugose, at base with an acutely raised carina (from lateral aspect appearing as a raised tooth) which branches to form laterally a distinct blunt tooth on either side, below these teeth are the blunt-toothed or subacute latero-posterior angles, and there is also a blunt tooth or protuberance on either side against the lateral margins anteriorly; median segment posteriorly with a short stout neck. Forewings very long and broad, extending a little beyond apex of abdomen; stained yellowish; venation thick and distinct, fuscous; submarginal vein well distant from the costa which it joins at half wing length; marginal vein somewhat thickened, almost as long as the stigmal vein which is perpendicular and very long for the family; pale yellow lines indicate basal, median, discoidal, recurrent, and radial veins. Hindwings two-thirds as long as the forewings, narrow slender, with a long costal vein. Petiole of abdomen stout, a little longer than wide, its lateral margins carinate, rugose, and with a paired median carina that projects into the incised abdomen; body of abdomen slender, about three times as long as its greatest width, conical, but the apex is blunt; viewed from the side gently convex above and beneath, and abruptly truncate at apex; smooth and shining, with a very few scattered setae; consisting of one segment only; anterior margin triangularly incised to form a short basal fovea. Legs slender; trochanters long and slender; femora slender for basal third, then much thickened; tibiae and tarsi slender, the latter 5-jointed with a pair of slender tarsal claws; intermediate tibiae a little longer than their femora, their tarsi a little longer than the tibiae; posterior tibiae plainly longer than their femora, and a little longer than their tarsi, the basal tarsal joint as long as 2-4 united; legs pilous, the tarsi spiny; posterior tibiae with two apical spurs.

Described from the following series: three females collected by L. Wilson at Marsden South-west Riverina, N.S.W., 15.5.1919, and bred from pupae of one of the sheep-maggot flies; one female bred from pupae of *Ophyra nigra* Wied., Yardry, near Hay, N.S.W., 20.8.1916, J. L. Froggatt; three females bred from pupae of *Calliphora (Neopollinosa) villosa* R.D., Moree, N.S.W., J. L. Froggatt; one female caught by sweeping pine scrub, Grenfell, N.S.W., 1918, W. W. Froggatt. Thus the species is well established in the State.

In Farmer's Bulletin No. 113, June, 1917, of the New South Wales Department of Agriculture, "Sheep-Maggot Flies, No. 3," by W. W. Froggatt and J. L. Froggatt, on page 32 the discovery of this parasite is recorded and a general description given, and on the opposite page very good figures are given. The following extract is taken from this bulletin: "This is a very different hymenopteron from the previous ones found attacking the maggots and pupae of the blow-flies,* and, as only about half a dozen specimens have been secured, it is not of much economic importance; yet, as it is evidently a primary parasite, it is well worth noticing."

The *Diapriidae* appear to confine their activities to Dipterous hosts, but so far this record of their breeding is the first in Australia.

The species is somewhat variable in the relative length of the pedicel and first flagellar joint, and in the foveae at the base of the scutellum. One female has a conspicuous thick protuberance at the apex of the abdomen; this process is very possibly retractile, which would account for its absence in the other specimens.

The types and cotypes are in the collections of Mr. W. W. Froggatt; one cotype is in the author's collection.

Family BELYTIDAE.

This family does not seem to be well represented in Australia, sixteen species having been recorded. The species described below differs considerably from all the Australian forms, falling in the group in which the scutellum is more or less spined or toothed, and containing four South American species described by Kieffer (Ann. Soc. Sci. Brussels, xxxiii., 1909) in four different genera, *Prosoxylabis* Kieffer, *Monoxylabis* Kieffer, *Acidopsilus* Kieffer, and *Odontopsilus* Kieffer, of which the first alone is founded on a female; the insect described herewith shows some diversity in the venation from all these, but the author does not deem it advisable to propose a new genus for its reception.

PROSOXYLABIS PICTIPENNIS, n.sp.

♀.—Length, 3.5mm.

Head, thorax (except the scutum), abdominal petiole, and the legs very deep red; scutum and body of abdomen bright chestnut; the first eight antennal joints bright reddish yellow, the apical seven black.

Head normal, subglobose, the antennal prominence very distinct; from lateral aspect the frons triangular, covered with a dense fine golden pubescence; eyes moderately small, ocelli small, close together. Antennae 15-jointed; scape slender, as long as the four following joints combined; pedicel short, a little longer than wide; funicle joint 1 distinctly longer, twice as long as its greatest width; 2-6 gradually shortening, 6 as wide as long; club 7-jointed (the first club joint really forms a transition between the funicle and club), its joints 1-6 somewhat wider than long, the apical joint twice as long as the penultimate. Thorax about twice as long as its greatest width; pronotum not visible from above; scutum plainly wider than long, covered with long fine golden pubescence, the parapsidal furrows delicate; scutellum on either side of basal fovea with dense golden pubescence, its disc with scattered pubescence; basal fovea large, subcircular, divided by a median carina that continues along the disc to terminate in a blunt tubercle or tooth posteriorly; postscutellum and median segment with a dressed sparse pubescence, the latter long. Forewings long and broad, extending well beyond apex of abdomen, marginal cilia short; discal cilia very dense and rather coarse very deeply embrowned, with a broad subhyaline band across the wing a little before the apex, a small subhyaline area just before the marginal vein, and a

*The two other known enemies of sheep-maggot flies are the Chalcids *Nasonia brevicornis* Girault and Saunders, and *Chalcis calliphorae* Froggatt.

similar area a little beyond the marginal vein, both against the costa; the broad band has its proximal margin straight, its distal margin deeply incised at the middle; venation obscure, consisting of a submarginal vein which joins the costa at nearly half wing length, a short linear marginal vein continued in a very oblique stigmal vein; no other veins visible. Petiole of abdomen long, several times as long as wide, and half as long as body of abdomen, carinate laterally and with three dorsal carinae; body of abdomen broadly ovate, not much longer than its greatest width, wholly smooth and shining, the second segment (first body segment) occupying four-fifths of the surface, the remaining segments very short and transverse. Legs normal, the femora clavate, the tibiae and tarsi slender.

Described from one female labelled "In moss, Mt. Wellington, Tasmania, 20.2.1902."

The paucity in the venation is possibly due to the cloudiness of the wings.

The type is in the collection of Mr. W. W. Froggatt.

CYANOGENESIS IN PLANTS.

PART IV.—THE HYDROCYANIC ACID OF HETERODENDRON—A FODDER PLANT OF NEW SOUTH WALES.

By JAMES M. PETRIE, D.Sc., F.I.C., LINNEAN MACLEAY FELLOW OF THE SOCIETY IN BIOCHEMISTRY.

(*From the Physiological Laboratory of the University of Sydney.*)

Heterodendron oleaefolia was a tree little known till the coming of the recent great drought which has devastated so large an area of the stock country.

In times of plenteous rain the rich grass-lands of the Western Plains yield abundance of food for large herds of sheep and cattle. But when the periodic recurrence of a drought approaches, the grass gradually disappears, and other fodder plants also become scarce. It is then that food for stock is supplemented by cutting down the foliage of trees and mixing the latter with the available food. Then the time soon arrives when only the foliage of trees is left to feed the starving animals. Many of these trees are evergreen, and display their young fresh leaves in a tempting way, when all other vegetation has dried up and disappeared. Such are the conditions under which Nature affords us opportunities for feeding experiments on a large scale, yet we find the periods go past and the results and observations are unrecorded.

Some of these plants, the foliage of which was used in this way on the large stations by the Castlereagh River during the last great drought, are given in the following list under their local names. They are all evergreen trees, and specimens have been sent down at various times for examination.

TREES USED FOR FEEDING STOCK DURING THE DROUGHT IN THE WEST.

1. Rosebush—*Heterodendron oleaefolia* Desf. (Fam. Sapindaceae.)
2. Whitewood—*Atalaya hemiglauca* F. v. M. (Sapindaceae).
3. Wild Orange—*Capparis Mitchelli* Lindl. (Capparidaceae), also called wild pomegranate and bumble.
4. Quinine-tree—*Alstonia constricta* F. v. M. (Apocynaceae).
5. Supple Jack—*Ventilago viminalis* Hook. (Rhamnaceae).
6. Wilga—*Geijera parviflora* Lindl. (Rutaceae).
7. Leopard Wood—*Flindersia maculosa* F. v. M. (Rutaceae).
8. Myall—*Acacia Cunninghami* Hook. (Leguminosae).
9. Beefwood—*Grevillea striata* R.Br. (Proteaceae).
10. Needlebush—*Hakea leucoptera* R.Br. (Proteaceae).
11. Quandong or native peach—*Fusanus acuminatus* R.Br. (Santalaceae).
12. Sandalwood—*Fusanus persicarius* F. v. M. (Santalaceae).
13. Belar—*Casuarina glauca* Sieb. (Casuarinae).
14. Kurrajong—*Brachychiton populneus* R.Br. (Sterculeaceae).
15. Box (*Eucalyptus* spp.), Pine, Honeysuckle creeper.

The foliage of all the above trees formed good food for sheep and cattle, and the animals fattened on it. While on certain stations sheep would not eat the leaves of some particular tree, such as Sandalwood and Eucalyptus, on a neighbouring station they were fed entirely on it.

It was observed by one station-owner that Supple Jack gave the best results, although in general the mixed foliage was most satisfactory and beneficial to the cattle.

The Wild Orange was eaten by sheep and cattle with great relish: both the leaves and stems as thick as a man's finger were eaten with no ill effects.

The foliage of some trees, such as the Rosebush, Wild Orange, Supple Jack and Wilga was eaten in large quantities, while small quantities of other trees like the Myalls satisfied the cattle. The feeding of cattle and sheep with the Rosebush will be described separately.

Heterodendron, the Rosebush of the Castlereagh, is endemic in Australia, and grows plentifully in the Western and Northern Interior of New South Wales, and also in the other States. There are only two species, *H. oleaefolia* and *H. diversifolia*, the latter being more confined to the northern areas and Queensland.

H. oleaefolia is a large shrub in some districts, while in others it grows as a tree to a height of 40 feet. It is known by many vernacular names, according to the locality, and samples bearing some of the following names have been received by the writer:—Whitewood (Dubbo), Rosewood (Coonamble), Western Rosewood, Rosebush (Coonamble), Emubush, Cabbagebush (Broken Hill), Boonery tree (Narrabri), Dogwood, Ironwood (Nymagee), Bluebush (Bourke to Cobar), Bullock bush (Broken Hill). This serves as a good example of the inadequacy of common names for plants; but the danger lies, not only in the number of such names, but in the fact that the same vernacular name is applied, in another locality, to some quite different plant, for example, Whitewood, as in the two lists. Nor do these local names refer in a single case to the well-known trees of the same name growing in older countries; for example, the Whitewood of North America, the Leopard wood and the Beefwood of South American forests, and the Indian Rosewood are quite different trees.

RECORD OF STOCK-FEEDING WITH ROSEBUSH.

Heterodendron has been described by a number of writers as a good cattle fodder, and by one as "the best fodder-tree of the West." Notwithstanding these statements by local authorities and others, a considerable mortality among both sheep and cattle occurred in 1915 on stations near the Castlereagh River. At Enfield, 400 sheep died in a single night after eating the fresh leaves of this plant. The latter was therefore suspected and specimens were sent to the writer for examination.

In the beginning of 1918, when the last great drought commenced, the mixed herbage was used with apparently no bad results. Gradually, as time went on, the trees other than Rosebush became very scarce, and at last on certain stations owners were left with no alternative but to use Rosebush alone. In 1919, on Nelia Station 90 sheep died; on Loyola station 4 sheep died, and 3 cows, which had eaten only a little of the leaves, were very sick, but recovered. At Wyreema station a single branch of Rosebush was cut and fed to sheep, and 6 died. Enfield station lost 9 bullocks, and Oakstand station a number of sheep through the same cause. In the latter instance the leaves were cut in the evening, and next morning 3 sheep were found lying down and breathing heavily. Their ears were cut, but no blood flowed. Two died during the morning, and the third was treated by artificial respiration, and by putting salt in its mouth. It recovered a little, and after a few hours got up and walked about. The next morning it was seen to drag the hind legs slightly but otherwise it was apparently well. It died two days afterwards. There was no other food available but the fresh leaves of *Heterodendron*.

On the same station, in 1920, when the drought was very severe, and the stock were being fed almost entirely on this one plant, the animals died at the rate of one or two each day. In June, on Locharino station, a Rosebush was cut in the afternoon for 15 cattle, and towards evening the whole 15 were ill. They were treated for some hours with warm water and salt, and in a few days 12 had recovered. In every case the animals showed frothing at the nose and mouth.

The record from Narrabri district may also be given. The plant is known here as the "Boonery tree," and is much used for feeding stock in times of drought. It is considered by the stockmen to be a good edible shrub, and the animals are said to be very fond of it. The Stock Inspector informed the writer, however, that frequently numbers of sheep died suddenly when first fed on the leaves, more especially if rain fell at the same time.

On one cattle station in this district, in 1919, a stock-owner lost 6 cattle. They died suddenly, succumbing without a struggle. On another station in the same locality, a number of cattle died suddenly. They were seen to eat the suckers, or young growth of the Boonery trees, which had been topped for cattle food during the previous year.

Preliminary Tests.

In the first samples which were tested it was proved that no poisonous alkaloid or other group of well-known active principles was present. However, on allowing the crushed leaves to macerate with water for a few hours, free hydrocyanic acid was detected in the solution. The presence of hydrocyanic acid was confirmed by the almost immediate change of colour of the sodium picrate test-paper, and by the formation of prussian blue. The powerful reaction obtained by testing quite a small quantity, even a single leaf, was sufficient to indicate the presence of a considerable amount of some poisonous cyanogenetic compound.

In the list of trees whose foliage was used for feeding stock, two only were found to be cyanogenetic—*i.e.*, to yield hydrocyanic acid when treated in the manner described,—namely, the Rosebush and Wild Orange. In the latter, *Capparis Mitchelli*, we have the first record of a cyanogenetic plant in the family Capparidaceae.

Heterodendron oleaefolia.—Samples were received from the Stock Inspectors at various times and also from a number of station-owners. They were tested in the following months, during the period 1915 to 1920.

January, Gulargambone.
February, Narrabri district.
May, Coonamble district.
June, Coonamble district.
November, Coonamble district.
December, Gulargambone.

All these samples were very strongly cyanogenetic.

That the hydrocyanic acid was involved in the constitution of some cyanogenetic glucoside was shown by its behaviour towards enzymes.

(1) A small quantity of the leaf-powder was placed in two bottles with strips of sodium picrate paper suspended from the corks: (*a*) to one was added a few drops of chloroform, and (*b*) the other was left as a control. The result was hydrocyanic acid evolved from (*a*) only.

(2) The plant powder, with sufficient water to cover, was placed in two test-tubes. (*a*) was kept at 40° C. for 1 hour; (*b*) was boiled for 5 minutes and also kept at 40° for 1 hour, the test paper used in each. The result showed in (*a*) a colour change to deep red within a minute, and in (*b*) no colour reaction after 24 hours. (*c*). To the tube (*b*) was then added a small speck of emulsin powder prepared from sweet almonds, and the mass again digested at 40° C. After a few minutes the test-paper showed a deep red colour.

These experiments were done also with aqueous extracts from the plant, the boiled solutions yielding no hydrocyanic acid till emulsin was added.

The plant therefore contains a glucoside and an enzyme, the latter being able to decompose the glucoside with liberation of hydrocyanic acid, under conditions favouring enzyme action. The glucoside is also decomposed by the emulsin of almonds.

Cyanogenetic Plants of the Family Sapindaceae.

In the chemical literature of the cyanogenesis in plants there already exist the records of six plants of the family *Sapindaceae* in which hydrocyanic acid has been obtained. These are:

Alectryon excelsum Gaertn., a New Zealand tree (Greshoff).

Alectryon tomentosus Radlk., a native New South Wales tree (Smith and White).

Alectryon coriaceus Radlk., *ibid.*

Cupania spp. (Greshoff).

Schleichera trijuga Willd., an East Indian plant.

Ungnadia speciosa Endl., a Mexico and Texas tree (Cheel and Penfold).

Heterodendron oleaefolia added to this list makes the seventh cyanogenetic plant of the *Sapindaceae*.

The only other existing species, *H. diversifolia*, has been tested by the writer in specimens from New South Wales and Queensland, but has always given negative results, showing the absence of any cyanogenetic compound.

Estimation of the Hydrocyanic Acid.

Many difficulties were met with in attempting to determine the true amount of hydrocyanic acid which this plant is capable of evolving under special circumstances.

The enzymes characteristic of the various cyanogenetic plants are known to act differently in most cases, especially as to their relative velocities and the position of the equilibrium point. These plants also contain substances which act as inhibiting factors during the hydrolysis of the glucoside, that is, which oppose its decomposition. There are likewise present certain bodies whose influence tends to recombine the products of hydrolysis and thus decrease the amount of hydrocyanic acid available for estimation.

When the leaves of *fresh* plants are macerated in water, there is no doubt that their protoplasm continues its physiological function for some time, and utilises part of the liberated hydrocyanic acid in the synthetic processes of metabolism. Although in a few cases it has been shown that the same glucoside occurs in certain widely different plants, such as phaseolunatin in Beans and Flax seeds, gynocardin in *Pangium edule* and *Gynocardia odorata*, the great majority of the cyanogenetic plants probably contain different glucosides. In artificial hydrolysis such as with mineral acids, etc., these glucosides behave differently towards the hydrolysing agent.

These few statements, to which others could be added, will suffice to show that no single stereotyped method can be used for all cyanogenetic plants in the determination of their hydrocyanic acid. Results of some kind will be obtained, but unless that particular method is discovered which is entirely suited to the plant under investigation, the results will be remote from the truth. These difficulties can be surmounted only by conducting extended series of experiments to determine the value of these various factors, and their influence on the amount of hydrocyanic acid obtained. Details of such experiments on *Heterodendron* form the subject matter of this paper.

Quantitative Estimations.

The Material Investigated.—For the purpose of these experiments a quantity of the plant was obtained from stations on the Castlereagh.

Sample i. was collected in December, 1915, near Gulargambone town, in a paddock where cattle were lying dead or dying. It was named "Whitewood."

Sample ii. was collected in June of 1917, near Coonamble, under the name of Rosewood. It was described as a valuable fodder plant when mature, but considered very poisonous to stock when in the state of young and succulent growth.

Sample iii. was obtained from Coonamble in November, 1917, under the name of Rosebush.

The samples ii. and iii. may therefore be looked upon as representing the winter and summer growths of the same year, just before the commencement of the drought.

Sample iv. was obtained from Oakstand Station, near Coonamble, in February, 1920, when the drought was very severe.

The writer desires to express his indebtedness and thanks to Mr. Symons, Chief Inspector of Stock, and to Mr. C. S. Campbell, of Oakstand Station, for the supply of plants for this investigation.

The General Method.—The plant material was mixed with water and the glucoside decomposed by various means. The hydrocyanic acid which was liberated was then distilled by boiling in a steam or air current into sodium hydroxide solution. This alkaline solution was evaporated in a vacuum still at a temperature below 70° C. to about 1 cc. volume. The latter was converted into prussian blue, and the tints observed in a Duboscq colorimeter, were compared with standard prussian blues prepared from solutions of known strength of potassium cyanide.

In some cases the alkaline solution of the distillate was titrated with centinormal silver nitrate.

The processes by which the glucoside may be hydrolysed and the hydrocyanic acid set free are:—

(*a*) Boiling with water.

(*b*) Boiling with mineral acids (hydrochloric and sulphuric).

(*c*) Maceration with water at 40° C. (autolysis).

(*d*) Maceration with emulsin of sweet almonds.

These processes have yielded widely differing results when applied to the different cyanogenetic plants, and investigators have discussed them in detail, with reference to some of the well-known fodderplants, such as sorghum.

A. Direct distillation in a current of steam.

The sample of powdered leaves was treated rapidly in the distillation flask with 250 ccs. of boiling water in order to destroy the enzyme. It was then boiled in a current of steam and the distillate received in a solution of sodium hydroxide. After distilling for one hour, the contents of the flask were acidified to 5 % with sulphuric acid, and the distillation continued. In some cases the enzyme was destroyed by treating the leaves directly with boiling 5 % sulphuric acid and immediate distillation.

Results.—The hydrocyanic acid obtained is expressed as milligrams in 100 grams of plant-material dried at 100° C.

TABLE V.

Direct distillation of leaves.

	Exp.	Time.	Particular treatment.	HCN mgs. %
Sample I. containing 60 mgs. % HCN.	1	1st hr.	Distilled with water alone in steam cur.	2
		2nd ..	.. with 5 % sulphuric acid	4
		3rd ..	.. ..	4
			Total in 3 hrs., unfinished	10
	2	½ hr.	Distilled with water alone in steam	none
		1 ..	.. with 5 % sulphuric acid	none
		1 ..	.. ..	0·5
		1 ..	.. ..	0·5
		1 ..	.. ..	3·0
			Total in 4½ hrs., unfinished	4·0
	3	½ hr.	Distilled with water alone without steam	none
		1 ..	.. with 5 % sulphuric acid	2
		1 ..	.. ..	2
		1 ..	.. ..	2
		1 ..	.. ..	2
		½ ..	.. ..	none
			Total in 5 hrs., finished	8
	4	½ hr.	Added boiling 5 % sulphuric, distilled in current of steam	none
		½ ..	..	2
		½ ..	..	1
		½ ..	..	none
			Total in 2 hrs., finished	3
	5	1 hr.	Added boiling 5 % hydrochloric, distilled in rapid air-current	8
		1 ..	..	4
		1 ..	..	1
		1 ..	..	none
			Total in 4 hrs., finished	13
Sample II. containing 328 mgs. % HCN.	6	1 hr.	Distilled with water alone in air-current	2
		1 ..	..	0
		1 ..	..	0
	7	1 hr.	Added boiling 5 % sulphuric, distilled in air-current	3
		1 ..	..	6
		1 ..	..	8
			Total in 3 hrs., unfinished	17

Deductions from Table A.—(1). The glucoside in this plant is not decomposed by boiling with water. In most cases no hydrocyanic acid was obtained, and in some a very small amount was distilled over. The maximum quantity thus obtained was 2 mgs., or about 3 % of the total acid, and was probably the result of the enzyme acting for a short interval before its complete destruction, that is, before the whole mass could be raised to the temperature of the boiling water.

(2). Boiling with dilute acids likewise results in very incomplete decomposition. Two kinds of results are apparent: in one the hydrocyanic acid slowly increases per hour (Nos. 1, 2 and 7), in the other the evolution comes to an end in the third or fourth hour of boiling (Nos. 3, 4 and 5). Hydrochloric acid produces more than sulphuric acid.

B. Autolysis, or Maceration of the plant in water.

Here the glucoside comes in contact with its own enzyme, and is decomposed with liberation of hydrocyanic acid. Into a distillation flask fitted with its cork and tubes were placed 5–50 gms. of leaves with 500 ccs. of water. This was kept in an incubator at 40° C. for varying periods, then distilled with and without 5 % sulphuric acid

TABLE B.

Autolysis of leaves.

	No.	Time of maceration.	Particular treatment.		HCN. mgs. %
Sample I. containing 60 mgs. % HCN.	8	1 hr.	then distilled with sulphuric acid		12
	9	3 ,,	,, ,,		25
	10	18 ,,	,, ,,		33
	11	1 day	,, ,,		45
	12	1 ,,	,, with hydrochloric acid		51
	13	3 ,,	,, with sulphuric acid		40
	14	5 ,,	,, ,,		40
	15	8 ,,	,, ,,		17
Sample II. 328 mgs. % HCN.	16	1 day	then distilled with water alone in air-current	July 1917	120
	17	1 ,,	,,	Aug. ,,	111
	18	1 ,,	,,	Oct. ,,	111
Sample III. 307 mgs. % HCN.	19	1 day	then as in Sample ii.	Nov. 1917	109
	20	1 ,,		Dec. ,,	113
	21	1 ,,		Jan. 1918	111
	22	1 ,,		Oct. ,,	121
Sample IV. 50 mgs. %	23	1 day	then as in Sample ii.		38

Deductions from Table B.—(1). When the leaves are allowed to stand at an optimum temperature, which in the case of most cyanogenetic enzymes is about 40° C., hydrocyanic acid is set free in amounts much greater than were obtained with acid hydrolysis

(2). With regard to the time of maceration, the maximum yield, as shown in Nos. 8-15, was that obtained for 1 day: 45 mgs. % when distilled with sulphuric, and 51 mgs. % when distilled with hydrochloric acid.

(3). Leaves of sample ii. were dried and powdered at the beginning, and the powder left in an open tray. When taken for experiments 16-18, it is shown that the yield is practically the same from July to October. Leaves of sample iii. were powdered separately for each experiment, and here again the yield is almost constant during the entire period of one year.

(4.) Sample ii., collected in midwinter, yielded the same amount of hydrocyanic acid as the sample iii., collected in the summer, in the same locality.

C. Autolysis with added enzyme.

The object of these experiments was to determine whether there existed in the plant sufficient enzyme for the complete hydrolysis of its glucoside. It has been stated already that when the plant-enzyme was destroyed by boiling water, the glucoside could still be hydrolysed by adding the enzyme prepared from sweet almonds. In these experiments "emulsin" was added simply as grated almonds.

The method was the same as in the previous series.—The leaf-powder with the emulsin added was macerated with water in an incubator at 40° C. for 1 day, then distilled by boiling in a current of air.

Throughout series B and C, the whole of the liberated hydrocyanic acid was obtained in 1½ hour's distillation.

TABLE C.

Autolysis with emulsin.

	No.	Particular treatment.	HCN, mgs. %
Sample I.	11	Control autolysed *without* emulsin	45
	24	10 gms. leaves autolysed with 10 gms. emulsin	60
Sample II.	16	Control autolysed *without* emulsin	120
	25	5 gms. leaves autolysed with 2 gms. emulsin	157
	26	" " 5 "	262
	27	" " 10 "	328
Sample III.	19	Control autolysed *without* emulsin	109
	28	5 gms. leaves autolysed with 5 gms. emulsin	294
	29	5 " 5 "	297
	30	10 " 5 "	300
	31	10 " 10 "	307
	32	10 " 15 "	297
	33	10 " 20 "	302
Sample IV.	23	Control *without* emulsin, autolysed 1 day	38
	34	10 gms. leaves autolysed with 10 gms. emulsin	50

Deductions from Table C. (1). It is seen at once, from the greatly increased yield of hydrocyanic acid in all samples, that the plant was deficient in its enzyme.

(2.) The maximum amount was obtained by addition of 10 gms. of emulsin, which liberated the very large amount of hydrocyanic acid (No. 27) corresponding to 0.328 % of the leaves. Therefore by addition of emulsin during the maceration of the leaves the yield of hydrocyanic acid was increased almost threefold in samples ii. and iii.

(3). The amount of enzyme is important also. A small quantity was not able to hydrolyse unlimited amounts of glucoside, for in the case of sample ii., Nos. 16 and 27, the liberation of the additional 9 mgs. of hydrocyanic acid from

5 gms. of leaves required the enzyme from 10 gms. of almond powder. The ratio of enzyme to glucoside was not constant.

D. On the existence of free hydrocyanic acid in plants.

Numerous attempts have been made in the past by various investigators to determine what they assumed to be the uncombined portion of the hydrocyanic acid in the plants. In most of these the methods used have been shown to be faulty. When boiling water or dilute acid is poured on a mass of leaves in a flask the glucoside and enzyme, both being soluble, are brought into contact with one another, and some portion of the mass will remain at a temperature sufficiently low for enzyme action during at least a few seconds. In this initial period enzymes are known to be exceedingly active, and so it happens that unless special precautions are taken some hydrocyanic acid will be liberated in most cases. Since it is so difficult to destroy the enzyme in plant leaves in this manner, other substances have been tried whose presence will prevent enzyme action. The chief of these is tartaric acid.

Method.—Leaves were powdered, water with a little tartaric acid added, and the flask placed in the incubator, at 40° C., for 1 day. In some, the leaves were allowed to fall from the grinding mill into the tartaric acid solution, in others the intact leaves were steeped in the solution for 5 minutes, then put through the mill in presence of excess of solution, and the powder received also in the solution. Maceration and distillation followed as previously described.

TABLE D.

Autolysis in presence of tartaric acid.

	No.	Particular treatment.	HCN mgs.%
Sample II	16	Control *without* tartaric acid	120
	35	Macerated in 1 % soln. of tartaric acid	40
	36	„ 5 % „	40
Sample III	37	Leaves steeped and ground in 5 % tartaric acid soln., distilled direct for 2 hrs.	none

Deductions from Table D.—The results given in the Table show that although the amount of hydrocyanic acid obtained is considerably reduced (Nos. 35, 36) when maceration takes place in presence of tartaric acid, yet this has not prevented a certain degree of decomposition from taking place. It is only when the leaves are kept in presence of tartaric acid during the whole of the crushing and bruising of their tissues that enzyme action is entirely prevented (No. 37). Any free, uncombined hydrocyanic acid, existing in the plant as such, would have distilled over from the tartaric acid solutions.

Therefore no uncombined hydrocyanic acid exists in the leaves of *Heterodendron.*

E. The influence of chloroform on autolysis.

In the preliminary testing of a plant for hydrocyanic acid the plasmolysis of the tissues is usually brought about by chloroform vapour. Chloroform is also often used as a preservative of plants and their extracts against the formation of moulds. Plants or extracts on which moulds have been allowed to grow are valueless for these investigations, as it is known that fungi can simulate many enzymes in their action. For this reason chloroform is much used in the biochemical laboratory.

To test whether chloroform exerted any influence on the action of the enzyme during these autolysis experiments a number of trials were made. To the flask containing the plant-powder was added 1 cc. of chloroform dissolved in 500 ccs. of water. (The solubility of chloroform is 1 in 200.)

TABLE E.

Autolysis in presence of chloroform.

	No.	Particular treatment.		HCN mgs %
Sample II.	16	Control - macerated *without* chloroform	1 day	120
	38	Macerated with chloroform 0·2 % solution	1 ..	72
	39	.. ..	4 ..	79

The results of a number of experiments were, in general, the same as those represented in Table E. The yield of hydrocyanic acid was considerably decreased by the addition of 1 cc. of chloroform during the autolysis.

F. Autolysis of the extracted glucoside.

In some plants which have been investigated, complex factors have been recognised which greatly interfere with the proper action of the enzyme. The difficulty has been frequently overcome by first extracting the glucoside with water or alcohol in a Soxhlet extractor.

In these experiments the leaves were first treated rapidly with boiling alcohol to destroy the enzyme, and then extracted in a Soxhlet with alcohol. After distilling off the solvent the residue left was:—

In No. 40 mixed with water and autolysed with emulsin.

In No. 41 again extracted with water in Soxhlet, and the solution autolysed with 5 gms. of emulsin for 1 day.

TABLE F.

Autolysis after extraction of the glucoside.

	No.	Particular treatment.	HCN mgs %
Sample III	30	Control — plant autolysed with emulsin for 1 day	300
	40	Extracted residue autolysed with emulsin	275
	41	Aqueous solution of extracted residue autolysed with emulsin for 1 day	271

Result.—In the case of *Heterodendron* the yield is not increased by previous extraction of the glucoside and hydrolysis of its solution.

DISCUSSION OF THE RESULTS.

TABLE A.—The direct distillation of the leaves with water alone yields sometimes a trace of hydrocyanic acid and sometimes none. Until recently, any hydrocyanic acid obtained in this manner was considered to exist in the free state in the plant. *Cynodon incompletus* (blue couch grass), when its enzyme was destroyed by pouring on boiling water, and then distilled, yielded 35 % of its hydrocyanic acid, although it was found subsequently that no free hydrocyanic acid existed in this grass. Where plants were distilled, starting with cold water, it has frequently been found that the whole of the hydrocyanic acid was evolved within half an hour, although the enzyme must have been destroyed at an early stage.

That the hydrocyanic acid obtained in this way is not free acid in the plant tissues was proved later in Table D. The work of numerous investigators has shown that enzyme action is very powerful during the first few seconds, and it is on this account almost impossible to destroy instantly the enzyme of leaves by pouring on boiling water. As the temperature of the mass rises the activity of the enzyme is rapidly increased, and this increased activity acts in opposition to the destruction of the enzyme, until the latter by rise of temperature overpowers it. At high temperatures, therefore, one may observe a great initial velocity of enzyme action, and this, after a few seconds or minutes, comes to an end. It is generally found that enzyme action is very incomplete at higher temperatures. Dr. Treub, late Director of the Gardens of Buitenzorg, has stated that this very rapid decomposition of the glucoside was of great physiological importance, as at a sudden demand hydrocyanic acid could be liberated and immediately utilised in the metabolism of the leaves.

Direct distillation with acid gave varying figures, the evolution of hydrocyanic acid ranging from 5 to 25 % of the possible amount. Some plants, such as Sorghum, *Poa flava*, etc., when treated in this way yield the whole of their hydrocyanic acid.

The glucoside of *Heterodendron* is very incompletely hydrolysed by boiling with dilute acids.

Table B.—The plant, when autolysed for 1 day, and the glucoside decomposed by its own enzyme, liberated in sample i., 45 mgs. %, in samples ii. and iii. 120 mgs. %, and in sample iv. 38 mgs. %. Numbers i. and iv. are equivalent to three fourths of the total hydrocyanic acid present, while ii. and iii. are only a third.

These experiments show that the leaves are deficient in enzyme.

Some cyanogenetic plants such as Sorghum, *Prunus* spp., *Panicularia* spp., etc., yield much less hydrocyanic acid after maceration, and this method cannot be used for the estimation. In these plants the greatest yield was obtained by direct distillation with acid.

Table C.—When the action of the natural enzyme of the plant is assisted by adding emulsin, the yield of free hydrocyanic acid is greatly increased, the maximum amount obtained being 328 mgs. %.

In similar investigations, Guignard showed in the case of *Sambucus nigra* (the elder), that the addition of emulsin before maceration gave no further increase. Viehoever, and his colleagues, in America, found the same condition to hold in their experiments on *Tridens flavus*; and the writer has found that in numerous other grasses an abundance of enzyme existed, sufficient to decompose the whole of the glucoside.

Treub's investigations show that emulsin of almonds has very little action on the cyanogenetic compounds of *Phaseolus lunatus*, *Pangium edule*, *Passiflora quadrangularis*, *Manihot*, etc.; in certain other plants such as *Sorghum*, *Hevea*, *Alocasia*, the action is neither regular nor abundant, while in numerous others the emulsin acts rapidly and freely. *Heterodendron* belongs to the latter group.

TABLE D. When amygdalin is boiled with dilute mineral acids such as hydrochloric or sulphuric, it is hydrolysed. When the latter are replaced by organic acids such as tartaric, no decomposition of the glucoside takes place. Tartaric acid like the mineral acids, has been shown to prevent the action of enzymes entirely. For these reasons it is used to detect the presence of any hydrocyanic acid which may exist in the uncombined state, that is, not in a glucoside. Various workers have recorded the presence of non-glucosidal hydrocyanic acid in plants, but the writer has not yet detected it in a single instance.

GENERAL.—(*a*). There are some plants in which the cyanogenetic glucoside increases to a maximum amount during the earlier and vigorous period of their metabolism. It then gradually becomes less till towards the end of the season it has dwindled to a relatively small amount and sometimes has disappeared entirely. In such plants the glucoside is stored only temporarily, it is used up during the active vegetative periods, and there is none found in the ripe seeds.

Examples of these plants are the Sorghum, which in the ripe stage is left with an amount of dhurrin equivalent to about 14 mgs. % of hydrocyanic acid (Brunnich), and sometimes with none (Treub); and the Lotus of Egypt, which yields 345 mgs. % of hydrocyanic acid during the height of its vigorous growth, but when its seeds are ripe it yields no hydrocyanic acid. Again, Ribes (currants) and others gradually lose their hydrocyanic acid compounds.

(*b*). There is another group of cyanogenetic plants in which the hydrocyanic acid remains almost constant throughout the whole period of growth. This includes *Passiflora* spp., *Sambucus nigra*, *Phaseolus lunatus* and *Indigofera galegoides*. Although it is difficult to compare these plants with the evergreen tree *Heterodendron*, it may be noted from Table B that the latter plant contains practically the same amount of glucoside in winter as in summer.

(*c*) When cyanogenetic plants are collected and spread out to dry, two courses are followed: one in which the glucoside gradually disappears, the other in which it remains unchanged for very long periods.

As examples of the first course may be mentioned *Cynodon incompletus* (blue couch grass), which shows during four weeks' drying in the open air, a gradual diminution to zero; *Alocasia macrorrhiza*, from which no hydrocyanic can be obtained after a few weeks; and Sorghum, which loses about three-quarters of its glucoside under these conditions. As an example of the second course we note from Table B that sample ii. during four months remained almost constant, and sample iii., lying openly for twelve months also remained about the same. It may be stated then that though plants like Sorghum may be rendered much less deleterious by air-drying or curing, the foliage of *Heterodendron* cannot be treated in this way with any advantage.

The enzyme in the dried leaves of *Heterodendron* is apparently quite inactive at the ordinary temperature, hence the constancy of the yield of hydrocyanic acid during long periods of drying. In this respect it differs from the enzymes of most other plants; for instance, Brill found that his samples of *Pangium edule*, owing to the action of a very active enzyme, continued to lose hydrocyanic acid from the time they were cut.

The quantity of hydrocyanic acid evolved from *Heterodendron* is relatively very large. It may be compared with that from some of the richest cyanogenethe plants hitherto investigated. The leaves of the following plants contain the amounts stated in mgs. % of the dry material.

	HCN
Pangium edule, Greshoff	1100 mgs. %
Taraktogenos Blumei, Treub	333
Heterodendron oleaefolia, this paper	328
Phaseolus lunatus (Lima beans), Treub	320
Gynocardia odorata, Treub	220
Indigofera galegoides, Treub	154
Bitter almonds (seeds), Guignard	150
Passiflora Herbertiana (native to N.S.W.), Treub ..	143
Hevea Brasiliensis (Para rubber plant), Treub	138
Andropogon sorghum, Dowell..	51
Cynodon incompletus (blue couch grass), Petrie ..	25

Calculation of fatal dose of Heterodendron *leaves.*

The lethal amount of hydrocyanic acid is usually stated as 1 mg. per kilogram of body-weight.

A man or sheep would therefore require about 60 mgs.

This amount is obtained from about 40 bitter almonds.

This amount is also obtained from 90 gms. of fresh green leaves of *Heterodendron*, which is equivalent to 3 ozs. in weight, and 230 fresh leaves of average size, or to 1 oz. of air-dried leaves.

A single leaf of *Heterodendron* of average size will yield 0.35 mg. of hydrocyanic acid; and 1 oz. weight of leaves which have been cut and lying in the sun and air to dry, will give sufficient hydrocyanic acid to poison a sheep. *Heterodendron* is therefore much more poisonous than bitter almonds; in fact, it is more than twice as strong, and thirteen times more so than the blue couch grass.

SUMMARY.

Heterodendron oleaefolia is a native Australian evergreen tree, the foliage of which was much used for cattle-feeding during the drought. It contains a cyanogenetic glucoside yielding, when hydrolysed, 0.328 % of hydrocyanic acid. It is therefore one of the most poisonous cyanogenetic plants known, yielding more than twice as much hydrocyanic acid as bitter almonds. One ounce of the air-dried leaves forms a lethal amount for one sheep.

The leaves are invariably found to be deficient in enzyme, and required the addition of emulsin in the estimation, to bring about the complete decomposition of the glucoside.

NOTES ON AUSTRALIAN *TABANIDAE*.

By Eustace W. Ferguson, M.B., Ch.M., and Gerald F. Hill, F.E.S.

The present paper is the outcome of correspondence between the two authors on the question of the identification of specimens of Australian *Tabanidae*.

One of us (E.W.F.), while in London, had the opportunity of examining the types of Australian *Tabanidae* in the Natural History Branch of the British Museum, and of comparing specimens with the types. In many instances the identifications were made by Miss Ricardo. Authentically identified specimens of many species were thus available, and these have been compared with such types as are in the collection of the Australian Institute of Tropical Medicine at Townsville.

The correspondence and comparison of specimens have revealed the fact that considerable synonymy exists among recently described species. Some of this is due to misidentification of previously described species, but much is due to too much reliance having been placed on slight variation in characters which can be shown, with long series, to be variable within the one species.

Incidentally it has shown that the groups suggested by Miss Ricardo for the division of the genus *Tabanus* are valueless, at any rate as applied to Australian species. The characters separating groups vii., viii., ix. and x. are entirely superficial, depending solely on clothing, so that the grouping of a species is dependent on the degree of abrasion of the specimen.

While the paper deals mainly with synonymy, one new species has been described, and the descriptions of one or two others have been held up pending the receipt of further material or information.

We should like to acknowledge the help we have received from Dr. Guy A. K. Marshall, Director of the Imperial Bureau of Entomology, in comparing specimens with types in the British Museum.

Demoplatus nigrovittatus, n.sp.

Closely allied to *D. australis* Ricardo, but differing in colouration of the abdomen.

♂. *Face* brown, with yellowish-brown tomentum and rather sparse brown hairs; separated from cheeks by deep groove; cheeks similar; beard white. *Palpi* with second joint long, somewhat club-shaped as in *D. australis,* but black. *Proboscis* comparatively short. Antennae reddish-brown, second joint about half the length of the first; third joint apparently 8-annulate, but annuli somewhat indefinite and hard to distinguish, basal part somewhat wider than rest of joint, first and second joints with long dark hairs. *Eyes* contiguous, moderately finely facetted, bare. Ocelli present. *Thorax* dark brown, with brown tomentum and indistinct traces of 3 longitudinal tomentose vittae, the median darker, the submedian more yellowish in anterior half, darker posteriorly, the lateral margins with similar yellowish-grey tomentum; pubescence long and fine, greyish in colour, rather scanty, denser posteriorly and above wing roots. Sides dark brown with long, silky, light grey pubescence. *Scutellum* dark brown, with long grey pubescence. *Abdomen* reddish, with a moderately broad, median, black vitta extending the length of the abdomen, and somewhat expanded on first segment; lateral borders with black markings on 3-6 segments; pubescence light brown, with traces of creamy on the segmentations. Venter of a lighter reddish-yellow colour, without any black vitta; with fine greyish pubescence and a fringe of shorter fine creamy pubescence along posterior margin of segments. *Legs* reddish-yellow, tarsi with apical joints infuscate; posterior tibial spurs rather short. *Wings* clouded with brown, most marked along the anterior border and along the cross veins; distribution of shading similar to *D. australis*, but darker. *Length*, 11.5 mm.

Hab.—N.S. Wales: Kendall. (Miss M. Henry.)

Described from two males caught on flowers in garden on 26th February and 18th March, 1920. Both specimens have the wings damaged at the tips, and it is uncertain whether the first posterior cell is closed or open; but it is probably open as in *D. australis*. Apart from the colour of the abdomen, which is most striking, the species can be separated by the structure of the 7th tergite. In *D. nigrovittatus* the apical border of this segment is practically truncate, while in *D. australis* the margin is strongly bisinuate, the median portion being produced in a strongly rounded lobe. The antennal annulations are hard to distinguish, in this respect resembling *D. australis*, though the shape of the annulations is slightly different in the two species.

Type in Australian Museum, Sydney.

SILVIUS INDISTINCTUS Ric.

Ricardo, Ann. Mag. Nat. Hist., (8), xvi., (1915), p. 262; *S. hilli*, Taylor, Proc. Linn. Soc. N.S.W., xl., Pt. 4, 1915, p. 806; *S. borealis*, Taylor, *loc. cit.*, p. 809.

Specimens of *S. indistinctus* Ric. were determined by Miss Ricardo, and are unquestionably the same as *S. hilli* Taylor, a series of which has been examined by both authors, and the type by one of us (G.F.H.). Mr. Taylor was probably misled in his identification of *S. indistinctus* (Proc. Linn. Soc. N. S. Wales, 1916, xli., Pt. 4, p. 753) by a specimen so identified by Mr. Austen and quite distinct from the species as identified by Miss Ricardo herself.

The species is a variable one in the colouration of both thorax and abdomen and in the presence or absence of the median abdominal spots.

The type of *S. borealis* has also been examined and, though there appears to be a very slight difference in that the callus is less bulbous, we cannot regard it as other than conspecific with *S. indistinctus* Ric.

SILVIUS NOTATUS Ric.

Ricardo, Ann. Mag. Nat. Hist., (8), xvi., 1915, p. 264; Taylor, Proc. Linn. Soc. N.S. Wales, xliv., Pt. 1, 1919, p. 43; *S. psarophanes*, Taylor, *op. cit.*, xlii., Pt. 3, 1917, p. 520; ? *S. fuliginosus*, Taylor, *op. cit.*, xl., Pt. 4, 1915, p. 810.

This appears to be a very widespread species and to a certain extent variable. Among our specimens is one from Sea Lake, Mallee District, Victoria, which was compared with the type (E.W.F.) from Kalamunda, Western Australia, in the British Museum.

We associate with this specimens from Lake Hattah, Victoria; Narrabri, N.S. Wales; and Springsure and Burnett River, Queensland. The New South Wales and Queensland specimens show some slight difference in that the forehead is slightly narrower and the antennae are rather lighter. The Burnett River specimens (♂, ♀) were bred out by Miss Bancroft and bear a label:—"Bred from larvae found in wet sand at river edge, Burnett R., 18.11.19." They are in excellent preservation, and the abdominal clothing is much more marked than in our other specimens, in which it is somewhat abraded. Through them we were able to associate *Silvius psarophanes* with *S. notatus;* the former species being identified with the Burnett River male. Males and females of *psarophanes* have also been bred out in Townsville (G.F.H.) and correspond with the Springsure and Burnett River specimens.

S. fuliginosus Taylor, of which we have examined the type and compared it with our series of *S. notatus*, appears hardly separable. It is somewhat smaller and the forehead is distinctly narrower than in the Victorian specimens, in which respect the New South Wales and Queensland specimens are intermediate. The antennae and legs are decidedly lighter in colour than in the Victorian specimen, but here again it is linked up by the intermediate specimens. We are inclined to regard it as not being specifically distinct, though it may be necessary to retain the name as a subspecies. Further specimens from the Northern Territory will probably be necessary to settle the status of *S. fuliginosus*.

SILVIUS SORDIDUS Taylor.

Taylor, Proc. Linn. Soc. N.S. Wales, xl., Pt. 4, 1915, p. 808; *S. tabaniformis* Taylor, *loc. cit.*, p. 813.

We have examined the types of Taylor's species and other specimens from the same district (G.F.H.), and cannot find any valid reason for maintaining them as distinct. The type of *S. tabaniformis* has more conspicuous clothing, but the type of *S. sordidus* is certainly considerably abraded. The colour of the abdomen is somewhat lighter in *tabaniformis*, but the type is apparently an immature specimen.

In his description, Taylor states that the inner margins of the eyes in *S. sordidus* are parallel, while under *S. tabaniformis* he states that the inner margins are slightly convergent towards the base. The difference, however, when the two types are compared is inappreciable.

TABANUS LEUCOPTERUS van de Wulp.

Van de Wulp, Tijdsch. voor Entom., xi., 1868, p. 98; *T. griseohirtus*, Taylor, Proc. Linn. Soc. N.S. Wales, xli., Pt. 4, 1916, p. 753.

This species was originally described from the Aru Islands, and a specimen in the collection of the South Australian Museum from Stewart River, Queensland, was determined by Miss Ricardo. This has been compared with a series of *T. griseohirtus* Taylor, including the type, and the species are certainly identical. The series shows some variation in size and in the colouration of the clothing, a specimen from Kimberley perhaps representing a variety, but too closely allied to be separated. The species appears to be widespread in the north of Australia and in the islands immediately to the north.

TABANUS PALLIPENNIS Macq.

Macquart, Dipt. Exot., Suppl. 1, 1844, p. 160; Ricardo, Ann. Mag. Nat. Hist., (8), xiv., 1914, p. 397.

A species of *Tabanus* from the Burnett River District, Queensland, bred out from larvae by Miss Bancroft, is tentatively referred to *T. pallipennis*.

Following is a detailed description of the specimens:—

A moderately small species with three well-defined abdominal vittae.

♂. Face rather deeply sunken, black, densely clothed with grey tomentum and with white pubescence; cheeks with grey tomentum and pubescence; beard grey. Palpi with second joint short, oval, creamy yellow, with mixed grey and black pubescence. Antennae brown, the basal joints more greyish; first joint broader and partially concealing second joint, the latter small, somewhat crescentic, both joints with a few, short, black hairs at apices; third joint rather slender, the basal portion angulate but hardly toothed above. Eyes large, contiguous for greater portion of length, separated below to allow of the appearance of a small strongly nitid black callus; the upper two-thirds of the eyes set with moderately large facets, the lower third with much finer facets.

Thorax black with median, submedian and sublateral grey tomentose stripes, clothed with black erect pubescence and with rather scanty, decumbent, golden pubescence on the grey stripes; sides clothed with grey tomentum, with long, fine, pubescent tufts, mingled dark and grey. Scutellum dark brown with slight reddish tinge, with black pubescence on dorsum and rather scanty, golden hairs along free margin.

Abdomen dark brown to black, with three vittae of elongate, pale grey, somewhat creamy spots, the segmentations also narrowly edged with same colour; median vitta extending from third segment to apex, spots elongate, broader at posterior margins of segments, forming a continuous vitta; sublateral vittae extending from first segment to apex, the vittae more interrupted, the spots not reaching the anterior border of each segment and not triangular in shape; pubescence black, with a few creamy hairs on some of the spots. Venter dark brown, segmentations narrowly edged with grey, pubescence black, grey on segmentations.

Legs dark brown, tibiae lighter yellowish-brown, apical half of fore tibiae darkly infuscate, tarsi rather darker than tibiae, the anterior tarsi black; pubescence grey on femora and basal half of anterior tibiae, black elsewhere.

Wings rather dark grey, with whitish areas in centres of cells, only visible from certain directions against a black background, cross veins lightly suffused with brown; veins brown, stigma narrow, fairly conspicuous; appendix present.

♀. Resembles male in general appearance. Face not sunken, densely clothed with greyish tomentum and rather dense, whitish pubescence, cheeks similar, beard white. Palpi with second joint short, very stout, apex not produced but rather sharply pointed, yellowish brown, with short, mixed pale and dark pubescence. Antennae as in male. Forehead rather broad, distinctly wider at vertex than anteriorly, densely clothed with grey tomentum, with brownish tinge in places and darker on vertex, pubescence black in centre and above, shorter and creamy at sides; callus transverse, reaching eyes, black, tumid and shining, a second, round, black callus in centre of forehead, occupying about half the width. Eyes with facets uniform, bare. *Thorax* as in male. *Abdomen* with median vitta extending to first segment, with more distinct, creamy, almost golden pubescence on the vittae. Venter with fine black pubescence in centre of the segments, grey at the sides. Legs and wings as in male.

Dimensions: ♂, ♀, 12 mm.

Bred from larvae found in wet mud, Cattle Corner, Wingfield (60 miles from Eidsvold), November, 1919 (No. 1).

This species is related to *T. rufinotatus* Bigot, but differs in its broader form, and broader forehead with larger secondary callus, spotted wings, and in its general appearance. This species has been placed under *T. pallipennis* Macq., though it does not completely agree in all details: in Macquart's description there are said to be three calli on the front, the lower two contiguous and sometimes united: in the present specimens there are only two calli, unless the dark area on the vertex be regarded as a third callus, and the middle one is equidistant from the vertex and the lower callus. The wings also differ from the description: in *T. pallipennis* they are described as a little greyish, though the name *pallipennis* would indicate a whitish winged species. Under a lens the wings appear as described above, but in certain lights they appear decidedly pale and the dark spots around the cross-veins are not conspicuous. This pale appearance is more marked in a female recently received from Lake Hattah, Victoria (Nov., 1919 - J. E. Dixon). It is possible that *T. pallipennis* Macq. is a distinct species, but until specimens are available agreeing completely with the description it seems preferable to treat these specimens as belonging to Macquart's species.

TABANUS DUPLONOTATUS Ric.

Ricardo, Ann. Mag. Nat. Hist., (8), xiv., 1914, p. 396; *T. parvicallosus*, Taylor (*nec* Ricardo), Proc. Linn. Soc. N.S. Wales, xlii., Pt. 3, 1917, p. 524; *ibid.*, Rec. Aust. Mus., xii., No. 5, 1918, p. 64.

This species has been wrongly identified by Taylor; we have specimens compared with the types of both Miss Ricardo's species, and specimens identified by Taylor and recorded above as *T. parvicallosus* agree with *T. duplonotatus*.

TABANUS INNOTABILIS Walker.

Walker, List Dipt. Brit. Mus., Part 1, 1848, p. 177; *T. dorsobimaculatus* Macq., Dipt. Exot., suppl. iv., 1850, p. 28; Ricardo, Ann. Mag. Nat. Hist., (8), xv., 1915, p. 273; *T. duplonotatus*, Taylor (*nec* Ricardo), Proc. Linn. Soc. N.S. Wales, xli., Pt. 4, 1916, p. 755.

As the species identified by Taylor as *T. duplonotatus* Ric. did not at all correspond with a specimen compared with the type (E.W.F.), specimens were sent to London (G.F.H.) and have been identified by Dr. G. A. K. Marshall as *T. innotabilis* Walker.

TABANUS APREPES Taylor.

Taylor, Proc. Linn. Soc. N.S. Wales, xliv., Pt. 1, 1919, p. 56; *T. batchelori*, Taylor, *loc. cit.*, p. 58.

The types of the two species have been very carefully compared and we are unable to maintain them as distinct; the principal difference between them is that *T. batchelori* has the wings slightly clouded with brown along the veins, whereas in *T. aprepes* the wings are practically clear. A series from Burnett River, however, shows considerable variation in the amount of suffusion, and varies from specimens in which the wings are more strongly marked than in *T.*

batchelori to specimens in which the wings are clear. There is also considerable variation in the colouration of the abdomen, possibly depending on maturity, as all of the specimens are bred. Both types can be absolutely "matched" among the series.

TABANUS NEOGERMANICUS Ricardo.

Ricardo, Ann. Mag. Nat. Hist., (8), xv., 1915, p. 283; *op. cit.*, (8), xix., 1917, p. 219; *T. hilli* Taylor, Proc. Linn. Soc. N.S. Wales, xliv., Pt. 1, 1919, p. 64; *T. fugitivus*, Taylor, *loc. cit.*, p. 61.

The determination of the above synonymy is based on the comparison by one of us (G.F.H.) of specimens identified by Miss Ricardo as *T. neogermanicus* Ric. with Taylor's types. Taylor has placed his species in two different groups, *fugitivus* in Group ix. and *hilli* in Group x., but the distinction between these two groups is often a matter of abrasion and the groups are not natural ones. in any case, from the description, *hilli* would appear to be wrongly placed in Group x., as the segmentations are described as greyish. A comparison of the two descriptions reveals no difference apart from differences in what might be described as shades of colour. The determination in regard to *fugitivus* was checked by the examination by both of us of a paratype which is absolutely identical with the specimens determined by Miss Ricardo.

TABANUS BREVIOR Walker.

Walker, List Dipt., 1, 1848, p. 188; *T. anellosus*, Summers, Ann. Mag. Nat. Hist., (8), x., 1912, p. 226; Ricardo, Ann. Mag. Nat. Hist., (8), xv., 1915, p. 279; *T. australis*, Taylor, Proc. Linn. Soc. N.S. Wales, xli., Pt. 4, 1916, p. 257; *T. crypserythrus*, Taylor, *op. cit.*, xliv., Pt. 1, 1919, p. 60.

This species has been misidentified in Australian collections. Specimens of *T. australis* sent to London (G.F.H.) have been determined by Dr. G. A. K. Marshall and Mr. E. E. Austen as *T. brevior* Walker. Examination of a short series of specimens of *T. australis* and *T. crypserythrus*, including specimens identified by Taylor, showed that the species were identical. The types of Taylor's two species have also been compared (G.F.H.).

TABANUS NEOPALPALIS, nov. nomen.

T. palpalis, Taylor (*nom. praeocc.*). Proc. Linn. Soc. N.S. Wales, xliv., Pt. 1, 1919, p. 66.

The name of this species being preoccupied by an Indian species *T. palpalis* Ricardo (Records Indian Museum, iv., No. vi., 1911, p. 212)—we propose the above to replace it. The name *T. milsoni* Taylor, is also preoccupied by *T. milsonis* Ricardo, but in this instance we understand that the name has already been altered by Mr. Taylor.

TABANUS NIGRIMANUS Walker.

Walker, List Dipt., 1, 1848, p. 183; *T. badius*, Summers, Ann. Mag. Nat. Hist., (8), x., 1912, p. 225; Ricardo, *op. cit.*, (8), xv., 1915, p. 285; ? *T. daphoenus*, Taylor, Proc. Linn. Soc. N.S. Wales, xliv., Pt. 1, 1919, p. 54.

Comparisons of specimens of *T. daphoenus* Taylor with the descriptions of *T. nigrimanus* Walk., and *T. badius* Summers, leaves no doubt in our minds that Taylor's species is the same as Walker's. We have thought it better, however, to query the identification until a specimen of *T. daphoenus* can be actually compared with the type of *T. nigrimanus*.

TABANUS MINUSCULUS, nov. nomen.

Tabanus minor Taylor (*nec* Macquart), Proc. Linn. Soc. N.S. Wales, xliv., Pt. 1, 1919, p. 64.

A change of name is necessary for Taylor's species, as *T. minor* has already been utilised by Macquart (Dipt. Exot., Suppl. 4, 1850, p. 33) for a species from Patagonia.

TABANUS REGIS-GEORGII Macquart.

Macquart, Dipt. Exot., 1, 1838, p. 132; Ricardo, Ann. Mag. Nat. Hist., (8), xvi., 1915, p. 276: *T. spadix*, Taylor, Proc. Linn. Soc. N.S. Wales, xli., Pt. 4, 1916, p. 761; *T. brisbanensis*, Taylor, *op. cit.*, xlii., Pt. 3, 1917, p. 527; *op. cit.*, xliv., Pt. 1, 1919, p. 67.

We have compared a long series of *T. regis-georgii* with specimens of *T. brisbanensis* Taylor received from the Queensland Museum, and with the type of *T. spadix*, and are unable to discover any tangible differences. The species is a very variable one in the colour of the clothing, in the width of forehead and shape of callus.

The Tasmanian specimens referred by Mr. Taylor to *T. brisbanensis* are evidently the species described by one of us (E.W.F.) as **T. diemenensis*, distinguished by the facetting of the eyes in the male.

For our identification of *T. regis-georgii* we are relying on Miss Ricardo's determination of the species in the British Museum. At the same time it seems unlikely, though not impossible, that the range of our east coast species extends to King George Sound. On the other hand we have seen Victorian specimens. Should the species from King George Sound prove to be different it will be necessary to re-establish the name *T. spadix*.

DASYBASIS APPENDICULATA Macq.

Macquart, Dipt. Exot., Suppl. 2, 1846, p. 25, pl. 1, fig. 1; Walker, List Dipt., Pt. v., Suppl. 1, 1854, p. 267; Ricardo, Ann. Mag. Nat. Hist., (7), xiv., 1904, p. 350.

This does not appear to have been identified in Australian collections of Australian *Tabanidae* since it was first described, though Bigot has referred a second species from Chili to the genus.

We have specimens before us of a species that agrees fairly well with both generic and specific descriptions with the exception that there are the usual five divisions on the third joint of the antennae. The divisions are however, obscure and might readily be miscounted, and the base of the third joint is not angulate but somewhat swollen in the middle, corresponding in this respect to Macquart's description.

The species is allied to *Tabanus gentilis* Erichson, and *T. froggatti* Ric., but may be distinguished from both by the head being somewhat compressed antero-posteriorly so that the forehead is relatively shorter and broader than in these species.

Walker's notes on the genus are valueless, as he placed therein two species now referred to *Pelecorrhynchus* and some of the generic characters given by him

*Description sent for publication to the Royal Society of Victoria.

are founded on these. Should our identification prove correct, the genus *Dasybasis* would have to sink as a synonym of *Tabanus*, as the species is too closely allied to *Tabanus froggatti* and *T. gentilis* to admit of separation, and these two latter species are connected by others with the more typical hairy-eyed species of *Tabanus*.

STIBASOMA HEMIPTERA Surcouf.

Bull. Mus. nat. d'Hist. nat., Paris, No. 2, 1912, pp. 62-63.

This species seems to have been quite overlooked by recent workers in Australian *Tabanidae*. The type had the antennae broken when described, which leaves some doubt in our minds as to whether it is ascribed to the correct genus. On the other hand there are other instances where South American genera have been recorded also from Australia.

The description does not fit any species known to us.

DESCRIPTIONS OF NEW FORMS OF BUTTERFLIES FROM THE SOUTH PACIFIC.

By G. A. Waterhouse, B.Sc., B.E., F.E.S.

For some time past I have been receiving butterflies from the islands of the South Pacific, and amongst them there have been many new records and several new races. The purpose of this paper is to record the more important of these, particularly as my friend Mr. H. W. Simmonds has succeeded in capturing, in Fiji, some species of high interest. In the Transactions of the Entomological Society of London, 1904, I gave an account of some collections from Fiji, and Fruhstorfer, in Stett. ent. Zeit., 1902, also gives a list from the same islands, whilst in the Proceedings of the Zoological Society of London, 1892, Mr. H. H. Druce gives a list of the *Lycaenidae* of the South Pacific. Besides the new races described below, Mr. Simmonds was able to capture the rare *Eulepis caphontis* Hew.

NYMPHALINAE

Eulepis pyrrhus tiberius, n. subsp.

♀. Above, this race differs from *sempronius* in being paler and the orange tornal patch of the hindwing is not so prominent.

Beneath, the forewing is paler, the dark bar across middle of cell is narrower. In the hindwing the central white area is larger, the three, red-brown, crescent-shaped spots towards the tornus are much smaller, the black subterminal spots are faint and the orange-brown terminal line is very pale.

Hab.—Lord Howe Is., Feb., 1915. One female.

When I received this specimen, I at once recognised that a distinct race inhabited the island, being much paler above and the markings beneath being obscure. Its chief difference is the great reduction of the dark subterminal spots of the hindwing beneath. There are two other specimens recorded from the island, but they seem to have been lost. The late Mr. Geo. Masters, who had seen these specimens, always considered they were different from *sempronius*.

Hypolimnas inopinata, n.sp.

♂. *Above.* Forewing rich black; a broad discal band beyond cell, from costa to vein 3, white margined with iridescent purple; a band of four subapical spots, white; sometimes two small discal white spots below vein 3. Cilia white, at veins black. Hindwing rich black; a very large central spot, iridescent purple. Cilia white, at veins black.

Beneath. Forewing red-brown; tornus shading to black; markings as above but white band not margined purple; lowest of subapical spots and two towards tornus dusted with pale metallic-blue scales; a series of interrupted terminal lines white, towards tornus dusted with pale metallic-blue; costa towards base and upper edge of cell pale metallic-blue, extending as two pale blue bars into cell, the outer the larger; an irregular pale blue band beyond end of cell. Cilia white, at terminations of veins black. Hindwing brown; costa and bar at end of cell red-brown; basal half of wing dusted with white scales; discal series of spots pale metallic blue; tornus black; a series of broad terminal lines white, towards tornus pale metallic-blue; a white line on dorsum near tornus, above which is an irregular pale blue area. Cilia white, at terminations of veins black.

♀ as in male, larger, more highly coloured beneath. The pale metallic markings in both sexes appear greenish in some directions.

Hab. Waidoi, Fiji. Four specimens caught by Mr. Simmonds, May, July, and August, 1919. One male, Nasogoto, Navai, Fiji, caught by Mr. E. J. Goddard, Feb., 1905.

This species has puzzled me very much, coming as it does from a locality where the race of *H. bolina* is extremely variable, but the different white band above and the different underside to the hindwing do not place it with *bolina*, of which I have numbers of Fijian specimens. Mr. Simmonds, who has caught *bolina*, is confident it is distinct. He tells me that it is a purely mountain species, lives in the rain forest and, like all butterflies in Fiji, it responds readily to the first glimpse of sunshine and is only found along the rivers, where they rise rapidly to the mountains. At one time I thought it might be an extreme eastern race of *H. alimena*.

Issoria egista Cram.

The following races have been described from the South Pacific,—*gaberti* from Tahiti, *samoana* from Samoa, *bowdenia* from Tonga, *scyllaria* from Lifu, Loyalty Is., and *shortlandica* from the Solomon Is. Of these, the race from Samoa is the most distinct. To these I now add races from the New Hebrides and Fiji. From the typical form from the southern Moluccas, the eastern races differ chiefly in their paler upper sides, the narrower dark borders to the wings and the much smaller dark spots on the underside.

Issoria egista vitiensis, n. subsp.

♂. *Above.* Forewing bright orange; apex and termen narrowly black; bar beyond cell and subapical bar black. Hindwing bright orange; termen narrowly black.

Beneath. Forewing orange-red; a series of cell bars brown; a whitish bar beyond end of cell; between veins 5 and 6 a large whitish spot; a discal series of pale bluish lunules inwardly edged brown. Hindwing orange-red; a series of pale bluish lunules outwardly edged brown; beyond is an indication of a series of brown dots; an interrupted brown subterminal line from apex to vein 3.

Hab.—Labasa, Vanua Levu, Fiji, Mar., 1908, caught by Mr. R. N. Ross.

This race has much narrower dark borders to the forewings above than the Australian *propinqua* or *scyllaria*, and on the under side the pale discal spots are more prominent, whilst the discal brown spots have almost disappeared. It is intermediate between *scyllaria* and *samoana*.

Issoria egista hebridina, n. subsp.

♂. This race occupies an intermediate place between *vitiensis* and *scyllaria*. Above, the borders to the wings are not so narrow as in *vitiensis*, a discal series of brown spots is indicated on the forewing, and the general colour is not quite so bright.

Beneath, the discal series of dark spots is present on both wings and the pale spots are not so prominent as in the Fijian race. In both *hebridina* and *vitiensis* the purplish suffusion found on the underside of several other races is absent. My specimens are from Vila, New Hebrides.

LYCAENIDAE.

Deudorix epijarbas diorella, n. subsp.

♂. *Above.* Forewing black; a central red patch below cell in upper portion of interspace between veins 2 and 3, and slightly extending above vein 3; a slight red scaling on vein 1*a* at one-third from base. Cilia black. Hindwing red; costa broadly and base black; dorsum brown; termen and veins in red area faintly black; anal lobe black, inwardly bordered with red and outwardly with metallic-blue; tail very short, brown. Cilia red, towards tornus black.

Beneath. Forewing brown; a slightly darker bar at end of cell and a much darker brown discal band, both faintly edged whitish; dorsum paler. Cilia dark brown. Hindwing brown; a slightly darker bar at end of cell and an irregular, darker, broad discal band narrowly edged white; a subcaudal spot in area 2 black, outwardly edged orange and inwardly metallic-blue; anal lobe black, outwardly edged metallic-blue, inwardly white; tornus above anal lobe irregularly metallic-blue. Cilia dark brown.

Hab.—Suva, Fiji. Four males caught by Mr. Simmonds, Feb., 1920.

Allied to *dioris* from Australia and *woodfordi* from Guadalcanar, Solomon Is., but with even less red on the forewing than the latter, the tail shorter than that of *mathewi* from the New Hebrides. It agrees with the other eastern races in not having the black spot of the anal lobe above completely ringed with colour, and with the figure of *mathewi* in having the subcaudal spot of hindwing beneath crowned with metallic-blue, and not completely ringed with colour. This capture by Mr. Simmonds extends the range of *D. epijarbas* further eastward than has hitherto been known.

PAPILIONIDAE.

Papilio macleayanus insulana, n. subsp.

♀. *Above.* Forewing brown-black; basal portion of cell and dorsum at base pale green; a spot at end of cell, a large subcostal spot at three-fourths and a smaller spot in base of area 4 green; a series of large subterminal spots cream; base of areas 2 and 1*a* whitish. Hindwing brown-black; base green; rest of basal half of wing whitish; a series of subterminal spots cream.

Beneath. Forewing as above, but paler; green basal area larger and subterminal spots obscured. Hindwing brown; basal half green, outwardly edged white; subterminal spots obscure.

Hab.—Lord Howe Island, where the insect is not uncommon, but very difficult to capture.

This race is readily recognised from that found in Australia by the much larger subterminal spots to both wings above. I have now seen a number of similar specimens, all females, and there is no difficulty in distinguishing them from typical *macleayanus*.

HESPERIDAE.

Badamia exclamationis subflava, n. subsp.

♂. *Above.* Forewing brown: costa lined yellow-brown; a large spot about middle of cell, yellowish hyaline; a pair of large discal spots in areas 2 and 3, yellowish hyaline; sometimes a minute subapical dot yellowish hyaline; sometimes an orange spot just above middle of vein 1*a*. Cilia brown. Hindwing brown; central area extending towards dorsum, yellow-brown. Cilia yellow-brown.

Beneath Forewing yellow-brown; hyaline spots as above, margined yellowish; area 1*a* towards base brown-black; large patch towards tornus yellowish. Cilia brown. Hindwing yellowish-brown; indications of a paler discal band, ending above tornus in a large yellow spot; towards tornus broadly brown-black. Cilia yellowish-brown.

Hab.—Waidoi, Fiji, two specimens caught by Mr. Simmonds, Nov., 1919; Ba Mts., Fiji, two specimens caught by Mr. L. V. Waterhouse, Jan., 1906.

This subspecies has a much yellower appearance than any specimens from the large number I have from both within and without Australia. Mr. Simmonds' specimens are in fine condition, and he writes that on a trip in Fiji, he saw this skipper in company with a number of *Parata bilunata.* Between 6 and 7.30 a.m. numbers of skippers were seen passing the boat; the morning was wet, the wind off shore, and the distance between two and four miles.

ORDINARY MONTHLY MEETING

27th October, 1920.

Mr. J. J. Fletcher, M.A., B.Sc., President, in the Chair.

The President announced the receipt of a very valuable addition to the library, of books and pictures bequeathed to the Society by the late Mr. F. M. Clements, F.L.S., F.Z.S.

The President offered the congratulations of members to Professor Sir Edgeworth David, K.B.E., (in absentia), and Mr. J. H. Campbell, M.B.E., on the Honours recently conferred on them by their inclusion in the British Empire Order.

The President announced that the Council is prepared to receive applications for four Linnean Macleay Fellowships, tenable for one year from 1st April, 1921, from qualified Candidates. Applications should be lodged with the Secretary, who will afford all necessary information to intending candidates, not later than 30th November, 1920.

The Donations and Exchanges received since the previous Monthly Meeting (29th September, 1920), amounting to 7 Vols., 63 Parts or Nos., 1 Bulletin, 5 Reports and 18 Pamphlets, etc., received from 40 Societies and Institutions and one private donor, were laid upon the table.

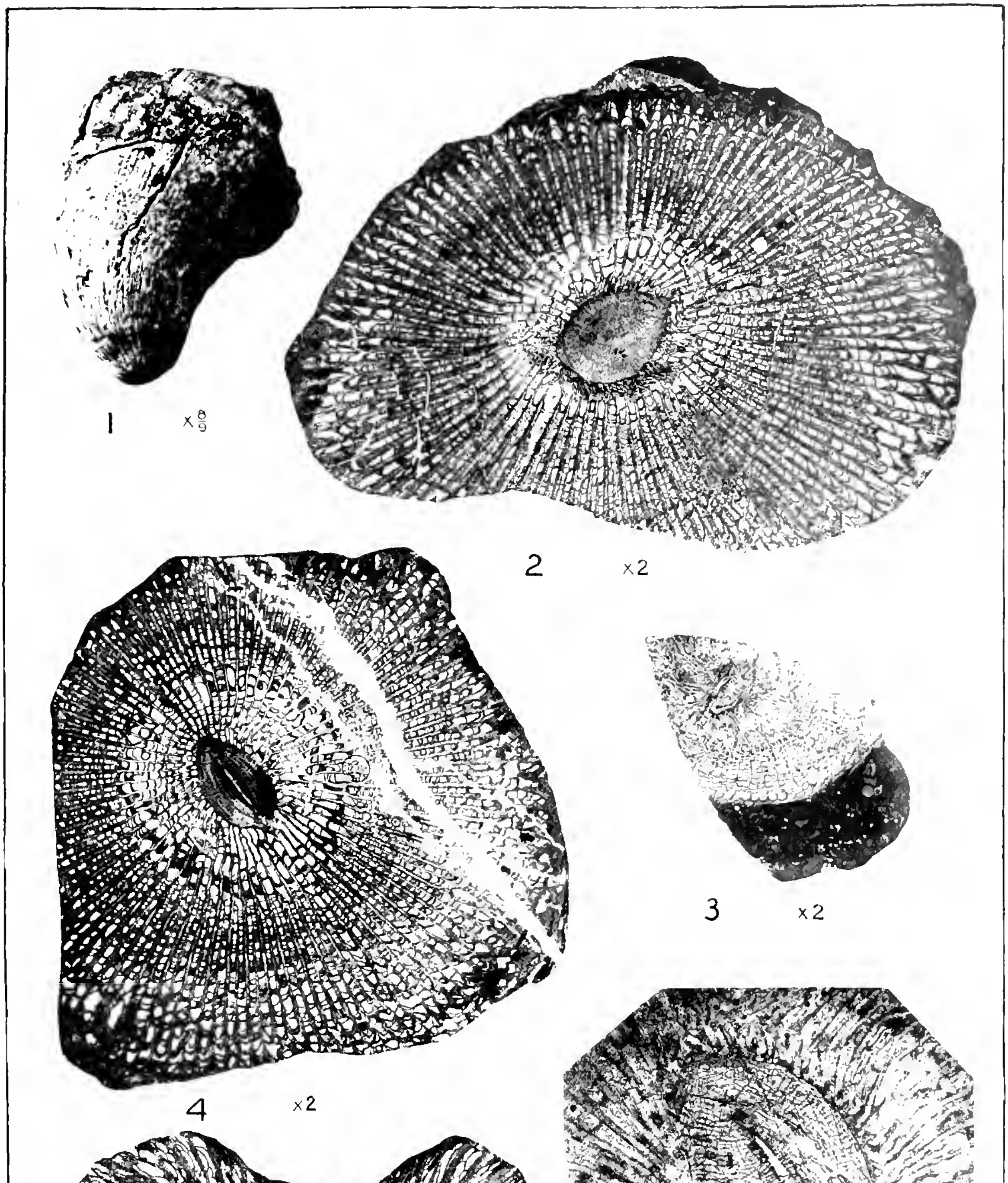
NOTES AND EXHIBITS.

Mr. W. W. Froggatt exhibited a series of flies from India, including *Chrysomyia bezziana* Villeneuve, *C. flaviceps* Walker, *C. rufifacies* (= *C. albiceps* W.), *C. nigriceps* Patton, *Lucilia serenissima* Fabr. and *L. craggii* Patton. A number of these cause cutaneous myiasis in man and animals in India. Also specimens of *Bibio imitator* from suburban gardens.

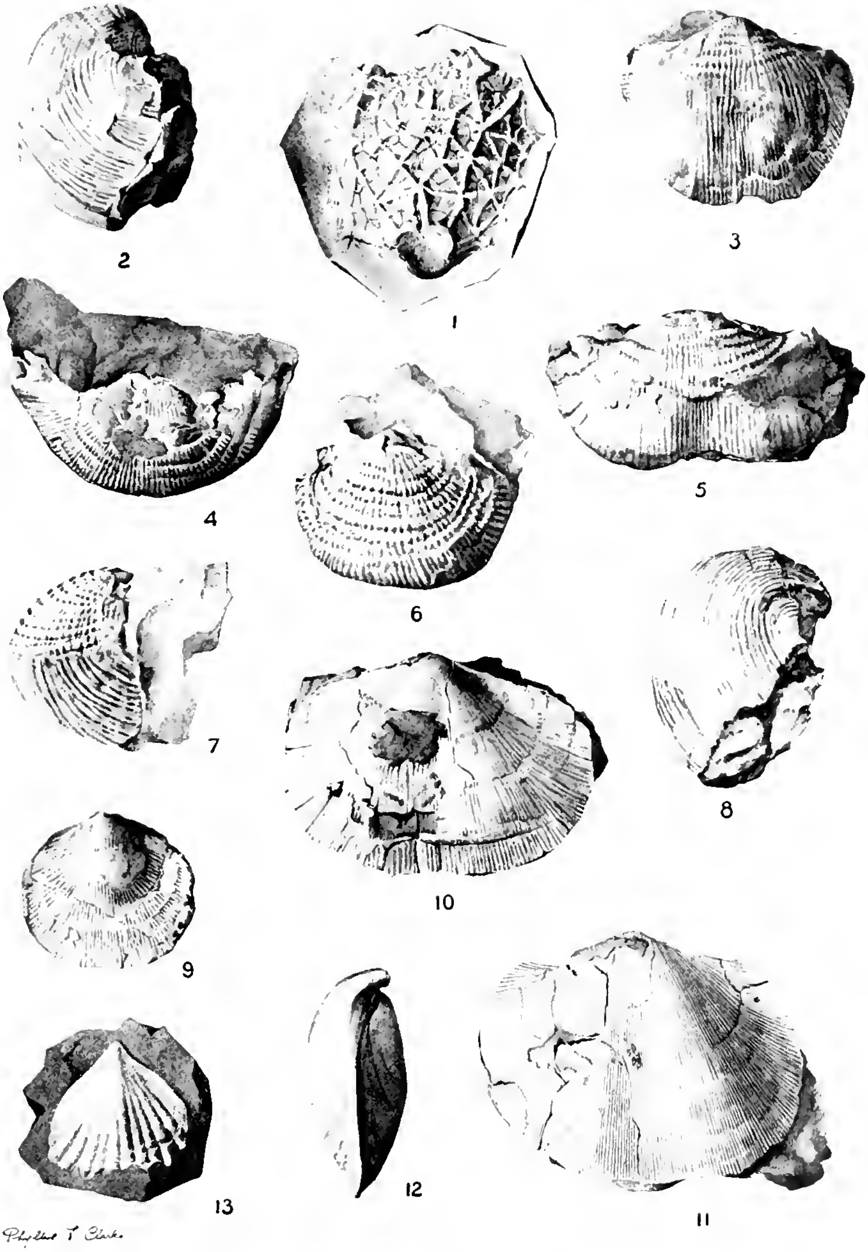
Mr. G. H. Hardy exhibited a pair of flies, *Chrysomyza aenea* Fabr. taken in a garden at Haberfield, 28th March, 1920. The species is new to the Australian fauna.

Mr. Waterhouse exhibited the first specimen of *Heteronympha solandri* Waterh. reared from the egg. The history of the specimen is that a female was caught at Mt. Kosciusko on 15th February, 1920, and on dissection of the abdomen four eggs were obtained; one only was fertile and this emerged on 28th February and was looked after very carefully; the larva pupated at Sydney on 8th September, and a male emerged on 10th October, about three months earlier than the usual time of appearance at Mt. Kosciusko. The female parent, the cast larval heads from the 2nd, 3rd, and final instars and the pupal skin were also shown.

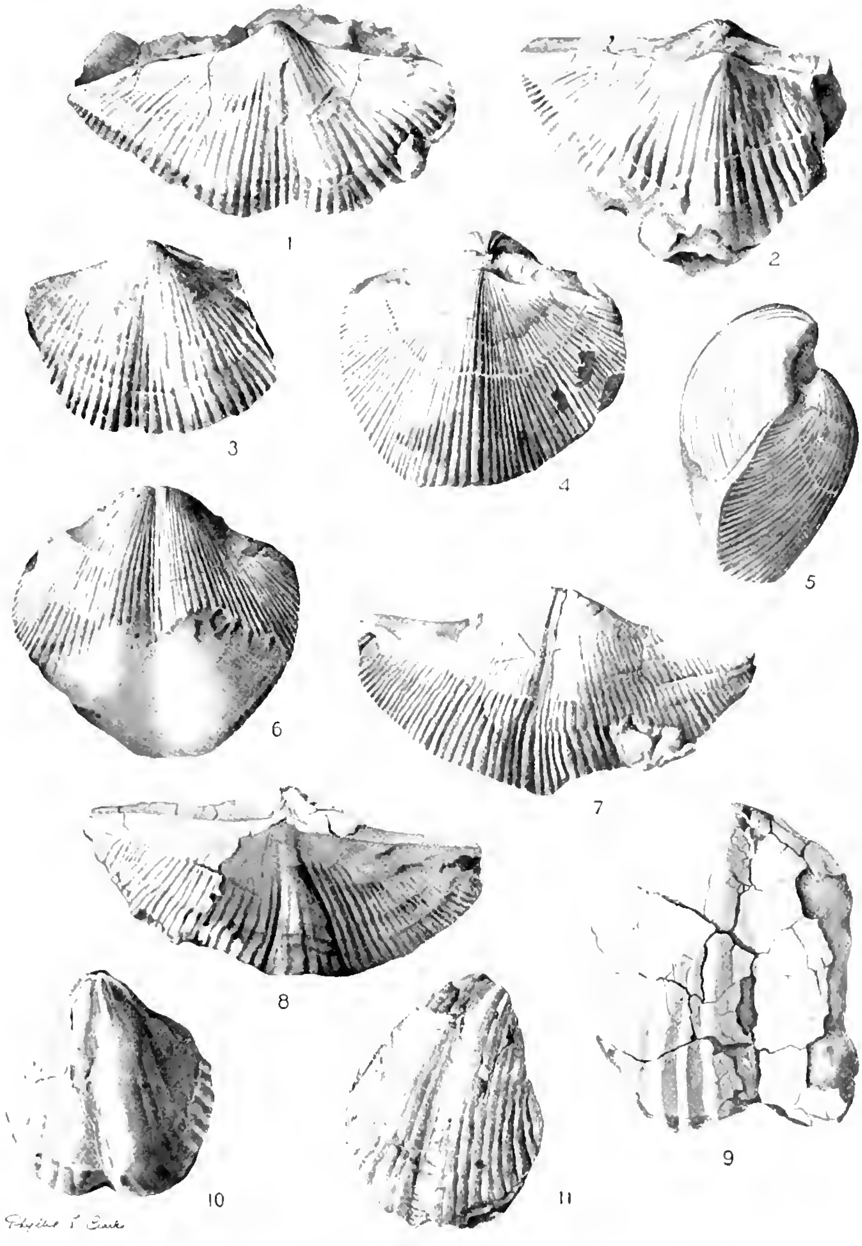
(Printed off 31st October 1920.)



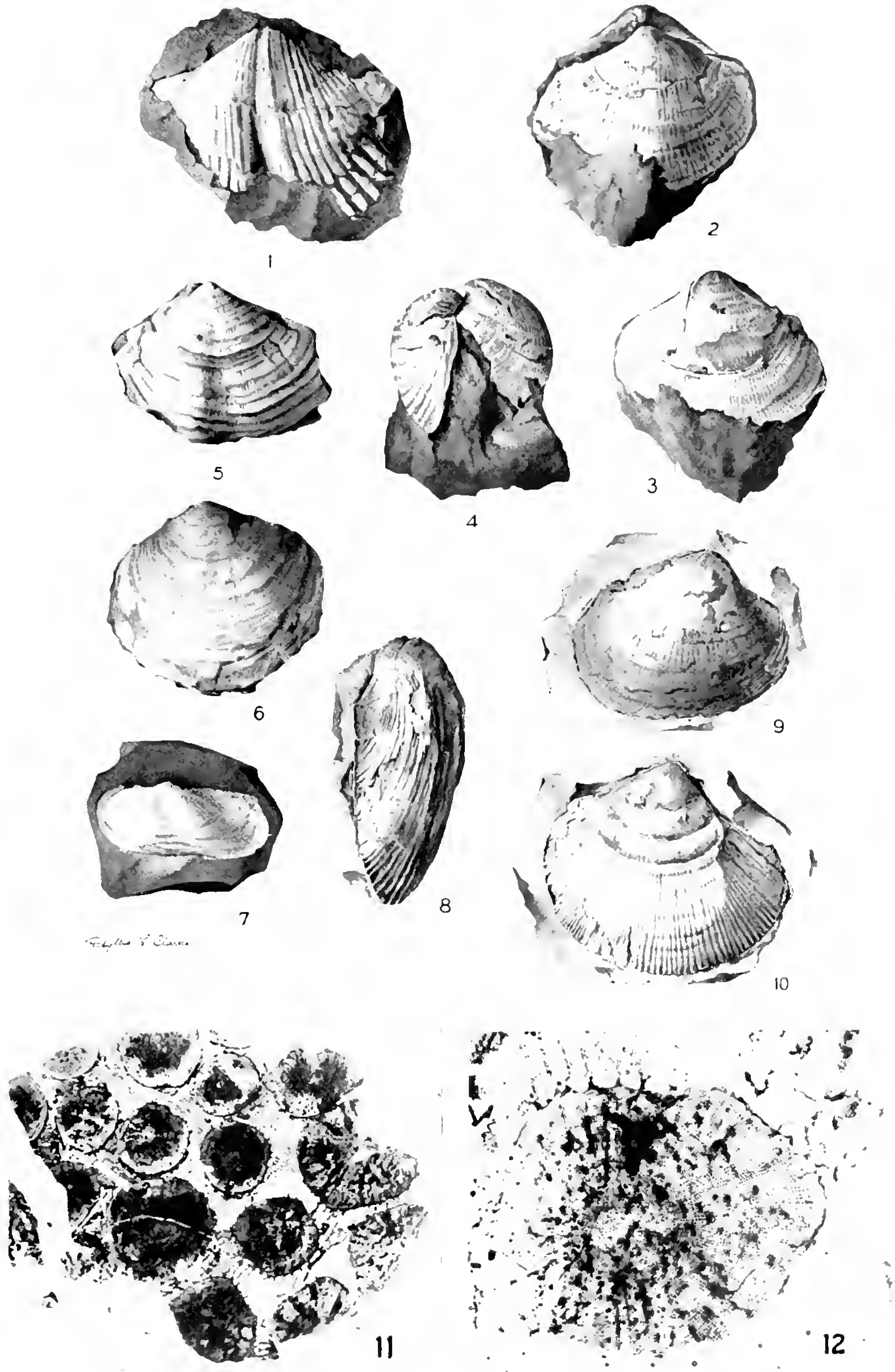
Amygdalophyllum etheridgei, n. gen. et sp.



Lower Carboniferous Fossils from S.E. Babbinboon.

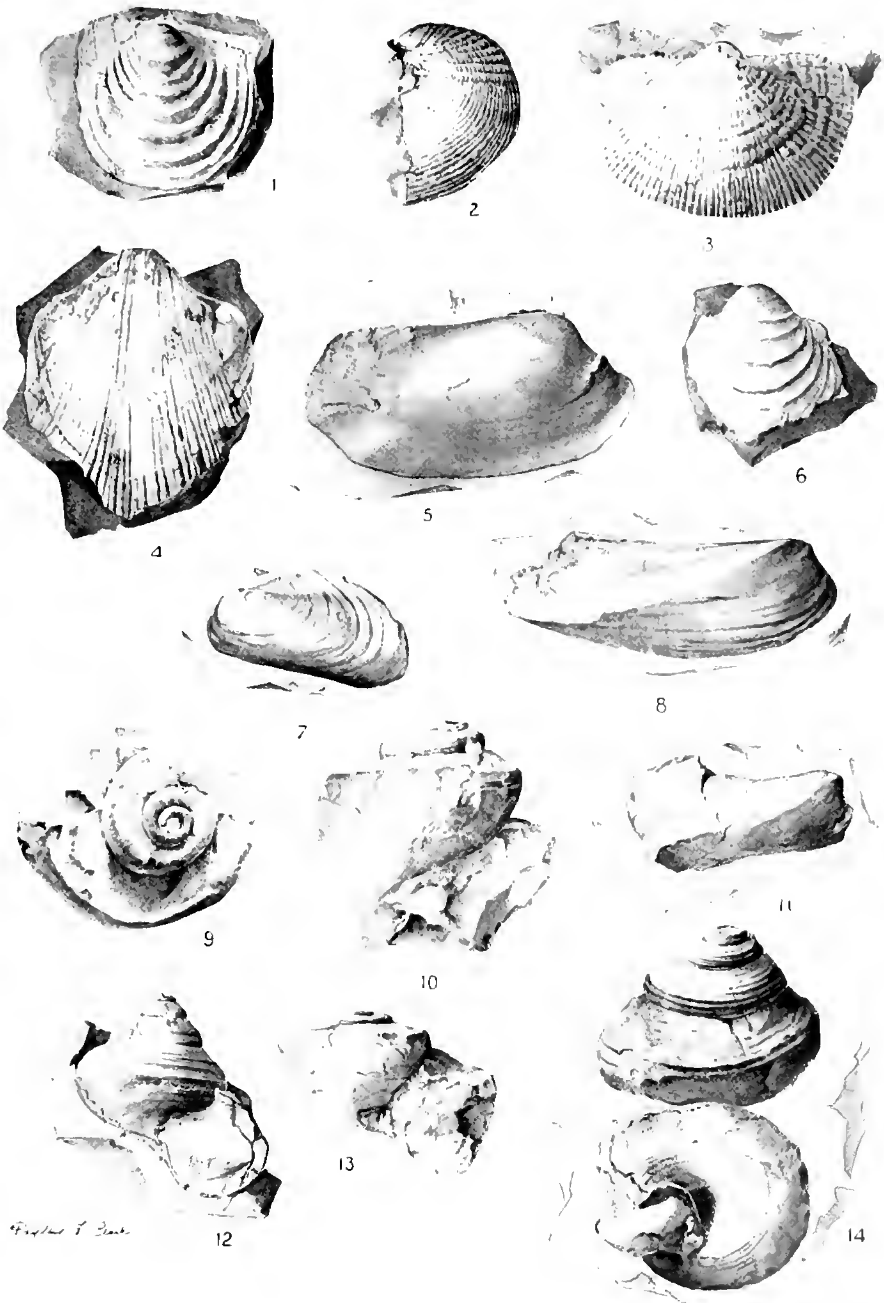


Lower Carboniferous Fossils from S.E. Babbinboon.

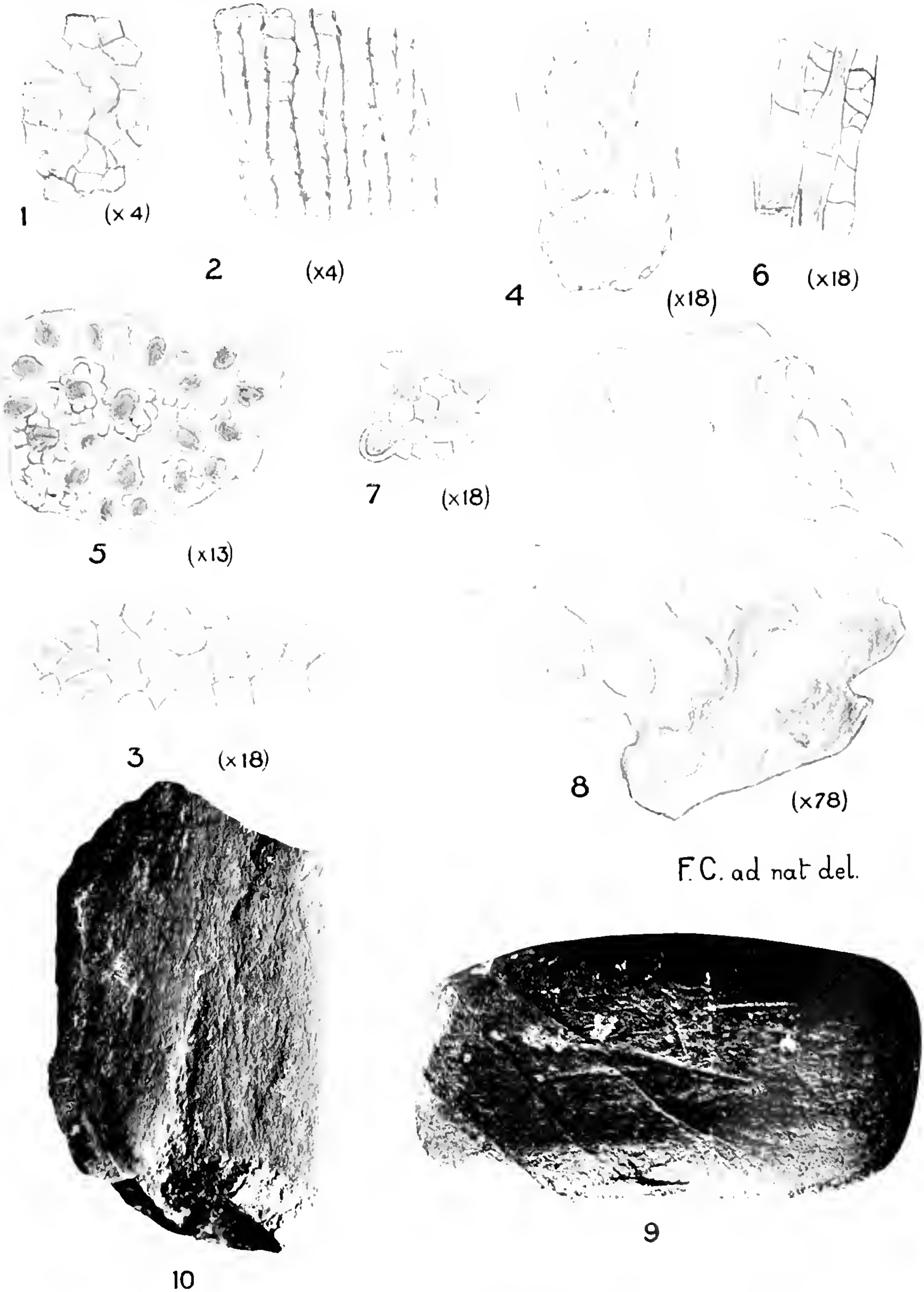


Lower Carboniferous Fossils from S.E. Babbinboon.
Silicified Roots from near Currabubula.

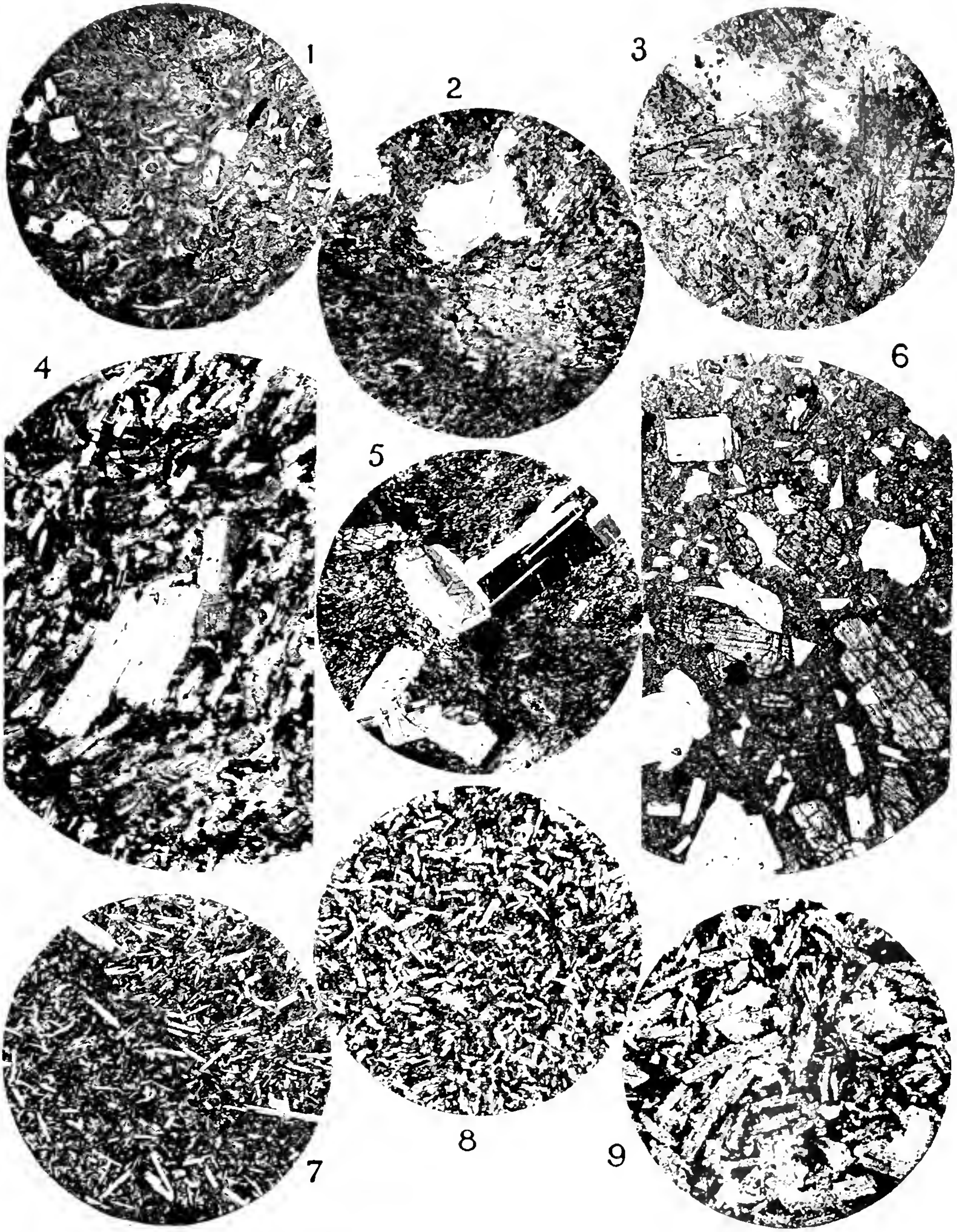
Lower Carboniferous Fossils from Somerton, Babbinboon and Carroll



Lower Carboniferous Fossils from Somerton District.



Lower Carboniferous Fossils from Babbinboon and Mooroowarra; and Glaciated Pebbles from Browne's Creek and Rocky Creek.



Carboniferous Rocks from the Currabubula District.

Mr. E. Cheel exhibited a series of specimens collected in the coastal district from Sydney to the Upper Clarence, also at Hill Top and on the Blue Mountains including *Boronia ledifolia* J. Gaz.; *B. ledifolia* var. *rosmarinifolia* (B. rosmarinifolia A. Cunn.) with pure white flowers from Hill Top (E. Cheel, July, 1914), Bell (Miss H. Gregson, Sept., 1914), Mount Wilson (J. H. Maiden, Dec., 1914), near Cowan Station (W. F. Blakely and D. W. C. Shiress, Sept., 1919), and specimens with double flowers from Hill Top (E. Cheel, Aug., 1915); *B. ledifolia* var. *triphylla* (B. triphylla Sieber) from Port Hacking (W. Slade, Aug., 1914), Kurrajong Heights (H. Dixson, Sept., 1897), National Park (M. Bell, Aug., 1901), Woy Woy (Miss A. C. Johnstone, July, 1916), and double-flowered specimen from Lindfield (E. G. Jacobs, Aug., 1913); *Boronia pinnata* Sm. with double flowers from Redfern (Mrs. Boyce, Nov., 1900) and Hornsby (W. F. Blakely, Apr., 1914); *Eriostemon lanceolatus* Gaertn. with pure white flowers, Tomago (Lady Windeyer, Sept., 1903), Rose Bay (Oct., 1906), Nelson's Bay (J. L. Boorman, Aug., 1911); *E. Crowei* F. v. M. with pure white flowers from Hornsby (W. F. Blakely and D. W. C. Shiress, Feb., 1920); *Kennedya rubicunda* Vent. with greenish-white flowers, Wahroonga (M. S. Barnett, Sept., 1920); and *Ceratopetalum gummiferum* Sm. with white flowers from between Hornsby and Dural (W. J. Pitty, Dec., 1919).

Mr. Cheel also exhibited on behalf of Miss A. A. Brewster specimens, and a chart, showing doubling of flowers and deterioration of the stamens of *Eriostemon lanceolatus* from Maroubra (October, 1920). In one specimen the stamens had multiplied to 16; in the more changed flowers the number varied from 1 to 4, and in one case there was left only a single anther seated on one of the inner petals. In two flowers the pistil was absent and 5 small petals were present in place of the carpels; in another the five degenerated carpels were partly green and partly pink.

Mr. John Mitchell exhibited a series of Silurian and Devonian brachiopods from N.S.W.

REVISION OF AUSTRALIAN LEPIDOPTERA—*LIPARIDAE*.

By A. Jefferis Turner, M.D., F.E.S.

Whatever the cause, the study of the Bombycine Families of Lepidoptera has been strangely neglected. No revision of the world-fauna of these groups has appeared, although from the smaller number of species this would be an easier task than it has been with the *Noctuidae, Geometridae, Pyralidae, Tortricidae,* and *Tineidae*. A revision of the genera is badly needed, and there has been even considerable confusion as to the families. This perhaps is one of the reasons why they have been neglected, though it has been to a large extent removed by the researches of Sir G. Hampson, published in the first volume of his Catalogue of the Lepidoptera Phalaenae and in his Moths of India. Another difficulty with regard to the Australian species is that so many of them have been described by authors innocent of morphological knowledge, and are therefore difficult of recognition. Fortunately, I have been able to examine many Australian types in the British Museum, and nearly all of the older species have now been identified, and can be referred to their right positions. Since then I have examined not only my own collection and that of the Queensland Museum, but also many specimens sent to me by Mr. George Lyell, of Victoria, by Mr. J. A. Kershaw from the National Museum, Melbourne, and by Mr. A. M. Lea from the South Australian Museum. Thanks to their generous help, and to the permission of the Directors of these Museums, a very large amount of material has been available for the purposes of this paper.

Family LIPARIDAE.

This family has also been known as the *Lymantriadae*. The older name was abandoned under the impression that the generic name *Liparis* Ochs. was preoccupied, but it appears that this preoccupation was pre-Linnean, and consequently inoperative. Formerly I enlarged the conception of the family (Trans. Ent. Soc., 1904, p. 470) to include the *Hypsidae* and *Anthelidae* as subfamilies, but I am now of opinion, for reasons which will be given presently, that the three groups are better regarded as three families.

The *Liparidae* may be defined as follows:—Tongue absent. Antennae bipectinate to apex in ♂, and nearly always in ♀ also. Head, thorax, abdomen, and femora hairy. Forewings with 1 (usually known as 1*c*) absent, 5 approximated to 4 at origin, 8 and 9 always stalked, either from cell or areole. Hindwings with frenulum present; 1 absent, discocellulars angled, 5 arising from below angle and approximated to 4, 6 and 7 usually stalked, 8 approximated and usually connected with cell somewhere between ⅓ and middle, rarely anastomosing.

The absence of a tongue, the approximation of the origin of the second branch of the median (vein 5) to the cubitus, and the connection of the subcostal of the hindwing with the cell about its middle, are sufficient to distinguish this family. In all these respects except the first it agrees with the *Hypsidae*. Its next nearest ally is the *Noctuidae*, the distinguishing point, apart from the presence of a tongue, being that in the latter the subcostal anastomoses with the cell in the hindwing near its base. This basal anastomosis is present in the genus aptly named by Meyrick *Haplopseustis* (for it is an evident deceiver), as to whose correct position there has been some difference of opinion. The presence of a tongue, although short and weakly developed, confirms the conclusion that *Haplopseustis* belongs to the *Noctuidae*; for, although the presence of a tongue in a primitive genus of *Liparidae* would be a not impossible discovery, the venation of the forewing of *Haplopseustis* shows that it is not primitive. The connection between the hindwing cell and subcostal in this and other families is really due to the persistence of the first branch of the radial, which has been shortened by their approximation. Sometimes the vein is not distinctly developed between the approximated points, or there may be an actual anastomosis as in *Acyphas*. In the more primitive genera a typical areole is present as in most *Noctuidae*. In many cases this has been lost by coalescence, leaving 7, 8, 9, 10 stalked, an intermediate condition being preserved in the African genus *Lacipa*, which has a small areole from which proceeds the common stalk of these veins. But the areole may also be lost by the obsolescence of the base of vein 9, leaving 10 disconnected, as sometimes occurs in *Iropoca*. In *Redoa* the areole becomes long and narrow, the allied *Leucoma* from Europe and *Euzora* differ from this in 10 having become disconnected. There is a tendency in this family for the obsolescence of the wings in the ♀; this occurs in three of our genera (*Euome*, *Orgyia*, *Iropoca*).

The family is a fairly large one, and in Australia there are 60 species, which I refer to 18 genera. This is a larger number of species than is found in the Palaearctic region, and in the Nearctic region the family is still more poorly represented. On the other hand Hampson's Moths of India contains a larger number, and Janse's check-list of the Moths of South Africa records twice as many species. The group is most developed in warm regions, and most of our species are from the coasts of North Australia, Queensland and New South Wales. Only seven species (*Porthesia*, *Oligeria*, *Acyphas*, *Orgyia*) come from South-east Australia, and only two (*Acyphas*, *Orgyia*) come from the South-west of the continent. Our genera may be divided into three or four natural groups:

1. Those with a normal areole, *Laelia*, *Dasychira*, *Olene*, *Orgyia*, widely distributed genera, which are very scantily represented here, together with the monotypical *Iropoca* and *Axiologa*.

2. A small group in which the areole tends to obsolescence, first by becoming long and narrow as in *Redoa*, and then by 10 becoming disconnected as in *Euzora* and in the exotic genus *Leucoma*. Of this we have only two species.

3. A much larger group in which the areole has disappeared by coalescence, leaving 7, 8, 9, 10 stalked. This may be divided into (*a*) the *Lymantria* group, containing also *Euome* and *Dura*, and (*b*) the *Euproctis* group containing also *Heracula*, *Habrophylla*, *Acyphas*, *Oligeria*, *Porthesia*, and *Ieta*. This last is the only group at all largely represented in Australia, where it comprises three-fifths of the whole number of species.

1.	Forewings without areole	2.	
	Forewings with areole (10 sometimes disconnected in *Iropoca*)	12.	
2.	Forewings with 7, 8, 9, 10 stalked, or 9 absent and 7, 8, 10 stalked	3.	
	Forewings with 7, 8, 9, stalked, 10 separate		*Euzora.*
3.	Hindwings abbreviated, cell ½		*Icta.*
	Hindwings and cell normal	4.	
4.	Hindwings with 4 absent		*Porthesia.*
	Hindwings with 4 present	5	
5.	Hindwings with 8 anastomosing with cell from ½ to ⅔	6.	
	Hindwings with 8 approximated and connected with cell at a point only	8.	
6.	Forewings with 9 absent	7.	
	Forewings with 9 present		*Habrophylla.*
7.	Posterior tibiae without middle-spurs		*Oligeria.*
	Posterior tibiae with middle-spurs		*Acyphas.*
8.	Forewings with 7 arising long before 10	9.	
	Forewings with 10 arising before, or opposite, or at least near 7	10.	
9.	Palpi short or moderate, porrect or oblique		*Euproctis.*
	Palpi long, erect, reaching vertex		*Heracula.*
10.	Forewings with 11 anastomosing or connected with 12		*Dura.*
	Forewings with 11 free	11.	
11.	Posterior tibiae without middle-spurs, ♀ with wings much aborted		*Enome.*
	Posterior tibiae with middle-spurs, ♀ with wings normally developed		*Lymantria.*
12.	Forewings with areole long and narrow, 7 from about middle		*Redoa.*
	Forewings with areole normal, 7 from its extremity	13	
13.	Forewings with 7, 8, 9 stalked from areole, or 10 disconnected, ♀ apterous	14.	
	Forewings with 7 approximated or connate (very rarely short-stalked), ♀ with wings developed	15.	
14	Posterior tibiae without middle-spurs		*Orgyia.*
	Posterior tibiae with middle-spurs		*Iropoca.*
15	Forewings with 11 anastomosing with 12		*Axiologa.*
	Forewings with 11 free	16.	
16.	Palpi with terminal joint very short or concealed ..	17.	
	Palpi with terminal joint well-developed		*Laelia.*
17	Abdomen with dorsal crest on second segment, palpi with second joint strongly dilated		*Olene.*
	Abdomen without crests, palpi not dilated		*Dasychira.*

Gen. 1. ICTA.

Icta, Wlk., List Lep. Brit. Mus., iv., p. 922.

Head and thorax with appressed hairs; frons flat. Palpi very short, porrect; terminal joint minute. Thorax and abdomen not crested; abdomen hairy, tuft in ♂ large. Tibial spurs short and stout; posterior tibiae with both pairs present. Forewings long and narrow; without areole, 2 from ¾, 3 from shortly before angle, 4 and 5 connate from angle, 6 from upper angle nearly connate with 7, 7, 8, 9, 10 stalked, 11 from shortly before angle; discocellulars strongly angled inwards. hindwings nearly as broad as forewings but much shorter: cell very long (⅘), discocellulars strongly oblique, 2 from ⅔, 3 and 4 stalked from angle, 5 curved at base and somewhat approximated to 4, 6 and 7 stalked from upper angle, 8 anastomosing or connected with cell about middle.

An isolated genus with curiously elongate forewings and abbreviated hindwings, almost zygaeniform.

Head orange	*fulviceps.*
Head blackish	*tanaopis.*

1. ICTA FULVICEPS.

Icta fulviceps Wlk., List Lep. Brit. Mus., iv., p. 922.

♂. 28-29 mm. Head brownish-orange. Palpi ½; brownish-orange. Antennae brownish-orange; pectinations in ♂ 9. Thorax dark-fuscous; tegulae and extreme bases of patagia brownish-orange. Abdomen dark-fuscous; tuft brownish-orange. Legs ochreous; middle and posterior femora and tibiae mostly fuscous. Forewings narrow-elongate, costa straight to near apex, there gently arched, apex rounded, termen very obliquely rounded; fuscous; costal edge narrowly ochreous; cilia fuscous. Hindwings about ⅗ length of forewings, termen rounded; fuscous; cilia fuscous.

Two examples in the British Museum, one labelled "Australasia," the other "New Holland." The locality requires confirmation, but probably like the following, it comes from the north of the continent.

2. ICTA TANAOPIS, n.sp.

ταναωπις, elongate.

♂. 30 mm. Head, palpi, and thorax blackish. Antennae blackish; pectinations in ♂ 10. Abdomen reddish-orange; basal segment, a median dorsal line, and underside blackish. Legs blackish. Forewings elongate, spathulate, costa sinuate, slightly concave to ⅔, then arched, apex rounded, termen very obliquely rounded, termen as long as dorsum; blackish; cilia blackish. Hindwings short, about ⅗ length of dorsum of forewing, termen rounded, tornus somewhat projecting; thinly scaled; fuscous; on dorsum pale-ochreous; cilia fuscous.

Type in National Museum, Melbourne.

N.Q.: Claudie River, in February; one specimen taken by Mr. J. A. Kershaw.

Gen. 2. PORTHESIA.

Porthesia, Stph., Ill. Brit. Ent., ii., 1829, p. 65.

Palpi moderate, porrect; second joint sometimes hairy beneath; terminal joint very short. Thorax and abdomen without crests; tuft large, especially in ♀. Posterior tibiae with two pairs of spurs. Forewings without areole; 7, 8, 9, 10 stalked, 7 arising from before 10, 6 connate or short-stalked with the preceding veins. Hindwings with discocellulars angled, 3 and 4 coincident, 5 approximated or connate, 6 and 7 stalked, 8 closely approximated to cell near or beyond middle, and connected with it.

Type. *P. similis* Fuesl. from Europe.

1. Wings white	2.	
Wings more or less ochreous or orange	5.	
2. Dorsal edge of forewings with long, spathulate, ochreous scales	3.	
Dorsal edge of forewings without ochreous scales ..	4.	
3. Dorsum of abdomen partly blackish		*euthysana.*
Dorsum of abdomen not blackish		*paradoxa.*
4. Dorsum of abdomen, except base, blackish		*melanosoma.*
Dorsum of abdomen ochreous, bases of segments fuscous		*aliena.*
Dorsum of abdomen whitish		*galactopis.*
5. Forewings suffused with dark-fuscous		*melambaphes.*
Forewings not suffused with dark-fuscous	6.	
6. Forewings without transverse lines	7	
Forewings with pale transverse lines	8.	
7. Forewings often with pale terminal fascia, termen slightly oblique		*fimbriata.*
Forewings without pale terminal fascia, termen strongly oblique		*xuthoptera.*
8. Forewings very pale ochreous, lines indistinct		*acatharta.*
Forewings dark-ochreous or orange	9.	
9. Forewings with pale spots on termen		*trispila.*
Forewings without pale spots		*lutea.*

3. Porthesia euthysana.

Porthesia euthysana Turn., Trans. Roy. Soc. S. Aust., xxvi., 1902, p. 175.

The sexes are similar.

Q.: Mount Tambourine; N.S.W.: Ebor.

5. Porthesia paradoxa.

Chionophasma paradoxa Butl., Trans. Ent. Soc., 1886, p. 385; *Porthesia panabra* Turn., Trans. Roy. Soc., S. Aust., 1902, p. 176.

There is nothing paradoxical about this species. I have examined Butler's type; it has the ordinary structure of the genus.

Q.: Rockhampton, Brisbane, Mount Tambourine, Coolangatta; N.S.W.: Sydney, Bulli.

5. Porthesia melanosoma.

Porthesia melanosoma Butl., Ann. Mag. Nat. Hist., (5), ix., p. 87; *Porthesia mixta* Butl., *loc. cit.*, p. 88.

♂ ♀. 34-40 mm. Head, thorax, and antennae white. Palpi and pectus blackish. Abdomen blackish; dorsum of two basal segments white; apices of segments on underside white; tuft in ♂ white, sometimes ochreous-tinged, in ♀ ochreous. Legs white; anterior and middle pairs partly fuscous; in ♂, anterior tibiae and part of two basal tarsal joints ochreous. Wings white; in ♂, costa of forewings on underside suffused with fuscous.

Vic.: Beaconsfield, Moe, Gisborne, Forrest; Tas.: Launceston.

6. Porthesia aliena.

Porthesia aliena, Butl., Trans. Ent. Soc., 1886, p. 386.

♂. Head and thorax white. Palpi whitish-ochreous, upper surface near base fuscous. Abdomen pale-ochreous; bases of segments fuscous on dorsum; beneath wholly ochreous. Wings white; underside of hindwings partly ochreous-tinged.

These particulars were noted from the British Museum type. I have seen no other example.

Q.: Peak Downs.

7. PORTHESIA GALACTOPIS.

Porthesia galactopis, Turn., Trans. Roy. Soc. S. Aust., xxvi., 1902, p. 176.

N.Q.: Prince of Wales Island, Cairns, Mareeba, Townsville; Q.: Gayndah, Brisbane, Southport, Coolangatta.

8. PORTHESIA XUTHOPTERA, n.sp.

ξουθοπτερος, tawny-winged.

♂. 24 mm. ♀. 28-38 mm. Head, thorax, palpi, antennae, abdomen and legs ochreous. Forewings triangular, rather narrow, termen strongly oblique; ochreous without markings; cilia ochreous. Hindwings similar, in ♂ paler.

Differs from the following in the sexes being of the same colour.

N.Q.: Kuranda, near Cairns, one ♀ received from Mr. F. P. Dodd; Stannary Hills, one ♂, two ♀ received from Dr. T. Bancroft.

9. PORTHESIA FIMBRIATA.

Teara fimbriata, Luc., Proc. Linn. Soc. N.S. Wales, 1891, p. 285; *Porthesia fimbriata*, Turn., Trans. Roy. Soc. S. Aust., xxvi., 1902, p. 176.

The primary character given in the tabulation suffices to distinguish only the typical form of the ♂. There is another form nearly as common, which has the forewings wholly ochreous. This can be distinguished from *xuthoptera* by the forewings being proportionately broader, with less oblique termen. The ♀ is whitish, has narrower forewings, and can scarcely be distinguished from *galactopis*.

Q.: Stradbroke Island, Coolangatta. Attached to *Banksia serratifolia*.

10. PORTHESIA ACATHARTA.

Porthesia acatharta, Turn., Trans. Roy. Soc. S. Aust., xxx., 1906, p. 124.

Termen of forewing with long spathulate ochreous scales.

N.A.: Port Darwin; N.Q.: Cairns.

11. PORTHESIA TRISPILA, n.sp.

τρισπιλος, three-spotted.

♂. 25-27 mm. Head, palpi, and antennae pale-ochreous. Thorax and abdomen ochreous. Legs whitish-ochreous. Forewings triangular, costa moderately arched, apex rounded, termen bowed, oblique; pale-ochreous irrorated, except towards costa, with brown-fuscous; absence of irroration leaves two transverse lines and three terminal spots; first line from ⅓ costa to beyond ⅓ dorsum, at first outwardly-curved, then sinuate; second line from ⅔ costa to beyond ⅔ dorsum, similar in form to first line; large pale-ochreous spots at apex, above midtermen, and above tornus; cilia pale-ochreous, bases whitish, barred with fuscous on midtermen and tornus. Hindwings and cilia whitish. Underside whitish.

N.Q.: Kuranda, near Cairns; two specimens received from Mr. F. P. Dodd.

12. Porthesia melambaphes, n.sp.

μελαμβαφής, dark-eyed.

♂. 28 mm. Head and thorax fuscous, with some ochreous hairs. Palpi and antennae fuscous. Abdomen dark-fuscous, tuft and underside ochreous. Legs ochreous mixed with fuscous. Forewings triangular, costa gently arched, more strongly so near base, apex rounded, termen slightly bowed, oblique; ochreous, thickly irrorated with dark-fuscous; a large basal patch mostly fuscous; a suffused, fuscous, subterminal band with an acute, median, posterior tooth; cilia fuscous, apices partly ochreous. Hindwings with termen rounded; deep ochreous, with slight fuscous irroration; cilia ochreous, with some fuscous admixture. Underside ochreous.

Type in Coll. Lyell.

Vic.: Ocean Grange, near Sale, in March; one specimen.

13. Porthesia lutea.

Bombyx lutea, Fab., Syst., Ent., p. 574; *Artaxa chrysophila*, Wlk., List Lep. Brit. Mus., xxxii., p. 334; *Artaxa iobrota*, Meyr., Trans. Roy. Soc. S. Aust., xv., 1891, p. 194.

♂. 23-32 mm. ♀. 32-36 mm. Head, thorax, and abdomen orange-yellow, rather paler in ♀. Palpi pale-ochreous, apices fuscous. Antennae orange-yellow, paler in ♀, pectinations fuscous. Legs orange-yellow; tarsi pale-ochreous. Forewings broadly triangular, more elongate in ♀, costa moderately arched, apex rounded, termen slightly oblique; orange-yellow, paler in ♀; two whitish, slightly denticulate, transverse lines, rarely obsolete; first from ⅓ costa to ⅓ dorsum, angled outwards above middle; second from ⅔ costa to ⅔ dorsum outwardly curved, slightly sinuate towards dorsum; cilia orange-yellow. Hindwings and cilia orange-yellow.

Iobrota is a much darker form, the forewings ochreous-brown, the hindwings fuscous. Intermediate examples occur.

N.A.: Pt. Darwin; N.Q.: Cairns, Atherton, Stannary Hills, Dunk Island, Ingham, Townsville; Q.: Rockhampton, Gympie, Nambour, Brisbane, Stradbroke Island. Also from New Guinea.

Gen. 3. Oligeria, n.gen.

ὀλιγήριος, small.

Palpi minute. Antennae in ♂ short (less than ½), strongly bipectinate to apex. Posterior tibiae without middle spurs. Forewings without areole, 9 absent (coincident with 8), 7, 8, 10 stalked, 10 arising before 7. Hindwings with 3 and 4 connate or stalked, 5 separate, 6 and 7 stalked, 8 anastomosing with cell from before middle to ⅔.

A development of *Acyphas* distinguished by the minute palpi and loss of middle-spurs.

14. Oligeria hemicalla.

Orgyia hemicalla, Low., Trans. Roy. Soc. S. Aust., xxix., 1905, p. 176.

♂. 18-20 mm. Head dark-fuscous; face ochreous. Antennae, thorax, and abdomen dark-fuscous. Legs fuscous; tibiae and tarsi ochreous. Forewings triangular, costa gently arched, apex rounded, termen bowed, strongly oblique, longer than dorsum; dark-fuscous; cilia ochreous. Hindwings rather short, termen slightly rounded; orange; basal half fuscous, the line of junction irregularly dentate; cilia orange. Underside similar.

N.S.W.: Sydney; two specimens received from the late Mr. Masters. As they were taken many years ago and bore no labels, the locality needs confirmation. Vic.: Melbourne.

Gen. 4. ACYPHAS.

Acyphas, Wlk., List Lep. Brit. Mus., iv., p. 798; Kirby, Cat. Moths, i., 1892, p. 472; *Anepa*, Swin., Trans. Ent. Soc., 1903, p. 478.

Palpi short, porrect; second joint sometimes hairy beneath; terminal joint minute. Thorax and abdomen without crests; tuft large, especially in ♀. Posterior tibiae with two pairs of spurs. Forewings without areole, 9 absent (coincident with 8), 7, 8, 10 stalked, 10 arising before 7, 6 approximated, connate, or short-stalked. Hindwings with discocellulars angled, 3, 4, 5 separate, 6 and 7 stalked, 8 anastomosing with cell from ½ to ¾ or beyond.

Type, *A. fulviceps* Wlk.

The three genera *Porthesia*, *Acyphas*, and *Habrophylla* are doubtless derivatives of *Euproctis*, which they resemble in general appearance, but there are important structural differences. *Acyphas* is different from *Euproctis* in the venation of both wings, and there is room for one or more intermediate genera. The first species ascribed to this genus by Walker appears to be an *Orgyia*, but I opine that the type was fixed by Kirby, and Swinhoe's name comes too late. Although *Acyphas* is at present known only from Australia, it is not improbable that it will be found to have a wider distribution, when the Indo-Malayan species referred to *Euproctis* are critically examined.

1. Wings white with or without markings	2.	
Wings not white	4.	
2. Forewings in ♂ wholly white		*chionitis.*
Forewings in ♂ not wholly white	3.	
3. Forewings in ♂ with a subterminal ochreous line ..		*leptotypa.*
Forewings in ♂ with a tornal fuscous spot, or with more or less fuscous suffusion at least on underside		*leucomelas.*
4. Wings ochreous or orange		*amphideta.*
Wings fuscous		*fulviceps.*

15. ACYPHAS CHIONITIS.

Euproctis chionitis, Turn., Trans. Roy. Soc. S. Aust., xxvi., 1902, p. 177.

N.Q.: Cairns Herberton, Cardwell; Q.: Eidsvold, Nambour, Brisbane, Stradbroke Island, Mt. Tambourine; Vic.: Healesville; S.A.: Adelaide; W.A.: Waroona.

16. ACYPHAS LEPTOTYPA.

Euproctis leptotypa, Turn., Trans. Ent. Soc., 1904, p. 475.

N.Q.: Townsville, from larvae feeding on *Acacia aulacocarpa* (Dodd), Cairns.

17. ACYPHAS LEUCOMELAS.

Euproctis leucomelas Wlk., List Lep. Brit. Mus., iv., p. 838; *Porthesia anacausta*, Meyr., Trans. Roy. Soc. S. Aust., xv., 1891, p. 193; *P. hololeuca*, *ibid.*

♂. 28-38 mm. ♀. 28-42 mm. Head, thorax, and abdomen white. Palpi ochreous in ♂, whitish in ♀. Antennae white, pectinations fuscous. Pectus ochreous in ♂, faintly ochreous-tinged in ♀. Legs white; anterior pair with coxae and anterior surface of femora and tibia ochreous in ♂. Forewings triangular, costa gently arched, apex rounded, termen bowed, slightly oblique, more so in ♀; white; in ♂ sometimes a fuscous spot at tornus, or whole apical and terminal area suffused with dark-fuscous; cilia white, in dark examples of the ♂ they may be fuscous. Hindwings with termen rounded; white; in ♂ sometimes with a broad dark-fuscous suffusion over terminal half; cilia white, in dark examples of the ♂ they may be fuscous. Underside white; in ♂ a costal streak and apical blotch more or less fuscous, sometimes extensively suffused with dark-fuscous as on upper side.

The ♂ is very variable in the amount of fuscous suffusion, but some is always present on the underside of the forewing. This will distinguish it from the ♂ of *A. chionitis*, which has an ochreous costal streak from base on underside.

Vic.: Melbourne, Gisborne, Mt. St. Bernard (5000ft.); Tas.: Hobart, Swansea; S.A.: Penola.

18. Acyphas amphideta.

Euproctis amphideta, Turn., Trans. Roy. Soc. S. Aust., xxvi., 1902, p. 177.

I have not seen a ♀.

N.Q.: Innisfail, Atherton, Townsville.

19. Acyphas fulviceps.

Charnidas fulviceps, Wlk., List Lep. Brit. Mus., iv., p. 797; *Acyphas fusca* Wlk., List Lep. Brit. Mus., iv., p. 798.

♂. 36-40 mm. Head and thorax orange-ochreous. Palpi 1; orange-ochreous. Antennae fuscous, base of stalk whitish-ochreous; pectinations in ♂ 16. Abdomen fuscous. Legs fuscous; anterior pair, except tarsi, orange-ochreous. Forewings triangular, costa gently arched, apex rounded, termen bowed, oblique; fuscous; cilia fuscous. Hindwings with termen rounded; fuscous; cilia fuscous. Underside fuscous.

Described from a small series, including the types, in the British Museum.

Tas.: Hobart.

Gen. 5. Habrophylla, n.gen.

ἁβροφυλλος, soft-winged.

Palpi short, porrect, densely hairy; terminal joint concealed. Thorax and abdomen without crests. Posterior tibiae with terminal spurs only. Forewings without areole, 7, 8, 9, 10 stalked, 7 arising before 10, 6 connate. Hindwings with discocellulars angled; 3 and 4 stalked, 5 approximated, 6 and 7 stalked. 8 anastomosing with cell from $\frac{1}{3}$ to $\frac{3}{4}$.

A development of *Euproctis*, the venation of the forewings being that of *Euproctis* and *Porthesia;* the former has 3 and 4 of the hindwings sometimes stalked. In the long anastomosis of 8 with cell, it differs from both, and agrees with *Acyphas*; in the loss of the middle spurs it differs from all three.

20. Habrophylla euryzona.

Euproctis euryzona, Low., Trans. Roy. Soc. S. Aust. xxvi., 1902, p. 213.

Gen. 6. Euproctis.

Euproctis, Hb., Verz., p. 159.

Palpi moderate or short, porrect or obliquely porrect; second joint sometimes hairy; terminal joint short or moderate. Thorax and abdomen without crests;

tuft large especially in ♀. Posterior tibiae with two pairs of spurs. Forewings without areole, 7, 8, 9, 10 stalked, 7 arising from 8 before 10, 6 connate or from slightly below angle. Hindwings with discocellulars angled, 3 and 4 approximated, connate, or stalked, 5 well separated at origin, 6 and 7 stalked, 8 approximated or connected with cell about middle.

A large genus. Type, *E. chrysorrhoea* Lin. from Europe.

1.	Hindwings wholly or partly ochreous-tinged, ochreous or orange	2.	
	Hindwings fuscous	17.	
2.	Hindwings with fuscous terminal band		*stenomorpha.*
	Hindwings without fuscous terminal band	3.	
3.	Hindwings with orange terminal band		*subnobilis.*
	Hindwings without orange terminal band	4.	
4.	Forewings with darker transverse lines or fasciae ..	5.	
	Forewings without lines or fasciae	8.	
5.	Forewings with lines or fasciae fuscous	6	
	Forewings with lines or fasciae reddish-brown ..	7.	
6.	Wings whitish, slightly tinged with ochreous		*idonea.*
	Wings pale-ochreous		*aganopa.*
7.	Forewings with postmedian fascia		*epaxia.*
	Forewings with antemedian fascia		*hymnolis.*
8.	Wings unicolorous, without markings	9.	
	Wings not so	12.	
9	Wings pale ochreous	10.	
	Wings deep ochreous	11	
10.	Forewings with costa and cilia darker		*lucifuga.* ♀
	Forewings with costa and cilia not darker		*epidela.* ♀
11.	Wings and abdominal tuft ochreous		*crocea.*
	Wings reddish-ochreous, abdominal tuft whitish..		*arrogans.*
12	Hindwings with base fuscous	13.	
	Hindwings with base not fuscous	14.	
13.	Forewings whitish-grey		*habrostola.* ♀
	Forewings fuscous		*actor.* ♀
14.	Forewings unicolorous, whitish-grey		*habrostola.* ♂
	Forewings not so	15	
15	Forewings with pale transverse lines		*epidela.* ♂
	Forewings without transverse lines	16.	
16.	Forewings with pale ochreous terminal band		*edwardsi* (part).
	Forewings with ochreous spots only		*actor.* ♂
17.	Hindwings with termen not whitish	18.	
	Hindwings with termen whitish	20	
18.	Fore- and hindwings nearly unicolorous		*edwardsi* (part).
	Fore- and hindwings differing in colour	19.	
19.	Forewings without transverse lines		*pyraustis.*
	Forewings with paler transverse lines		*lucifuga.* ♂
20.	Forewings with complete, whitish, terminal fascia	21.	
	Forewings with writish incomplete fascia or terminal spots	22.	
21.	Forewings with anterior margin of fascia slightly wavy		*baliolalis.*
	Forewings with anterior margin of fascia dentate..		*marginalis.*
22.	Forewings with terminal spots not extending to apex		*limbalis.*
	Forewings with terminal spots extending to apex		*niphobola.*

21. EUPROCTIS STENOMORPHA, n.sp.

στενόμορφος, narrowly formed.

♂. 30 mm. Head orange. Palpi short (½): fuscous. Antennae dark-fuscous. Thorax dark-fuscous: tegulae and a posterior spot orange. Abdomen dark-fuscous, tuft orange. Legs ochreous; tibiae and tarsi fuscous. Forewings elongate-triangular, rather narrow, costa straight, apex pointed, termen bowed, strongly oblique; dark-fuscous; an inwardly oblique, orange-ochreous, median fascia, dilated beneath, but not reaching costa; cilia fuscous. Hindwings with termen slightly rounded; 3 and 4 connate or stalked; ochreous; a fuscous terminal band narrowing to a point at tornus; cilia fuscous; on tornus and dorsum ochreous. Underside similar but paler; a central ochreous suffusion in forewings extending on dorsum to base.

The wings narrower than in other species of the genus, and with a different *facies*, but a true *Euproctis*.

N.A.: Port Darwin, in September; two specimens received from Mr. F. P. Dodd.

22. EUPROCTIS IDONEA.

Euproctis idonea, Swin., Trans. Ent. Soc., 1903, p. 401.

I have not seen this species.

N.W.A.: Sherlock River.

23. EUPROCTIS AGANOPA, n.sp.

ἀγανωπός, of gentle appearance.

♂. 30-32 mm. Head, antennae, thorax, abdomen, and legs pale-ochreous. Palpi moderate (1), obliquely porrect; pale-ochreous. Forewings oval-triangular, costa strongly arched, apex round-pointed, termen bowed, oblique; pale-ochreous with a few fuscous scales; a dark-fuscous discal dot beneath costa about middle; two, fine, fuscous, transverse lines; first obsolete towards costa, angled outwards in middle, ending on ⅓ dorsum; second from beneath ¾ costa, sinuate, ending on ⅔ dorsum; in a second example the median area between lines is uniformly fuscous; cilia pale-ochreous. Hindwings with termen strongly rounded; 3 and 4 connate; pale-ochreous; cilia pale-ochreous. Underside wholly pale-ochreous.

N.Q.: Evelyn Scrub, near Herberton, in November; three specimens received from Mr. F. P. Dodd.

24. EUPROCTIS PYRAUSTIS.

Euproctis pyraustis, Meyr., Trans. Roy. Soc. S. Aust., xv., 1891, p. 194; *Euproctis scotochyta*, Turn., Trans. Roy. Soc. S. Aust., xxvi., 1902, p. 178.

Hindwings of ♂ with 3 and 4 approximated. The ♀ is unknown.

N.A.: Adelaide River; N.Q.: Cairns, Townsville.

25. EUPROCTIS LUCIFUGA.

Artaxa lucifuga, Luc., Proc. Linn. Soc. N.S. Wales, 1892, p. 250; *Euproctis chrysophaea*, Turn., Proc. Linn. Soc. N.S. Wales, 1902, p. 178; *nec* Wlk.

Hindwings of ♂ with 3 and 4 approximated, of ♀ with 3 and 4 stalked. I have already described this species, of which the sexes are strikingly dissimilar.

N.Q.: Cairns, Townsville; Q.: Eidsvold, Gayndah, Caloundra, Brisbane.

26. Euproctis epidela.

Euproctis epaocta, Turn., Trans. Roy. Soc. S. Aust., xxx., 1906, p. 125.

Hindwings with 3 and 4 stalked in both sexes.
N.A.: Port Darwin; N.Q.: Cairns.

27. Euproctis epania.

Euproctis epania, Turn., Trans. Roy. Soc. S. Aust., 1906, p. 125.

Hindwings with 3 and 4 approximated or stalked in ♂. I have not seen a ♀.
N.A.: Melville Island; N.Q.: Cairns, Herberton.

28. Euproctis hymnolis, n.sp.

ὑμνολις, worthy of praise.

♂. 40 mm. Head ochreous. Palpi slender, rather long (2¼); ochreous. Antennae ochreous. Thorax orange-ochreous. Abdomen ochreous, tuft grey. Legs ochreous. Forewings suboval, costa strongly arched, apex rounded, termen bowed, strongly oblique; orange-ochreous; a transverse fascia before middle defined by pale lines, angulated outwards above middle, above angle wider and orange-ochreous, beneath angle narrower, dark reddish-brown; posterior to fascia the veins are outlined in pale streaks; a postmedian band of slight reddish-brown irroration; cilia ochreous. Hindwings with termen rounded; 3, 4, 5, approximated at origin; pale-ochreous; cilia pale-ochreous. Underside pale-ochreous.

Type in Coll. Lyell.

N.Q.: Kuranda, near Cairns, in June; one specimen received from Mr. F. P. Dodd.

29. Euproctis subnobilis.

Porthesia subnobilis, Snel., Tijd. v. Ent., xxiv., 1881, p. 128; *Artaxa simulans*, Butl., Ann. Mag. Nat. Hist., (5), xiii., 1884, p. 200; *Euproctis ericodes*, Turn., Trans. Ent. Soc., 1904, p. 475.

Hindwings with 3 and 4 approximated.
N.Q.: Cairns, Innisfail. Also from Key I. and Amboyna.

30. Euproctis crocea.

Teara crocea, Wlk., List Lep. Brit. Mus., xxxii., p. 355; *Euproctis holoxutha*, Turn., Trans. Roy. Soc. S. Aust., xxvi., 1902, p. 178.

♂. 40-45 mm. ♀. 52 mm. Head, thorax, and antennae deep ochreous-yellow, sometimes orange. Palpi moderate (1), porrect; second joint not hairy; terminal joint moderate; ochreous. Abdomen ochreous or orange-ochreous, dorsum sometimes suffused with fuscous except towards base, tuft ochreous. Forewings triangular, costa slightly arched in ♂, more strongly in ♀; apex rounded, termen bowed, oblique; deep ochreous-yellow, sometimes ochreous-orange; sometimes with paler discal dot beneath mid-costa; cilia concolorous. Hindwings with termen rounded; 3 and 4 approximated, connate, or stalked; as forewings or slightly paler. Underside ochreous.

N.A.: Adelaide River; N.Q.: Innisfail, Townsville; Q.: Rockhampton, Brisbane, Mt. Tambourine. Also from New Guinea.

31. EUPROCTIS ARROGANS.

Artaxa arrogans, Luc., Proc. Roy. Soc. Q'land, 1899, p. 140; Turn., Trans. Roy. Soc. S. Aust., xxvi., 1902, p. 179; *A. meeki*, Druce, Ann. Mag. Nat. Hist. (7), xii., 1903, p. 222; *Euproctis arctada*, Swin., Trans. Ent. Soc., 1903, p. 409.

Reddish-ochreous; abdominal tuft whitish. Hindwings with 3 and 4 approximated. One ♀ has a minute areole in both forewings; this is a reversional abnormality.

N.Q.: Cooktown, Cairns, Innisfail, Cardwell, Ingham, Atherton. Also from New Guinea.

32. EUPROCTIS HABROSTOLA.

Euproctis habrostola, Turn., Trans. Roy. Soc. S. Aust., xxvi., 1902, p. 179; *Euproctis pura*, Swin., Trans., Ent. Soc., 1903, p. 405.

♂. 47 mm. Head, thorax, and antennae brown-whitish. Palpi short (½), porrect; second joint somewhat hairy beneath, terminal point minute; ochreous. Abdomen fuscous; base, tuft, and underside ochreous. Legs ochreous. Forewings triangular, costa moderately arched, apex rounded, termen bowed, oblique; brown-whitish; cilia brown-whitish. Hindwings with termen rounded; 3 and 4 approximated or connate; ochreous-yellow; cilia slightly paler. Underside ochreous.

♀. 60 mm. Palpi ⅔. Hindwings with basal and dorsal area fuscous both above and beneath, its edges suffused.

N.Q.: Townsville; Q.: Rockhampton.

33. EUPROCTIS ACTOR, n.sp.

ἄκτωρ, a leader.

♂. 55 mm. Head reddish-brown; face ochreous-fuscous. Palpi short (⅔), porrect; terminal joint minute; ochreous-fuscous. Antennae ochreous-fuscous. Thorax reddish-brown. Abdomen fuscous, sides brownish, tuft and under surface ochreous. Legs pale-ochreous. Forewings oval-triangular, costa strongly arched towards apex; apex rounded, termen bowed, oblique; rather pale fuscous; an outwardly-oblique, oval, pale-ochreous, discal spot beneath costa about middle; a series of longitudinal, oval, pale-ochreous, terminal spots of fairly large but unequal size, separated by fuscous or reddish-brown lines; cilia fuscous. Hindwings with termen strongly rounded; 3 and 4 approximated; ochreous, towards dorsum orange-ochreous; cilia ochreous. Underside wholly pale-ochreous.

♀. 70 mm. Head, thorax, and forewings wholly fuscous. Hindwings ochreous; basal third dark-fuscous. Underside similar.

N.Q.: Kuranda, near Cairns, in March (1♂, 1♀); N.S.W.: Lismore (1 ♂). It is quite possible that the pale spots on forewing of ♂ are variable and inconstant.

34. EUPROCTIS EDWARDSI.

Teara edwardsi, Newm., Trans. Ent. Soc., 1856, Pl. 18, f. 10; *Teara deficita*, Wlk., List Lep. Brit. Mus., xxxii., p. 352; *Teara indecora* Wlk., *op. cit.*, p. 353; *Teara togata*, Luc., Proc. Linn. Soc. N.S. Wales, 1891, p. 285.

♂. 40-50 mm. Head and thorax orange-ochreous, ochreous or greyish-ochreous. Palpi and antennae pale-ochreous or whitish. Abdomen dark-fuscous. Tuft and underside ochreous. Legs pale-ochreous or grey. Forewings oval-triangular, costa straight towards base, strongly arched towards apex; apex rounded, termen obliquely rounded; pale-grey; sometimes with ochreous discal spot and terminal band, the latter with irregular anterior margin, sometimes prolonged along dorsum; cilia orange-ochreous, greyish-ochreous or grey, on dorsum long. Hindwings with termen strongly rounded; 3 and 4 approximated or connate; ochreous or ochreous-grey-whitish, often suffused with fuscous towards base and dorsum; cilia concolorous.

♀. 53-55 mm. Head, thorax, palpi, antennae, wings, abdomen, and tuft fuscous.

The ♂ varies much in colouration.

Q.: Gayndah, Brisbane; N.S.W.: Sydney; S.A.: Adelaide.

35. EUPROCTIS BALIOLALIS.

Urocoma baliolalis, Swin., Cat. Oxf. Mus., i., p. 215, Pl. vi., f. 7 (1892).

♂♀. 40-48 mm. Head thorax, and antennae pale brownish-fuscous. Palpi short (½), porrect; second joint hairy; terminal joint minute; pale brownish-fuscous. Abdomen fuscous or dark-fuscous; tuft in ♂ brownish, in ♀ fuscous. Legs whitish-brown. Forewings rather narrow, elongate-oval, costa strongly arched, apex rounded, termen bowed, strongly oblique; pale-brownish-fuscous; a white terminal fascia suffused wholly, or only towards termen, with pale brownish-fuscous, anterior edge of fascia wavy; cilia whitish, tinged with pale brownish-fuscous. Hindwings with termen gently rounded; 3 and 4 connate in ♂, separate in ♀; fuscous; a terminal fascia and sometimes also costal area whitish; cilia whitish. Underside pale-fuscous with terminal white fascia on both wings, but sometimes forewings and costal area of hindwings are whitish.

N. Q.: Atherton; Q.: Brisbane, Toowoomba; Vic.: Kewell (Jas. Hill).

36. EUPROCTIS MARGINALIS.

Trichetra marginalis, Wlk., List Lep. Brit. Mus., iv., p. 845.

♂♀. 44-49 mm. Head fuscous or dark-fuscous, sometimes ochreous-tinged. Palpi short (½); fuscous. Antennae grey; pectinations ochreous-tinged. Thorax fuscous or dark-fuscous, sometimes ochreous-tinged. Abdomen dark-fuscous; tuft pale-ochreous. Legs fuscous. Forewings elongate-oval, costa rather strongly arched, apex rounded, termen slightly bowed, strongly oblique; fuscous with a few whitish scales; a continuous terminal whitish fascia from costa to tornus, its anterior edge sharply and irregularly dentate, its terminal edge more or less broadly suffused with pale-fuscous; cilia pale-fuscous. Hindwings with termen only slightly rounded; 3 and 4 connate or separate; fuscous; a broad white terminal band, sometimes prolonged along costa, narrowing to a point at tornus; cilia whitish or pale-fuscous, on tornus and dorsum fuscous.

Vic.: Gisborne; Tas.: ———; S.A.: Port Lincoln.

37. EUPROCTIS LIMBALIS.

Urocoma limbalis, H-Sch., Ausser. Schmet., i., f. 389.

♂♀.—42-54 mm. Head dark-fuscous; face ochreous-fuscous. Palpi 1; fuscous. Antennae whitish, towards base fuscous, in ♀ fuscous; pectinations ochreous-tinged. Thorax dark-fuscous. Abdomen dark-fuscous; tuft pale ochreous. Legs fuscous. Forewings elongate-oval, costa rather strongly arched, apex rounded, termen nearly straight, strongly oblique; dark-fuscous; a white terminal fascia, commencing in a point beneath apex and gradually increasing in breadth to tornus, its anterior edge wavy, its terminal edge broadly suffused with pale-fuscous; cilia pale-fuscous. Hindwings with termen only slightly rounded; 3 and 4 separate; fuscous, a broad, white, terminal band, sometimes produced along costa, narrowing to a point at tornus, in ♀ less pronounced or nearly obsolete; cilia white, on tornus and dorsum fuscous, in ♀ sometimes wholly fuscous. Underside similar.

Q.: Toowoomba; N.S.W.: Sydney; Vic.: Melbourne.

38. EUPROCTIS NIPHOBOLA.

Euproctis niphobola Turn., Trans. Roy. Soc. S. Aust., xxvi., 1902, p. 179.

The ♀ expands up to 51 mm. Hindwings with 3 and 4 approximated or stalked. The white terminal fascia of hindwings is not only interrupted in ♀ by the veins, but in both sexes is narrower than in *marginalis* and *limbalis*.

N.Q.: Townsville; Q.: Brisbane, Toowoomba, Chinchilla.

In the South Australian Museum is a small ♂ (32 mm.) labelled "S. Australia Guest Coll." with the whitish terminal spots obsolete. I think it is an aberration of this species.

Gen. 7. HERACULA.

Heracula, Moore, Proc. Zool. Soc., 1865, p. 804; Hmps., Moths Ind., i., p. 458.

Characters of *Euproctis* but palpi long, erect, reaching vertex. Type, *H. discivitta* Moore, from India.

39. HERACULA LEONINA.

Heracula leonina, Turn., Trans. Roy. Soc. S. Aust., xxvii., 1903, p. 17.

N.Q.: — — . The type of this species formerly in the Queensland Museum has disappeared. There is a specimen in the British Museum from New Guinea.

Gen. 8. DURA.

Dura, Moore, Lep. Atk., 1879, p. 56; Hmps., Moths Ind., i., p. 467.

Palpi moderate, ascending, sometimes reaching vertex; second joint long, densely rough-haired anteriorly; terminal joint very short. Thorax and abdomen without crests. Posterior tibiae with two pairs of spurs. Forewings without areole, 6 from below upper angle or short-stalked, 7, 8, 9, 10 stalked, 7 arising before 10, 11 anastomosing, connected, or at least closely approximated to 12. Hindwings with 6 and 7 separate, connate or stalked, 8 connected with cell slightly before middle.

This natural genus must be separated from *Imaus* Moore, which has 11 well separated from 12. *Dasychiroides* B.-Bak. differs only in the rounded hindwing, and is not I think tenable as a distinct genus. Type, *D. alba* Moore, from India. The genus is Papuan, extending into India and Australia.

1. Termen of hindwings angled	2.	
Termen of hindwings rounded	3.	
2. Forewings white		*marginepunctata.*
Forewings ochreous-grey		*ochrias.*
3. Hindwings fuscous		*pratti.*
Hindwings whitish		*prionodesma.*

40. DURA MARGINEPUNCTATA.

Imaus marginepunctata, B.-Bak., Nov. Zool., 1904, p. 410.

♂. 35-37 mm. Head and thorax whitish. Antennae whitish, pectinations ochreous-brown. Palpi moderately long (1¼), porrect, with dense long hairs on inferior surface; terminal joint moderate; whitish, external surface fuscous. Abdomen whitish. Legs whitish. Forewings triangular, costa rather strongly arched, apex round-pointed, termen slightly bowed, slightly oblique; whitish; four, slender, dentate, fuscous, transverse lines; first from costa near base, not reaching dorsum; second from ¼ costa to ⅖ dorsum; third from ¾ costa, curved inwards in disc and then downwards to ⅘ dorsum; fourth subterminal; costal edge fuscous towards base; a faintly marked, orbicular, fuscous ring in disc before middle; sometimes a dark-fuscous dot before middle of third line; dark-fuscous costal dots at commencement of lines; a terminal series of blackish dots between veins; cilia whitish. Hindwings suboblong, with a prominent rounded angle on vein 3; whitish; sometimes with slight grey terminal suffusion, and one or two, fuscous, terminal dots near angle; cilia whitish. Underside whitish.

N.Q.: Kuranda, near Cairns, in November, December, and February; Atherton; four specimens. Also from New Guinea.

41. DURA OCHRIAS.

Imaus ochrias, Turn., Trans. Roy. Soc. S. Aust., xxx., 1906, p. 126.

N.Q.: Thursday Island, one ♀ in Coll. Lyell, similar to ♂ but much larger (42 mm.); Cairns.

42. DURA PRATTI.

Dasychiroides pratti B.-Bak., Nov. Zool., 1904, p. 406, Pl. vi., f. 7.

♂. 44-46 mm. Head and thorax whitish. Antennae whitish, pectinations ochreous-brown. Palpi moderately long (1¼), obliquely porrect, rough-haired beneath; terminal joint moderate; whitish, external surface, except terminal joint, dark-fuscous. Abdomen grey with some whitish admixture, tuft whitish. Legs grey-whitish. Forewings elongate-triangular, costa strongly arched, apex rounded-rectangular, termen not oblique, rounded beneath; whitish, median area sometimes suffused with grey; four slender, dentate, fuscous, transverse lines; first near base; second from ¼ costa to mid-dorsum; third very acutely dentate, from ¾ costa to ¾ dorsum, curved outwards beneath costa, then strongly inwards, then downwards; fourth subterminal, with traces of a fifth line beyond and parallel; a terminal series of fuscous dots between veins; cilia whitish. Hindwings with termen rounded; fuscous; cilia whitish. Underside fuscous, dorsal and terminal areas of forewings whitish.

Probably *D. bicolora* B.-Bak. and *D. brunneostrigata* B.-Bak. are conspecific.

N.Q.: Kuranda, near Cairns, in October and December; three specimens received from Mr. F. P. Dodd. Also from New Guinea.

43. DURA PRIONODESMA, n.sp.

πριονοδεσμος, with saw-like band.

♂. 46 mm. Head ochreous-whitish. Palpi 1½; whitish; outer surface of second joint partly dark-fuscous. Antennae whitish, pectinations pale-grey. Thorax grey-whitish, tegulae ochreous-whitish. Abdomen whitish-ochreous. Legs whitish-ochreous. Forewings triangular, costa straight to beyond middle, thence arched, apex round-pointed, termen slightly bowed, oblique; 6 short-stalked, 7 arising before 10, 11 anastomosing at a point with 12; grey-whitish; markings fuscous; a dot on costa near base; an interrupted slightly wavy line from $\frac{1}{4}$ costa to $\frac{1}{3}$ dorsum; a sharply dentate sinuous line from $\frac{3}{4}$ costa to $\frac{2}{3}$ dorsum; some minute subterminal and terminal dots; cilia grey-whitish. Hindwings with termen rounded; whitish, towards base faintly ochreous-tinged; cilia whitish. Underside whitish.

T y p e in Coll. Lyell.

N.A.: Port Darwin in November; one specimen received from Mr. F. P. Dodd.

Gen. 9. E N O M E.

Enome, Wlk., List Lep. Brit. Mus., iv., p. 883.

Palpi moderate, porrect; second joint hairy; terminal joint short. Thorax and abdomen without crests, tuft moderate. Posterior tibiae without middle spurs. Forewings without areole, 7, 8, 9, 10 stalked, 10 arising before 7, 6 approximated or stalked. Hindwings with discocellulars angled, 3, 4, 5 separate, 6 and 7 connate or stalked, 8 approximated and connected with cell at about $\frac{1}{3}$. ♀ with wings much aborted.

T y p e, *E. ampla* Wlk., from India.

1 Hindwings white, forewings without discal dot	*pelospila*.
Hindwings tinged with fuscous or rosy, forewings with discal dot	*antennata*.

44. ENOME PELOSPILA.

Lymantria pelospila, Turn., Proc., Roy. Soc. Q'land, xxvii., 1915, p. 24.

N.A.: Pt. Darwin.

45. ENOME ANTENNATA.

Lymantria antennata, Wlk., List Lep. Brit. Mus., iv., 881; *Lymantria aurora*, Turn., Trans., Roy. Soc. S. Aust., xxvi., 1902, p. 181 (praeocc.); *Lymantria turneri*, Swin., Trans. Ent. Soc., 1903, p. 484.

The rosy suffusion of the hindwings is very variable in degree and may be wholly absent and replaced by fuscous.

N.Q.: Cape York, Cairns, Stannary Hills, Townsville; Q.: Brisbane; N.S.W.: Richmond River.

Gen. 10. L Y M A N T R I A.

Lymantria, Hb., Verz., p. 160.

Palpi moderate or short, porrect; second joint more or less hairy beneath; terminal joint moderate or short. Thorax and abdomen without crests. Posterior tibiae with two pairs of spurs. Forewings without areole, 7, 8, 9, 10 stalked, 10 arising before, or opposite 7. Hindwings with 3 and 4 approximated at origin, 6 and 7 connate or stalked, 8 approximated and connected with cell at, or shortly before middle. ♀ with wings fully developed.

T y p e, *L. monacha* Lin., from Europe.

1. Forewings with numerous interrupted, dark transverse lines		*nephrographa*.
Forewings with only two transverse lines	2.	
2. Forewings with discal spots whitish		*binotata*.
Forewings with discal spots dark-fuscous and ochreous		*reducta*.

46. LYMANTRIA NEPHROGRAPHA.

Lymantria nephrographa, Turn., Proc. Roy. Soc. Q'land, xxvii., 1915, p. 23.

Forewings with 10 arising opposite 7. Hindwings with 6 and 7 separate or stalked.

In the type vein 10 arises on one side after 7, but the venation of this wing is abnormal, vein 7 being connected beyond its middle by a crossbar with 8.

Q.: Mt. Tambourine, Killarney; N.S.W.: Dorrigo (South Australian Museum. A ♀ example, wings fully developed, expanding 82 mm., forewings with 10 arising on one side shortly beyond 7, on the other side absent. It seems that this species is subject to venational abnormalities.)

47. LYMANTRIA REDUCTA.

Darala reducta, Wlk., List Lep. Brit. Mus., iv., p. 888.

♂. 40-45 mm ♀. 56-60 mm. Head and thorax fuscous. Antennae fuscous, pectinations ochreous-tinged. Palpi in ♂ 1, in ♀ 1½, porrect; second joint hairy beneath; terminal joint moderately long; fuscous, darker in ♂. Abdomen and legs fuscous. Forewings elongate-triangular, costa strongly arched, apex rounded, termen obliquely rounded; 10 arising before 7; pale fuscous-grey; a suffused fuscous spot on base of costa; a wavy fuscous line from ⅓ costa to about mid-dorsum; a circular, ochreous, orbicular spot outlined and centred with dark-fuscous; an irregular reniform, fairly large, dark-fuscous spot, edged anteriorly and posteriorly with ochreous, and this again with fuscous; a slender, slightly dentate, slightly sinuate, fuscous line from ¾ costa to ¾ dorsum; some obscure, darker, terminal dots; cilia pale fuscous-grey. Hindwings with termen only slightly rounded; 6 and 7 stalked; whitish with pale-fuscous terminal suffusion; in ♀ wholly pale-fuscous; a suffused fuscous spot at end of cell; cilia pale-fuscous. Underside grey-whitish with two fuscous discal spots in forewings, one in hindwings.

N.Q.: Cairns, Atherton; Q.: Gympie, Nambour, Brisbane, Dalby, Cunnamulla; N.S.W.: Lismore.

48. LYMANTRIA BINOTATA.

Leptocneria binotata, Butl., Trans. Ent. Soc., 1886, p. 386, Pl. 9, f. 3.

♂. 34-38 mm. ♀ 42-54 mm. Head whitish or whitish-ochreous. Palpi in ♂ 2, in ♀ 2½; whitish, outer surface of second joint sometimes fuscous. Antennae whitish-ochreous; pectinations in ♂ 16, in ♀ 5. Thorax whitish, grey-whitish, or whitish-ochreous. Abdomen ochreous-grey-whitish. Legs whitish or ochreous-whitish. Forewings elongate-triangular, in ♀ suboval, costa gently arched, apex rounded, termen slightly bowed, oblique; grey-whitish or whitish-ochreous; markings fuscous or grey; white-centred discal spots at ⅓ and middle, the former sometimes reduced to a dark-fuscous dot; a fuscous transverse line at ¼; a second line from ⅘ costa to ⅘ dorsum, outwardly curved beneath costa, then parallel to termen, and sometimes denticulate, sometimes obsolete; denticulate subterminal and submarginal lines more or less distinct; cilia concolorous. Hindwings with termen slightly rounded; whitish, grey-whitish, or ochreous-whitish; cilia concolorous.

In the Port Darwin form the ♂ is slightly ochreous-tinged with fuscous markings in forewing, the ♀ grey-whitish with grey markings. Butler's ♂ type from Peak Downs approximates more to the ♀ form.

N.A.: Port Darwin; Q.: Peak Downs.

Gen. 11. Euzora.

Euzora, Turn., Proc. Roy. Soc. Q'land, xxvii., 1915, p. 22; *Caragola*, Moore, Lep. Atk., p. 46; Hmps., Moths Ind., i., p. 489 (*praeocc.*).

Palpi very short, porrect; second joint hairy beneath; terminal joint minute. Thorax and abdomen not crested, tuft small. Posterior tibiae without middle spurs. Forewings without areole, 7, 8, 9 stalked, 9 separating near apex, 10 from cell. Hindwings with 3, 4, 5 well separated at origin, 6 and 7 connate or short-stalked, 8 approximated to cell at $\frac{1}{3}$ or before middle.

49. Euzora collucens.

Porthesia collucens, Luc., Proc. Linn. Soc. N.S. Wales, 1889, p. 1090.

♂. 29 mm. ♀. 35 mm. Head, thorax, and abdomen white. Palpi $\frac{1}{2}$; whitish-ochreous. Antennae white; pectinations whitish-ochreous. Legs white; anterior femora in ♂ pale-ochreous. Forewings triangular, costa gently arched, apex round-pointed, termen slightly bowed, oblique; lustrous white; there are no true markings, but owing to irregularity of surface, there appear to be two, oblique, postmedian bands; cilia white. Hindwings with termen slightly rounded; white; cilia white. Underside white.

This may be the same as *clara* Wlk. from India.

N.Q.: Atherton; Q.: Brisbane.

Gen. 12. Redoa.

Redoa, Wlk., List Lep. Brit. Mus., iv., p. 826.

Palpi moderate, obliquely porrect, thickened with appressed hairs; terminal joint concealed. Thorax and abdomen not crested. Posterior tibiae with two pairs of spurs. Forewings with areole long and narrow, 7 from about middle of areole, 8 and 9 connate or stalked from end of areole, 10 connate with them from end of areole. Hindwings with cell long ($\frac{2}{3}$), discocellulars angled, 3 and 4 widely separated at origin, 5 separate, 6 and 7 connate or stalked, 8 approximated and connected with cell at $\frac{1}{4}$.

50. Redoa submarginata.

Redoa submarginata, Wlk., List Lep. Brit. Mus., iv., p. 826; *Redoa transiens*, Wlk., Linn. Soc. Lond., Zool. vi., p. 128; *Leucoma hypparia*, Swin., Ann. Mag. Nat. Hist., (6), xii., p. 214 (1893).

♂. 37-38 mm. ♀. 41-42 mm. Head white, face orange-ochreous. Palpi 1; orange-ochreous, inner surface and base white. Antennae white, pectinations ochreous-tinged. Thorax and abdomen white. Legs white; apices of tarsi ochreous; anterior and middle pairs with a dark-fuscous spot on tibia near base, and another on base of tarsus. Forewings triangular, costa straight, slightly arched towards apex, apex pointed, termen nearly straight, slightly oblique; lustrous white with a strigulated appearance produced by small inequalities of surface; sometimes a minute blackish dot at end of cell; cilia white. Hindwings with termen nearly straight; white; cilia white. Underside white.

N.Q.: Cairns, Townsville. Also from the Archipelago, China, Ceylon, and India.

Gen. 13. ORGYIA.

Orgyia, Ochs., Schmet. Eur., iii., p. 208.

Palpi moderate, porrect, hairy beneath; terminal joint minute. Thorax with a posterior crest. Abdomen with a large dorsal crest on second and sometimes a small crest on third segment. Posterior tibiae without middle spurs. Anterior tarsi with dense tufts of hairs. Forewings with areole present, 7, 8, 9 stalked from areole, 10 separate. Hindwings with 3 and 4 connate, 5 well separate at origin, 6 and 7 stalked, 8 anatomosing with cell at about $\frac{1}{3}$. ♀ with wings minute or absent; antennae short, serrate.

Type, *O. antiqua* Lin., from Europe. Sir Geo. Hampson has recently substituted the name of *Notolophus* Germar, which is unfortunate, and used the name *Orgyia* for the genus hitherto known as *Dasychira*, which seems mischievous. When a name has been almost universally employed in one sense for about a century, to employ it in a different sense, even if it were not so changed by the adoption of an artificial mode of "fixing the type," is to reduce nomenclature into confusion. No one can tell, unless he knows the particular predilection of the author, what the name used by him really means.

1.	Hindwings yellow with blackish terminal band	*anartoides*
	Hindwings not yellow and without terminal band	2
2.	Forewings with whitish apical blotch	*athlophora.*
	Forewings without whitish blotch	*australis.*

51. ORGYIA ANARTOIDES.

Teia anartoides, Wlk., List Lep. Brit. Mus., iv., p. 804; *Teia pusilla*, Butl., Ann Mag. Nat. Hist., (5), ix., 1882, p. 88.

♂. 22-26 mm. Head ochreous. Palpi 1; ochreous. Antennae fuscous. Thorax fuscous mixed with ochreous, especially anteriorly. Abdomen dark-fuscous. Legs ochreous; anterior and middle tibiae and tarsi annulated with dark-fuscous. Forewings elongate-triangular, costa straight to $\frac{2}{3}$, thence strongly arched, apex rounded, termen nearly straight, oblique; ochreous-brown; a straight, blackish, sub-basal, transverse line; a circular darker brown spot, slenderly outlined with pale scales just beyond this above dorsum; a fuscous-brown line from $\frac{1}{3}$ costa to near mid-dorsum, anteriorly suffused, posteriorly acutely angled outwards above middle, and from this to dorsum dentate; a few, scattered, whitish scales in mid-disc, and a slender, oval, whitish ring beyond middle representing reniform; a blackish dentate line from $\frac{2}{3}$ costa, bent first outwards, and then strongly inwards, finally downwards to $\frac{2}{3}$ dorsum, followed by a brown suffusion; traces of a slender, whitish, subterminal line; cilia ochreous-brown with bars of darker brown. Hindwings with termen nearly straight; ochreous-yellow; a broad, blackish, terminal fascia; cilia ochreous. Underside of forewings ochreous; costa broadly suffused with fuscous; a short, broad, blackish, central streak from base; a blackish postmedian fascia not reaching dorsum; of hindwings as upperside.

♀. Apterous; clothed with dense hairs, dark-grey; antennae short, serrate.

Q.: Blackbutt (Tillyard); N.S.W.: Sydney; Vic.: Melbourne; Tas.: — — .

52. ORGYIA ATHLOPHORA, n.sp.

ἀθλοφορος, bearing the prize.

♂. 34-38 mm. Head and thorax pale ochreous-grey. Palpi $1\frac{1}{2}$; ochreous, upper edge fuscous. Antennae pale fuscous. Abdomen whitish-ochreous, dorsal crests fuscous. Legs whitish-ochreous annulated with fuscous. Forewings triangular, costa straight to $\frac{3}{4}$, thence strongly arched, apex rounded, termen very slightly bowed, slightly oblique; pale ochreous-brown; a blackish, obliquely transverse, sub-basal line; a dentate, fuscous, transverse line from $\frac{1}{4}$ costa to $\frac{2}{5}$ dorsum, preceded by a fine whitish line, and edged posteriorly by a narrow whitish suffusion; reniform slenderly outlined in whitish, not always distinct; a blackish, finely dentate line from $\frac{4}{5}$ costa, bent inwards below middle, and then downwards to $\frac{2}{3}$ dorsum; a whitish subapical blotch, from which proceeds a slender, interrupted whitish line to a whitish spot above tornus; an indistinct submarginal line, partly whitish, partly fuscous; cilia pale ochreous-brown. Hindwings with termen rounded; ochreous-whitish slightly suffused with fuscous towards termen; cilia concolorous. Underside of forewings pale ochreous-grey, costal area to $\frac{3}{4}$, and a transverse line at $\frac{3}{4}$ suffusedly fuscous; hindwings whitish-ochreous, a fuscous line from $\frac{3}{4}$ costa towards but not reaching tornus.

♀. Apterous; clothed with dense hairs; antennae short, serrate.

W.A.: Perth; 3 ♂ and 2 ♀ specimens received from Mr. L. J. Newman.

53. ORGYIA AUSTRALIS.

Orgyia australis, Wlk., List Lep. Brit. Mus., iv., p. 787; *Lacida postica*, Wlk., *op. cit.*, iv., p. 803; *Orgyia canifascia*, Wlk., *op. cit.*, xxxii., p. 325; *Orgyia ceylanica*, Nietner, Edinb. New Phil. Journ., xv., 1864, p. 34; *Orgyia ludekingii*, Snel., Tijd. v. Ent., 1879, p. 104, Pl. 8, f. 5.

♂. 29-33 mm. Head, thorax, and antennae fuscous. Palpi $1\frac{3}{4}$; ochreous-whitish with some fuscous suffusion. Abdomen fuscous, dorsal crests somewhat darker. Legs ochreous-whitish; anterior and middle pairs annulated with fuscous. Forewings triangular, costa moderately arched, more strongly towards apex, apex round pointed, termen straight, oblique; pale-brown; sometimes indications of a sub-basal, transverse, fuscous line; a dentate, fuscous, transverse line from $\frac{1}{4}$ costa to $\frac{2}{5}$ dorsum; a second line from $\frac{3}{5}$ costa, at first outwards, then bent strongly inwards, and again downwards to $\frac{3}{4}$ dorsum; the included median area is suffused with whitish, and contains a brownish reniform spot, partly outlined with fuscous; an obscure, whitish, subterminal line preceded by two or three short, longitudinal, fuscous streaks in costal area and followed by some fuscous suffusion; a slender interrupted, submarginal, fuscous line; cilia brown. Hindwings with termen gently rounded; fuscous; cilia fuscous. Underside fuscous.

♀. Apterous; covered with dense grey hairs; antennae short, serrate.

This description refers to Brisbane example. Males from Port Darwin and Cairns are rather smaller (22-28 mm.), the markings less distinct, and the median band infuscated, obscuring or covering the whitish area.

N.A.: Port Darwin; N.Q.: Cairns, Townsville; Q.: Brisbane; N.S.W.: Sydney. Also from the Archipelago, Formosa, Ceylon, and India.

Gen. 14. TROPOCA.

Tropoca, Turn., Trans. Ent. Soc., 1904, p. 477.

Palpi moderately long, porrect, with dense long hairs beneath; terminal joint short. Thorax with a posterior crest. Abdomen without crests but densely covered with long hairs. Posterior tibiae with two pairs of spurs. Forewings with areole usually present, 7, 8, 9 stalked from areole, connecting bar between 10 and their common stalk sometimes imperfectly or not developed. Hindwings with 3 and 4 approximated or connate, 6 and 7 connate, 8 connected with cell at or shortly before middle. ♀ with wings absent; antennae very short, serrate; posterior tibiae without middle spurs.

The following species, the only one at present referred to the genus, shows considerable variability in the venation. When the areole is absent, the position of the lost connecting bar is shown by a slight deviation and thickening of the two adjacent veins. I have one very abnormal specimen in which (1) in the right forewing the areole is absent, but indicated as just stated, (2) in the left forewing the areole is more elongate than usual and 7 is connate from its narrow extremity, (3) in the left hindwing 3, 4, 5 are stalked, in the right hindwing 3 and 4 are coincident, 3 and 5 stalked; but both hindwings are smaller than usual, and the right has a pathological notch near tornus. The ♀ is much degraded, and densely covered throughout with long hairs.

54. Iropoca rotundata.

Teara rotundata, Wlk., List Lep. Brit. Mus., iv., p. 851.

♂. 45-50 mm. Head grey-whitish. Palpi 1½; dark-fuscous. Antennae whitish irrorated with fuscous, pectinations brownish. Thorax grey-whitish, crest fuscous with some brownish hairs. Abdomen ochreous-brown, base of dorsum fuscous, underside grey-whitish. Legs grey-whitish; anterior and middle tibiae annulated with dark-fuscous. Forewings triangular, costa straight to near apex, then strongly arched, apex rounded, termen obliquely rounded; grey-whitish; markings dark-fuscous; a basal patch extending to ⅓, its posterior edge dentate on margins and middle, its centre irregularly suffused with grey-whitish; a denticulate transverse line from ⅘ costa, curved first outwardly, then inwardly, ending on dorsum before tornus; a dentate and blotched line near and parallel to this, thickened to a blotch beneath costa, again in middle, and thickened towards dorsum; cilia grey-whitish. Hindwings with termen rounded; fuscous with whitish suffusion; cilia whitish. Underside grey whitish.

♀. Wholly apterous. Head, thorax, and abdomen covered with dense, long, grey-whitish hairs. Antennae very short, slightly dentate. Legs whitish-ochreous, posterior tibiae without middle spurs.

Q.: Brisbane, Toowoomba. Both sexes from pupae found under bark of *Eucalyptus*; N.S.W.: Jervis Bay, near Nowra; a series of six ♂ and one ♀ bred from the larvae by Mr. Moss-Robinson; Vic.: Beechworth, Gisborne.

Gen. 15. Axiologa.

Axiologa, Turn., Trans. Ent. Soc., 1904, p. 477.

Palpi moderate, hairy, porrect. Antennae well pectinated in ♀. Thorax and abdomen not crested; base of abdomen densely hairy above. Posterior tibiae with two pairs of spurs. Forewings with 10 connected with 8, 9 opposite 7 to form an areole, 11 anastomosing shortly with 12. Hindwings with 5 approximated at base with 4, 6 and 7 short-stalked, 8 anastomosing with cell before middle.

As I have no material for examination, I have transcribed my former diagnosis. Type, *A. pura* Luc.

55. Axiologa pura.

Teara pura, Luc., Proc. Roy. Soc. Q'land, 1891, p. 75.

Gen. 16. OLENE.

Olene, Hb., Zutr., ii., p. 19; Hmps., Moths Ind., i., p. 452.

Palpi rather long, obliquely porrect; second joint greatly thickened by dense long hairs anteriorly; terminal joint minute, concealed. Thorax with a small posterior crest. Abdomen with a large dorsal crest on second segment. Posterior tibiae with two pairs of spurs. Anterior tibiae densely hairy, tarsi also hairy. Forewings with areole present, 8 and 9 stalked from areole, 7 connate or closely approximate, 10 well separate. Hindwings with 3 and 4 approximated at origin, 5 from shortly above angle of cell, 6 and 7 stalked, 8 approximated and connected with cell at ⅓ or before middle.

Nearly allied to *Dasychira*, from which it differs in the pronounced abdominal crest and strongly dilated palpi. Type, *O. mendosa* Hb.

56. OLENE MENDOSA.

Olene mendosa, Hb., Zutr., ii., p. 19, f. 293, 294; *Antipha basalis*, Wlk., List Lep. Brit. Mus., iv., p. 806; *Nioda fusiformis*, Wlk., *op. cit.*, v., p. 1070; *Rilia lanceolata*, Wlk., *op. cit.*, v., p. 1075; *Dasychira basalis*, Wlk., *op. cit.*, xxxii., p. 362; *Dasychira divisa*, Wlk., *op. cit.*, xxxii., p. 363; *Dasychira distinguenda*, Wlk., *op. cit.*, xxxii., p. 435; *Olene basivitta*, Wlk., *op. cit.*, xxxii., p. 436; *Dasychira sawanta*, Moore, Lep. E. I. Co., p. 340; *Turriga invasa*, Wlk., Char. Undesc. Lep., p. 15.

♂. 28-44 mm. Head, thorax, palpi, and abdomen brownish-grey. Abdomen grey-whitish, crest fuscous-brown. Legs grey-whitish mixed, especially tarsi, with brown and fuscous. Forewings triangular, costa rather strongly arched, apex rounded, termen very slightly bowed, slightly oblique; brownish-grey; markings fuscous; a sub-basal transverse line; a slightly dentate line from ⅓ costa to ⅖ dorsum; reniform partly outlined with fuscous or whitish; a dentate line from ¾ costa, at first outwardly curved, then bent inwards to beneath reniform, and again bent to end on ⅘ dorsum; an interrupted submarginal line; sometimes a large dark-fuscous spot just posterior to sub-basal line; sometimes a whitish spot in the same situation; sometimes whole of costal half of wing suffused with whitish; cilia brownish-grey, sometimes with fuscous bars. Hindwings with termen rounded; ochreous-grey-whitish; cilia concolorous.

♀. 50-60 mm. Forewings elongate-triangular, costa strongly arched, apex rounded, termen sinuate, strongly oblique; brownish, median area partly suffused with whitish; sub-basal line obsolete; a suffused fuscous streak on fold from base; a short, fuscous, subcostal streak from about ⅗, not reaching termen; sometimes a small apical whitish suffusion.

The sexes differ and the ♂ is variable, but the species is always easily recognisable. I have also several dwarfed ♀, 34-40 mm., pale-ochreous, with markings nearly obsolete.

N.A.: Pt. Darwin; N.Q.: Cooktown, Cairns, Ingham, Townsville; Q.: Rockhampton, Duaringa, Brisbane. Also from Java, Ceylon, and India.

Gen. 17. DASYCHIRA.

Dasychira, Stph., Ill. Brit. Ent. Haust., ii., p. 58.

Palpi rather long, porrect, hairy beneath; terminal joint short or concealed. Thorax with a small posterior crest. Abdomen with dense long hairs at base of dorsum but no true crest. Posterior tibiae with two pairs of spurs. Anterior tibiae and tarsi densely hairy. Forewings with areole present, 8 and 9 stalked from areole, 7 connate or closely approximated at origin, 10 well separate. Hindwings with 3 and 4 approximated or connate, 5 from shortly above lower angle of cell, 6 and 7 stalked, 8 approximated and connected with cell at $\frac{1}{3}$ or shortly before middle.

T y p e, *D. pudibunda* Lin. from Europe. A large genus, well represented in Indo-Malaya and Africa; but in Australia by only three species, two of which have a wide range outside the Australian region.

1. Hindwings with dorsal area deep-ochreous		*horsfieldi*.
Hindwings uniformly ochreous-whitish	2.	
2. Forewings whitish with fuscous-brown postmedian blotch		*ostracina*.
Forewings pale-ochreous with fuscous median streak		*securis*.

57. Dasychira horsfieldi.

Dasychira horsfieldi, Saund., Trans. Ent. Soc., 1851, p. 162; *Dasychira grotei*, Moore, Lep. E. I. Co., p. 338; *Dasychira arga*, Moore, Lep. E. I. Co., p. 339; *Dasychira kansalia*, Moore, Proc. Zool. Soc., 1879, p. 401; *Dasychira nilgirica*, Hmps., Ill. Het., viii., p. 58, Pl. 141, f. 13, 14; *Teara farenoides*, Luc., Proc. Roy. Soc. Q'land, 1892, p. 75.

♂. 45-48 mm. Head white. Palpi about 1; white, upper part of outer surface blackish. Antennae white, pectinations ochreous-brown. Thorax white with a few fuscous scales, crest mixed with fuscous and brownish. Abdomen deep-ochreous, underside and tuft whitish. Legs whitish; tibiae and tarsi with blackish dots on dorsum. Forewings elongate-oval, costa straight to near apex, thence arched, apex rounded, termen obliquely rounded; white, sometimes partly grey-whitish; slender lines and a few scattered scales fuscous; an irregularly, dentate, sub-basal line; a slightly dentate line from $\frac{2}{5}$ costa to mid-dorsum; reniform slenderly outlined with fuscous; a denticulate line from $\frac{3}{4}$ costa to tornus; an interrupted, irregularly dentate, subterminal line; a submarginal line, discontinuous on veins, the terminal ends of which are also fuscous; cilia whitish or grey-whitish irrorated with fuscous. Hindwings with termen rounded; deep-ochreous, paler towards termen; sometimes a terminal band of fuscous suffusion; cilia whitish sometimes mixed with fuscous. Underside whitish with some ochreous suffusion on basal area of forewings and dorsal area of hindwings; crescentic fuscous discal marks on both wings, sometimes also fuscous postmedian lines.

♀. 98 mm. Forewings with costa rather strongly arched; markings more suffused. Hindwings whitish with a suffused dorsal ochreous blotch.

N.Q.: Cairns, Innisfail, Townsville; Q.: Brisbane. Also from Java, Malay Peninsula, Ceylon, and India.

58. Dasychira ostracina.

Laelia ostracina, Turn., Trans. Roy. Soc. S. Aust., 1902, p. 181.

The type, which is the only example I have seen, is a ♀ in poor condition, but there appears to be a large reniform spot outlined with fuscous and with a central fuscous mark preceding the postmedian blotch on forewing. The correct locality is Cape York

59. Dasychira securis.

Psalis securis, Hb. Zutr., ii., p. 19, f. 291, 292; Moore, Lep. Ceyl., ii., Pl. 115, f. 1; *Arestha antica*, Wlk., List Lep. Brit. Mus., iv., p. 805; *Rigema falcata*, Wlk., *op. cit.*, xxxii., p. 437; *Rigema tacta*, Wlk., *op. cit.*, xxxii., p. 438; *Anticyra approximata*, Wlk., *op. cit.*, xxxii., p. 440.

♂. 40-46 mm. Head and thorax whitish-ochreous. Palpi 3; pale-ochreous with some dark-fuscous irroration on outer surface. Antennae whitish, pectinations pale-fuscous. Abdomen whitish. Legs ochreous-whitish; anterior pair pale-fuscous. Forewings elongate-oval, costa rather strongly arched, apex round-pointed, termen obliquely rounded; ochreous-brown-whitish with a very few, scattered, dark-fuscous scales; a broadly suffused, fuscous, median streak from base becoming indistinct in disc; dorsal area with slight fuscous suffusion; cilia pale-fuscous. Hindwings with termen slightly rounded; ochreous-whitish; cilia ochreous-whitish. Underside ochreous-whitish.

The only ♀ I have seen is one from South Africa sent me by Mr. A. J. T. Janse. It has the forewings narrower than the ♂, costa more strongly arched, apex acutely pointed, termen more oblique; the central streak more pronounced and expanded on termen.

N.Q.: Cairns; Q.: Rockhampton, Duaringa, Brisbane. Also from Java, Ceylon, India, and Africa.

Gen. 18. Laelia.

Laelia, Stph., Syst. Cat. Brit. Ins., ii., p. 52.

Antennae in ♂ well-developed with very long pectinations; in ♀ abbreviated with very short pectinations. Palpi rather long, porrect; second joint with dense long hairs beneath; terminal joint long (about ⅓). Thorax and abdomen without crests. Posterior tibiae with two pairs of spurs. Anterior tibiae densely hairy, tarsi also hairy. Forewings with areole present, 8 and 9 stalked from areole, 7 connate or rarely short-stalked, 10 well separate. Hindwings with 3, 4, 5 separate, 6 and 7 stalked, 8 approximated and connected with cell at about ⅓.

Type, *L. coenosa* Hb. from Europe. A genus of some size in the Indo-Malayan and African regions. It differs from *Dasychira* in the much longer terminal joint of palpi, and absence of any thoracic crest.

60. Laelia obsoleta.

Bombyx obsoleta, Fab., Ent. Syst., iii. (1), p. 463; *Laelia cremaea*, Meyr., Trans. Roy. Soc. S. Aust., xv., 1891, p. 193.

♂. 30-43 mm. Head ochreous. Palpi 3; ochreous. Antennae ochreous-whitish; pectinations very long, fuscous. Thorax and abdomen ochreous-whitish. Legs ochreous. Forewings triangular, costa straight, apex rounded-rectangular, termen straight, scarcely oblique; ochreous-whitish, with slight fuscous tinge; cilia whitish. Hindwings with termen very slightly rounded; as forewings. Underside similar.

♀. 38-44 mm. Palpi 2. Antennae short; pectinations very short (1). Abdomen with tuft and underside whitish. Wings without fuscous tinge; forewings with costa moderately arched.

N.Q.: Claudie River, Cairns, Herberton; Q.: Duaringa, Nambour, Brisbane, Mt. Tambourine; N.S.W.: Sydney.

Species unrecognised or wrongly referred to the family.

61\. *Iroa exoleta*, Swin., Cat. Oxf. Mus., i., p. 197. Perhaps not Australian.

62\. *Porthesia ? irrorata*, Luc., Proc. Roy. Soc. Q'land, 1892, p. 77.

63\. *Artaxa compacta*, Luc., Trans. Nat. Hist. Soc. Q'land, 1894, p. 106.

64\. *Artaxa usta*, Luc., Proc. Roy. Soc. Q'land, 1901, p. 76.

65\. *Euproctis pelodes*, Low., Proc. Roy. Soc. S. Aust., xvii., 1893, p. 159. Probably a synonym of *Epicoma tristis* Lew. (*Notodontidae*).

66\. *Teara erebodes*, Low., Trans. Roy. Soc. S. Aust., xvi., 1892, p. 14. A synonym of *Ochrogaster contraria* Wlk. (*Notodontidae.*)

67\. *Teara coralliphora*, Low., Proc. Linn. Soc. N.S. Wales, 1900, p. 32.

68\. *Orgyia retinopepla*, Low., Trans. Roy. Soc. S. Aust., 1905, p. 176.

69\. *Oenera heliaspis*, Meyr., Trans. Roy. Soc. S. Aust., xv., 1891, p. 192. I have not seen this species.

INDEX TO GENERA.

INDEX TO SPECIES.

Synonyms and unrecognised species in italics.

A NEW AVIAN TREMATODE.

By Eleanor E. Chase, B.Sc., Demonstrator in Zoology, University of Sydney.

(*Communicated by Professor S. J. Johnston, B.A., D. Sc.*)

(Plate xxvi.; and one Text-figure.)

Introduction.

The presence of *Holostomum* as an endoparasite of herons has been recorded by two authors. Brandes (1891, p. 594) records *H. cornu* Nitzsch and *H. cinctum* Brandes from various species of *Ardea*. Johnston (1904, p. 112) described, under the name of *Holostomum simplex*, a trematode from the intestine of the white-fronted heron *Notophoyx novae-hollandiae*, collected at Creel Bay, Broken Bay, N.S.W.

I record here the occurrence of another species of *Holostomum* in this heron, my description being based on three preserved specimens, one of which had been mounted whole, and two sectioned by Prof. S. J. Johnston, who had collected them at Terrigal, N.S.W. The limited and imperfect nature of the material, and, in particular, the lack of living specimens has prevented more than a summary description being given.

Description of the New Species.

Family HOLOSTOMATIDAE.

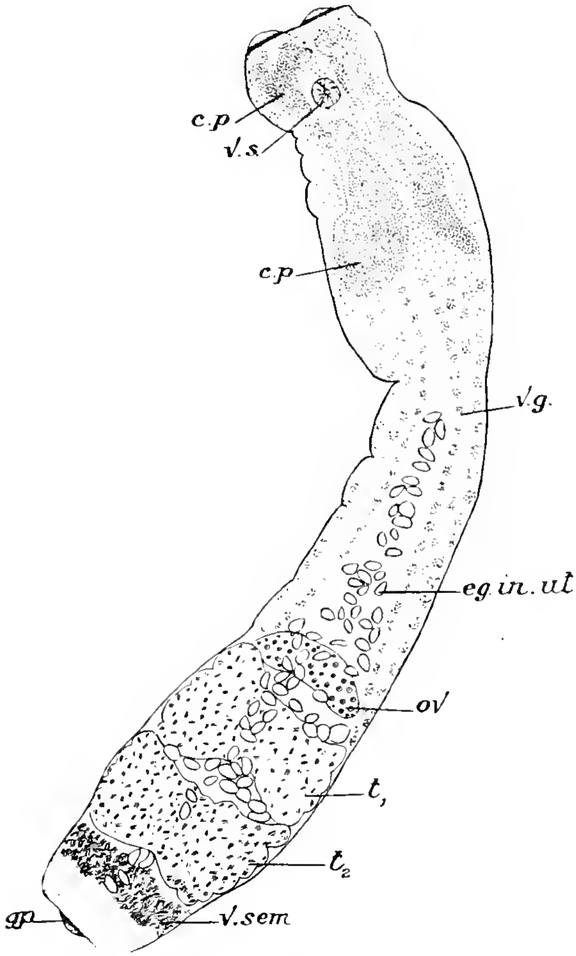
Subfamily HOLOSTOMEAE.

Genus Holostomum Nitzsch.

Holostomum repens, n.sp. (Pl. xxvi., figs. 1-5.)

External Characters.—*H. repens* is 6 mm. in length and shows the usual division into two regions, not well marked off from one another, the anterior 2 mm. and the posterior 4 mm. long. The latter is narrower than the anterior region, the diameter increasing towards the posterior end, and being greatest in the region of the testes, where it exceeds the width of the fore part of the body. In preserved specimens the dorsal surface has a concave curvature, owing to the contracted condition of the dorsal longitudinal muscle bands.

The clinging plug extends a short distance beyond the margin of the beaker-shaped anterior region, and the genital papilla also projects a short distance from the bursa posteriorly. (Text-fig. 1.)



Text.fig.1.—*Holostmum repens*, n.sp.

In all the described species of *Holostomum*, the oral sucker and the pharynx are both well-defined structures, but in *H. repens* only one cavity with thick muscular walls is found in connection with the mouth. With the limited amount of material at my disposal, a difficulty has been experienced in determining whether this structure represents an oral sucker, or pharynx, or a union of the two. In the Trematoda the absence of a pharynx is not common, although it does occur in some genera, *e.g.*, *Gorgodera*, but here the conclusion is forced upon me that the pharynx is present, and that no distinct oral sucker is represented. The posterior sucker, 0.133 mm. long, 0.095 mm. broad, with thickness of wall, 0.038 mm., opens into the narrow cavity between the dorsal body wall and the median process of the clinging plug.

The Clinging Plug.—The clinging plug comprises (1) a main ovoid mass, larger basally, divided into two lateral lobes by an oblique septum running from the dorsal body wall at half its length anteriorly to the ventral wall at its hinder level posteriorly. In this septum run the two branches of the alimentary canal and certain large excretory spaces (Pl. xxvi., fig. 4, *int. ex.*). Anteriorly the mass projects forward as two smaller lateral lobes, which end a little forward of the narrowest diameter of the cup (Pl. xxvi., fig. 3, *d. w.*); (2) a median process attached to the dorsal body wall anterior to the main lobes, narrowing distally, and enlarging into two small flattened lobes, capable of being bent over towards the ventral wall (Pl. xxvi., fig. 3, *m.d.p.*), but, when extended, reaching to the border of the cup; (3) a lamellar fold arising from the ventral body wall at the anterior level of the main mass, and expanding on both sides to form a collar embracing the median process, and the dorsal and ventral processes next mentioned (Pl. xxvi., fig. 3, *v.w.*); (4) a capitate process arising from the base of the median lobe dorsally and extending forwards to the level of the cup margin (Pl. xxvi., fig. 3, *pr*$_2$); and (5) a similar larger ventral process arising at the base of the lamellar fold, and projecting forwards to the same distance (Pl. xxvi., fig. 3, *pr*$_1$).

The main ovoid mass of the plug arises from the dorsal body wall posterior to the narrowest region of the cup (Pl. xxvi., fig. 3). It is divided into two lateral lobes, into which muscle fibres pass through the base of attachment from both an anterior and posterior direction. Vitelline glands are found throughout this division of the plug, but do not occur in any of the other processes.

The large gland spoken of by Brandes (1891, p. 360) as secreting a corroding substance, is situated just behind the base of attachment of this main dorsal mass (Pl. xxvi., fig. 2, *gl.*). The arrangement of the follicles of the gland point to the fact that the secretion is carried forward by a number of fine ducts, but no connection can be traced between this gland and certain ducts containing a definite secretion, which appear at the posterior extremity of the main mass of the plug, and run forward in the accessory processes.

The cup in which the plug lies occupies almost one third of the total body length, and is divided posteriorly into two lateral cavities by the oblique septum before mentioned (Pl. xxvi., fig. 4, *c.c.*).

Musculature.—Lying directly below the cuticle are two layers of muscle fibres, an outer circular, and an inner longitudinal layer. In addition, definite strands of oblique muscle extend through the parenchyma from the outer to the inner wall of the cup.

The region of the ventral sucker is very muscular, and it is here that the two main dorsal longitudinal bands of muscle have their origin. These bands run back below the dorsal surface to the posterior end of the body, and add greatly to the effectiveness of the plug as explained by Brandes (1891, p. 559). Contraction of these fibres causes a sharpening of the angle between the anterior and posterior regions, and the pressure of the individual parts of the plug against one another.

The dorsal median process of the clinging plug has numerous fibres at its base, and the bifid extremity is capable of being bent back on itself by the contraction of the fibres contained within these lobes (Pl. xxvi., fig. 3, *m.d.p.*).

There is a strong layer of circular muscle in the parenchyma of the wall surrounding the main ovoid mass of the plug, and it is continuous with the fibres, which run into the septum dividing the cavity of the cup (Pl. xxvi., figs. 2, 4 *cm.*).

Alimentary Canal.—Owing to the absence of a definite oral sucker as stated above, the mouth leads directly into a pharynx 0.114 mm. long, 0.057 mm. broad, with thickness of wall 0.019 mm.

The intestine is dorsal in position in fore part of the body, but (Pl. xxvi., fig. 4, *int.*) shows the two limbs crossing over in the septum to take up a ventral position in the posterior cylindrical region (Pl. xxvi., fig. 5, *int.*).

Excretory System.—There is a ramifying system of excretory vessels, but with the present imperfect specimens I am unable to give a detailed account of their distribution.

Reproductive System.—The reproductive system of *H. repens* is very similar to the description given by Brandes (1891, p. 590, Pl. xli., fig. 1) for *H. variabile*. The genital organs are, however, confined to the posterior third of the animal. The uterus, with the exception of its connection with the *vesicula seminalis*, has the same relations as in *H. variabile*. In the latter the *vesicula seminalis* opens into the uterus at the base of the genital papilla, whereas in *H. repens* it joins the female duct near the extremity of the papilla (Pl. xxvi., fig. 1).

The eggs are large, 0.095 × 0.076 mm.; 0.133 × 0.095 mm.

There are numerous vitelline glands, which extend into the anterior region, and are found in the two swollen masses of the dorsal wall of the plug (Pl. xxvi., fig. 2, *v.g.*). In the region of the reproductive organs, the follicles are confined to a ventral position, but they do occur dorsally both in front of and behind these organs.

Affinities.—*H. variabile* Nitzsch, according to Brandes (1891, p. 590, Pl. xli., fig. 1), is closely allied to *H. repens* in the general arrangement of the organs, but in shape *H. repens* is considerably more elongated, and the plug occupies a much greater proportion of the body. *Holostomum simplex* Johnston (1904, p. 112, Pl. vii., figs. 1-3), from the same host, has somewhat the same form, but the clinging plug is of a simpler type. In no other species described have I found the absence of oral sucker noted.

Host.—From the intestine of *Notophoyx novae-hollandiae*, collected at Terrigal, N.S.W.

Type No. W.544 in the Australian Museum, Sydney.

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Johnston. 1904. On some species of *Holostomidae* from Australian Birds. *Proc. Linn. Soc. N.S. Wales.*, xxix., pp. 108-116, Pl. v.-vii.

Linton. 1892. Notes on Avian Entozoa. *Proc. U.S. Nat. Mus.*, xv., pp. 87-113. Pl. iv.-viii.

Explanation of Plate XXVI.

Holostomum repens, n.sp.

Fig. 1.—Reconstruction of posterior region, showing relations of the reproductive organs.
Fig. 2.—Transverse section through the main lateral lobes of the dorsal wall of the plug.
Fig. 3.—Reconstruction of anterior region, showing various processes of the clinging plug.
Fig. 4.—Transverse section through the posterior region of the cup.
Fig. 5.—Transverse section through the testes, shell gland, uterus, vas deferens.

Explanation of Lettering for Text Figure and Plate.

b.c. bursa copulatrix; *c.c.* cavity of cup; *cm.* circular muscle; *c.p.* clinging plug; *d.lm.* dorsal longitudinal muscle; *d.w.* dorsal wall of plug; *e.g.* eggs; *eg. in ut.* eggs in uterus; *e.v.* excretory vessel; *gl.* gland; *g.p.* genital papilla; *int.* intestine; *lc.* laurer's canal; *lt.* lobes of testis; *m.d.p.* median dorsal process of plug; *m.v.d.* single unpaired vitelline duct; *ov.* ovary; *oot.* ootype; *ovid.* oviduct; *ph.* pharynx; pr_1. process arising from base of ventral lamellar wall; pr_2. process arising from base of median dorsal lobe; *r.s.u.* receptaculum seminis uterinum; *sh.g.* shell gland; t_1. anterior testis; t_2. posterior testis; *td.* transverse yolk duct; *ut.* uterus; *vd.* vas deferens; *v.g.* vitelline glands; *v.s.* ventral sucker; *v.sem.* vesicula seminalis; *v.w.* ventral lamellar wall of plug; *y.r.* yolk reservoir.

STUDIES IN LIFE-HISTORIES OF AUSTRALIAN DIPTERA BRACHYCERA.

Part i. Stratiomyiidae.

No. 1. *Metoponia rubriceps* Macquart.

By Vera Irwin-Smith, B.Sc., F.L.S., Linnean Macleay Fellow of the Society in Zoology.

(Plates xxvii.-xxviii., and 23 text-figures.)

Introduction.

During the past twelve months I have had the opportunity of collecting, in the neighbourhood of Sydney, many soil-inhabiting dipterous larvae, belonging, for the most part, to the section Brachycera. Of these, I have succeeded in rearing through to the imago, species of the families *Stratiomyiidae*, *Mydaidae*, *Tabanidae*, *Asilidae*, *Thereridae*, and *Bombyliidae*, and to the pupal stage, many other, as yet unidentified, species.

Very little work has been done, in any part of the world, on the early stages of the Brachycera, and the Australian forms have been, up to the present time, almost entirely unknown. The material now collected is therefore of considerable importance, as affording an opportunity of studying the life histories of these flies. Many gaps yet remain to be filled. In no case has it been possible to observe all stages in the development, but it is hoped that the preliminary study of the data obtained will prove useful as a basis for later, more extensive, investigations. The present paper is intended as the first of a series dealing with the biology of the group, arranged in the order of the families.

The *Stratiomyiidae*, usually placed by taxonomists at the beginning of the Brachycera series, are of special interest because of the peculiar, intermediate position which they occupy, in their mode of development, between the two great sub-orders of Diptera, distinguished by Brauer under the names *Orthorrhapha* and *Cyclorrhapha*.

Although classed with the Orthorrhapha, and developing a more or less perfect "pupa obtecta," they pass the entire pupal period within the last larval skin, which constitutes a hard, protective case, recalling the "puparium" of the Cyclorrhapha. And the opening up of this case, at the emergence of the fly, is in the form of a combination of the straight dorsal split of the Orthorrhapha, and the anterior circular split of the Cyclorrhapha.

A discussion of the significance of these characters is outside the scope of the present work. But the *Stratiomyiidae* have been taken first, both on account of the usually accepted position of the family, and because the abundance and accessibility of the material makes possible a fuller investigation of the life-history of one of this group, than is the case with the majority of the other families studied.

I wish here to acknowledge my indebtedness to Mr. G. H. Hardy, who is at present engaged on the taxonomic study of the species, *Metoponia rubriceps* Macq. with which this paper deals. It was his observation and identification of the fly in Sydney, in 1919, which afforded me the opportunity of studying its life-history, and I owe to him many helpful suggestions, and assistance with systematic work and with literature. I have also to thank Mr. C. Hedley, Acting Curator of the Australian Museum, for the facilities afforded me at the Museum for carrying out the investigation; and members of the Museum staff, generally, for their constant helpfulness during the progress of the work. To my mother I owe the preservation of living larvae over a period of two months, when, through illness and an enforced absence from Sydney, I was unable to attend to them myself. For the execution of Plate xxvii., in collaboration with myself, I have to thank my friend, Miss Edith Horrocks.

Historical.

At the end of this paper I append a list, with accompanying bibliography, of all the species of *Stratiomyidae* which have been recorded in the early stages. The latest list of this kind, of which I am aware, was published by Brauer in 1883, nearly forty years ago. In addition to being now very much out of date, its value is impaired by the incomplete way in which the references are quoted, and the lack of dates, and of a bibliography. Nevertheless, I have found it of great service, in the preparation of a revised and more up-to-date list, and have taken from it many references which I have had no opportunity of seeing elsewhere. The bibliography, which I have added, has been extended to cover, as far as possible, all works dealing in any way with the biology of the *Stratiomyiidae*. Here again I have been obliged to rely on earlier workers, and on catalogues such as those of the Royal Society and the British Museum, and the Zoological Record, for many references, since a large part of the literature quoted is not available to me. But I have endeavoured to make it as accurate as possible by a comparison of records in the various catalogues. Arranged in chronological order, and with explanatory notes, it forms in itself a brief historical review of all the work done to date on this subject. In appearance this is of considerable bulk, but its scope is limited. Certainly, more attention has been paid to the early stages of the *Stratiomyiidae* than to those of any other family of the Brachycera. Stratiomyid larvae seem to be plentiful in most parts of the world, and very often live under conditions which excite interest, or where they are readily found. But in many instances the reference to them consists merely of a record of their occurrence, and habitat, with or without a brief description of the larva. Thus Packard (1871), Lucas (1879), and Griffith (1882) note their occurrence in the salt water, and hot water of lakes and springs; Pearson (1882), the finding of a larva on a very exposed part of an ocean beach, Florentin (1899), a great mass of them in excessively saline pools in Lorraine, Markel (1844), their association with a nest of ants. The larvae which have been most frequently recorded and described are those living in water, especially the genera *Odontomyia* and *Stratiomyia*; and of these the species *Stratiomyia chamaeleon* L. has received the most attention. Being easily obtainable, these species have been used by workers engaged in a study of the comparative anatomy of the larvae of various insects, notably by Kunckel d'Herculais (1879), and Viallanes (1882 1885). But the descriptions have been, as a rule, confined to special organs, and no attempt has been made to give a general and complete account of the larval morphology and the metamorphosis of any of the *Stratiomyiidae*. Portions of the nervous system have been described, in this way, by Kunckel d'Herculais (1879), Viallanes (1882, 1885), and Henneguy and Binet (1892); the integument, by Leydig (1860), Viallanes (1882), and Plotnikow (1904); the malpighian vessels, by Vaney (1900); the pharynx, by Vaney (1902) and Jusbaschjanz (1910), and the head and mouth parts, by Becker (1910). The most important work on the development is that of Jusbaschjanz (1910), who deals in great histological detail with the development of the imaginal discs, etc.; but he gives no account of the general metamorphosis. He explains that such an account would require a much richer material than he had at his disposal at the time, and that he had not succeeded in getting many pupal stages, the few pupae he obtained being all in the later phases of development. He proposes to deal more completely, in a later work, with the phenomena of metamorphosis and development; but, if the promised work has appeared, it has not been accessible to me, and I have found no record of it in the catalogues. I have not seen Swammerdam's book (1737), but, according to Jusbaschjanz, he describes the metamorphosis of *Stratiomys chamaeleon* with an accuracy remarkable in such an early work. Good descriptions of the external features of larvae exist in various papers dealing with individual species; but the most important works, from a systematic point of view, are those of Brauer (1883), and Lundbeck (1907). Although Brauer deals with dipterous larvae in general, his work is very comprehensive in character. After discussing the value of larval characters in classification, and the metamorphosis of the different groups, he gives a section on the characters of the sub-orders and families, followed, in the case of the *Stratiomyiidae*, by a systematic table (p. 23) of the larval characters of the different genera. Lundbeck, in his valuable work on Danish Diptera, supplies a description of the larvae under the heading of each genus of the *Stratiomyiidae*, and finishes with a synoptic table (p. 74) of the larvae of all Danish genera.

Little or nothing is known of the life-histories, or even of the larvae, of the Australian *Stratiomyiidae*. The only published record of the early stages of any of this group, which I have been able to find, is that of Froggatt (1896), which relates to *Ephippium albitarsis* (?) Bigot.

Observations on the life-history of *Metoponia rubriceps* Macq.

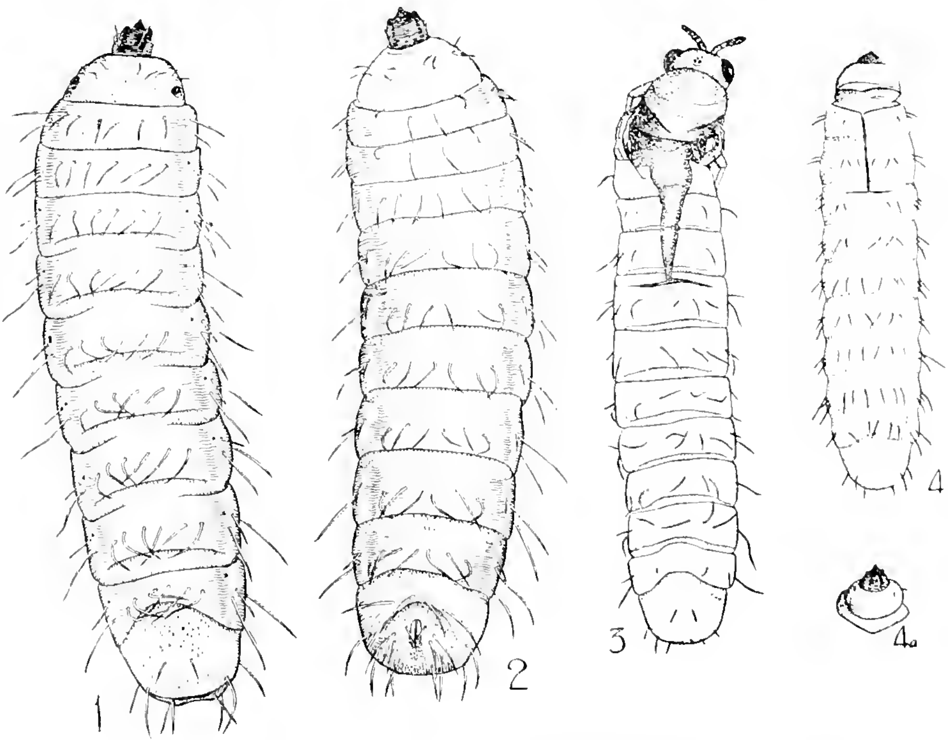
For a few weeks in the spring, and again in the autumn, this species makes its appearance, in fairly considerable numbers, over grassy areas in the neighbourhood of Sydney. Well cultivated lawns seem to be specially favoured haunts, and the flies, which are small, with feeble powers of flight, are usually found on, or about, the grass. They seldom rise far above the ground, though in the autumn of this year, one female specimen was captured on a window of the third floor of the Australian Museum. Like most Stratiomyids, they are sluggish in their habits, and remain for long periods at rest on the grass blades, where they are easily caught by inverting a glass tube over them. Mr. G. H. Hardy informs me that he has taken specimens from the middle of March to the end of April, and in the early part of November, but has never seen them at other times of the year.

The present investigation into the life-history was begun in May, 1919, when I received from Mr. Hardy a specimen tube containing a cluster of eggs on a grass blade, with the information that they were deposited by *Metoponia rubri-*

ceps within a few hours of her capture on the morning of the 16th April. Owing to an accidental delay in transmission, they did not reach me for nearly three weeks, during which time they had become shrivelled and dry, and, though kept undisturbed for another month, they failed to hatch out.

Attempts to secure further batches of eggs, by confining the two sexes in breeding cages containing grass sods, all proved unsuccessful. It was found that the flies, for the most part remained motionless in the one position from the time they were put into the cage until their death, a period varying from three to ten days; and no case of oviposition was observed.

In the following November Mr. Hardy directed my attention to the re-appearance of *M. rubriceps* on a grass plot behind the Australian Museum, with the suggestion that this might prove a natural breeding ground for it.



Text-fig. 1. Larva of *Metoponia rubriceps* Macq. Dorsal view. (x 10).
Text-fig. 2. " " Ventral view. (x 10).
Text-fig. 3. *M. rubriceps.* ♀ emerging from larval skin. (x 6¾).
Text-fig. 4. *M. rubriceps.* Empty larval skin of ♂. (x 6¾).
Text-fig. 4a. Detached 'head cap' of larval skin. (x 6¾).

Here a small sloping bank thirty feet long by twelve feet wide, in the middle of an asphalted courtyard, has been formed by laying down sandy black loam, to a depth of one to two feet, on a rubble foundation of broken bricks and stones, and planted with paspalum and couch grass, interspersed with dandelion plants and other weeds. It is kept well tended, and always contains a fair amount of moisture, so that the grass grows well, with thick rhizomes and closely matted roots.

On the 7th November a small portion of this turf was dug up, and a search made for larvae in soil spread out over a white concrete path. Together with numerous Hymenopteron and Coleopteron larvae, and some cocoons of wasps, and Syrphid flies, some twenty-eight larvae were found, of an undoubtedly Stratiomyid type, ranging in size from 5 to 11 mm. (Text-figs.1 and 2). Fourteen of these were kept alive, and confined together in a small cylindrical glass pot, containing an inch or two or soil, and some small grass sods, and covered with a glass lid. As the grass decayed, fresh sods were put in at intervals of two or three weeks, and a few drops of water added with them, so that the soil was kept just slightly damp. Five months later most of the larvae were still alive, but showed very little increase in size.

On the morning of the 13th April a male *Metoponia rubriceps* was found to have emerged. This date corresponded closely with that on which the flies had been observed first on the Museum lawn in the previous year. Accordingly, on the following morning, a visit was paid to the spot from which the larvae had been taken. Here, large numbers of imagines, both males and females, were found already out, swarming above the grass in fairly rapid flight, the unusual activity being due, probably, to a period of warm sunshine following several days' rain. From Mr. Hardy I learnt that a few individuals had first appeared a week or two before, but that they had not become numerous until within a few days of this time.

Larvae were found to be present in the soil in much greater numbers than had been observed in the previous November. A rough search through turf taken from an area less than two feet square revealed eighty-five larvae, in all stages of development, from larvae 3.2 mm. long, to fully developed pupae in larval skins 8 to 11 mm. long. Two female imagines were found just in the act of emerging, and were killed and fixed in this position, half way out of the larval skin (Text-fig. 3). These were both taken just at the surface of the soil. In the same position, among exposed rhizomes, were many empty cases, all showing a clean-cut, circular, aperture at one end, and measuring from 7 to 11 mm. long. In several instances the anterior extremity, forming a lid-like cap to the case, was still lightly attached to it on the ventral side (Text-fig 4), but broke away with the slightest movement (Text-fig. 4*a*).

The vertical levels, in the soil, from which larvae of different sizes were obtained, were carefully noted. The fully grown larvae were all found almost on the surface, about the junctions of stems and roots, mostly wedged in between the thicker rhizomes, especially of the paspalum grass. In colour, and segmented appearance, these bear a rather striking resemblance to the larvae. From this level, down to one to two inches below the surface, fifty of the larger larvae were taken. At a slightly lower level, three to four inches down, among the finer grass rootlets, were smaller larvae, always in close association with the grass. Several were found attached by the head-capsule to roots, and one, removed from the soil with its head buried in the root of a dandelion plant, remained in this position for several hours. About eighteen inches below the surface, the sub-soil and rubble foundation of the lawn were reached. No larvae were found at, or below, this depth, and only a very few at the ten-inch level. These last were of medium size, from 5 to 8 mm. long.

For the next two or three weeks flies continued to emerge in the large glass jar, containing grass sods, in which these larvae were confined. They made their appearance successively on the 19th, 23rd, and 30th April, and 3rd and 4th May. With the exception of two females on the 23rd, these were all males. By this time most of the remaining larvae of the larger size had been chloroformed and dissected. Some twenty of them were found in various stages of pupation within the larval skin; the rest still retained the unaltered larval structure.

On the 30th April, a second imago, a male, emerged from among the larvae collected in the previous November. These two are the only ones of this collection which have emerged to date (September, 1920). Six of the larvae are still alive, but none of them show any signs of pupating as yet.

After an interval of one month, on the 13th May, the Museum lawn was again examined. Imagines were now very scarce, only one male and two females being observed. There was a corresponding scarcity of mature larvae in the soil, but numerous empty larval skins were found on, or close to, the surface. In the deeper levels, among the terminal rootlets of the grass, smaller larvae were still plentiful. Over forty were collected in a few spadefuls of earth, the smallest of them being barely 2 mm. long, while others ranged up to 6 and 7 mm. A few larger larvae were found closer to the surface. Of these, three were found to contain female pupae, two of them being dead, and already beginning to decay. From a fourth, a dead and dried, but fully-formed male imago was taken.

It seemed evident that the smaller larvae belonged to one or several younger generations which were burrowing down to pass the winter at deeper levels, as the mature larvae migrated to the surface to pupate. But it was necessary to follow them up, later on in the winter, in order to find out just what had become of them. Accordingly, on the 3rd August, another examination of the lawn was made. On this occasion the soil was very damp after five or six weeks' continual rain, and only a small area of ground, about the size of the surface of the spade, was dug up. No larvae were found close to the surface, but eighteen, varying in size from 5 to 11 mm., were found among the terminal rootlets, at a depth of three or four inches, four larvae, from 5 to 8.5 mm., a little lower down, and three from 7 to 8.5 mm. at a slightly greater depth.

It will thus be seen that larvae of very varying sizes occur at all periods of the year, and that except when they are about to pupate, most of the larvae are found always at a depth of two or three inches below the surface.

Living larvae of all sizes, from 4 to 9 mm., and of all collections, from November onwards, are still being kept under observation, though a good many have died or been lost, owing to the predations of rats and mice, which infest the laboratories of the Macleay Museum, and appear to have developed a taste for fly larvae. On several occasions glass pots left overnight uncovered, or with loosely-fitting covers, have been found in the morning with the soil overturned, and all the larvae gone.

Life-cycle.

Fargeau and Serville, as early as 1825, quoting Macquart's description of *Pachygaster ater*, made the statement that the larvae require more than a year for their complete development. And Westwood (1840) says that the larva of *Clitellaria ephippium* found by Van Roser, although more than half-grown when found, was two years in arriving at the perfect state. Later writers appear to have paid very little attention to this question of the period occupied in the life-cycle of any of the *Stratiomyiidae*. Most of them content themselves with rather vague statements, as, for instance, that "the larvae hibernate, and development takes place in the spring and summer." Tragardh, in his description of *Pachygaster minutissima* (1914) makes the observation that during the summer only small larvae can be found, from which fact the deduction is drawn that only one generation is produced annually, which hibernates in the larva-stage, conforming to the account given by Perris (1870) concerning *Pachygaster pini*. Cros, in his interesting observations on the larval habits of *Stratiomyia anubis* (1911), records that, of a dozen larvae collected on the 22nd October, 1903, four yielded imagines in the following June, while from twenty-six larvae collected on the 31st December, 1909, five flies were obtained successively on the 25th June, and on the 4th July, 1910. But he gives no account of the fate of the remainder of the larvae.

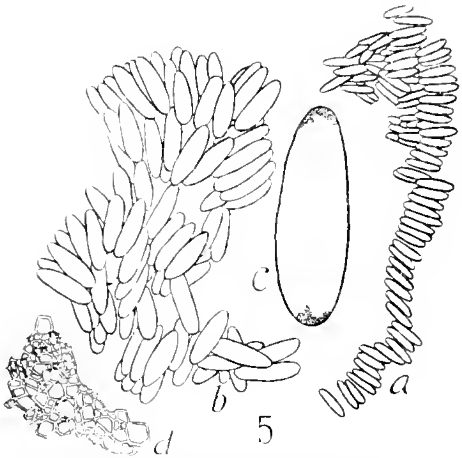
None of the larvae of *Metoponia rubriceps* have grown very much during their period in captivity, and some time must elapse before it is possible to determine the normal time occupied in larval development. However, it is already clear that, although two broods of flies appear annually, the larval period requires more than six months for its completion, and very probable that it requires considerably longer than twelve months. This may be deduced from the very slow growth of larvae in captivity, and the fact that larvae, already more than half-grown when taken in November, show no sign of pupating in the following September. Although it is not safe to arrive at definite conclusions from larvae kept under abnormal conditions, these conclusions are borne out by observations in the field, since small larvae are found at all times of the year, and larvae less than 5 mm. long five months after the last appearance of the adult flies. The smallest larva found, being only a little more than twice the size of the egg, was probably still in the first larval instar when taken, one month after the appearance of the imagines. It seems reasonable to assume that larvae of this, and perhaps the 3 and 4 mm. length, hatched from the egg during the season in which they were taken.

Unfortunately, no eggs were found in natural conditions, and, though several batches were obtained from females captured in glass tubes during the past autumn, none of them hatched out.

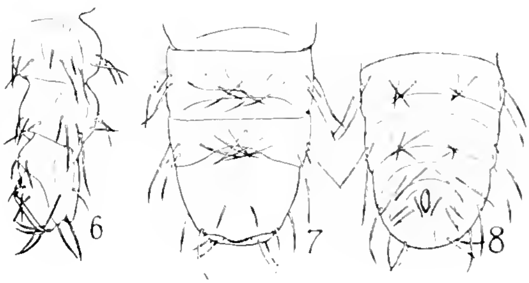
Various methods of keeping them were adopted—on damp blotting paper over a layer of damp soil, in a covered glass pot; on growing rhizomes of paspalum grass; directly on damp soil; or kept in the tube in which they were deposited. In most cases they were covered up from the light, and care was taken to prevent them from becoming completely dry. Under dry conditions they soon shrivelled up, while, when conditions were at all damp, the eggs were continuously thickly coated with fine beads of moisture, and many of them were found to be infested with fungus after a short time. However, a fair number retained their normal shape and appearance for ten weeks or more, but in no case did they show any sign of development. It is possible that all these eggs were infertile.

Oviposition.

Gravid-looking females taken during the morning, between 10 and 11 o'clock, usually oviposited very rapidly, the egg-laying being finished before midday. Usually the eggs were laid on the side of the glass tube, sometimes on cotton-wool. In one instance they were placed in a single, fairly even row, along the side of the vessel, adhering to one another laterally, and to the vessel by means of a sticky substance with which they are coated (Text-fig. 5*a*). But all the others laid in tubes, as well as those obtained in the single instance in which one female oviposited on soil in a breeding cage, formed one or two clumps, the eggs being piled up irregularly on one another, though often remaining in contact at the pole (Text-fig. 5*b*).



Text-fig. 5. *a*, Egg cluster *M. rubriceps*. (x 5); *b*, egg cluster. (x 10); *c*, single egg. (x 32); *d*, sculpturing on chorion of egg. (x 193).



Text-figs. 6–8. Posterior end of larva of *M. rubriceps*. Fig. 6. Lateral view. Fig. 7 Dorsal view. Fig. 8. Ventral view. (x 10).

The number of eggs deposited, in each case, by four females was carefully counted. The numbers were, respectively, 130, 163, 164, and 181. If these figures represent anything like the normal number, the fecundity of this species is much lower than is the case with *Stratiomyia chamaeleon* Deg., for which Mik (1896) gives the figure 636.

The Egg.

The eggs are opaque white in colour, and elongated oval in outline, slightly broader at one end than the other (Text-fig. 5*c*). They measure from .80 to .88 mm. in length, and .22 to .27 mm. in diameter. The chorion is thin, and its surface shows a very delicate sculpturing in the form of an irregular network of raised lines enclosing polygonal-shaped spaces (Text-fig. 5*d*). This marking can only be seen under high magnification, and when the chorion is torn away, or freed from the internal contents of the eggs by clearing. Treatment with caustic potash, or with clearing agents, such as clove and cedar oil, did not give good results, but more success was obtained when the eggs were immersed in chloroform, and afterwards cleared in xylol. They then mounted fairly well in Canada balsam.

Ecdysis.

I have been unable to determine the total number of ecdyses occurring during the larval period. Only one of the larvae kept in the laboratory has been observed to moult twice, once on the 3rd December, and the second time on the

8th June, when 8.2 mm. long. A single moulting occurred in a number of cases among the larvae taken in April and May. The majority of these were at the 7 mm. stage, but there were a few at 6, 8, 9, and 9.5 mm. Whether these lengths represent successive instars, there is not yet sufficient evidence to prove.

All the larvae escape from the old skin in much the same way. Before moulting the skin becomes dry and withered looking, much softer than when functional, and a lighter colour. The process, which usually occupies about an hour, begins by a splitting of the moult skin, along one side, from the third to the ninth or tenth segment, the larva slowly moving from side to side, and contracting. The skin of the anal region remains intact, and that of the anterior end is split off entire, between the third and fourth segments. Frequently the larva emerges from the posterior portion with its head still enclosed in this anterior "cap," which is subsequently shed. The empty moult skin stands out stiffly, retaining the same size and shape as when the larva is still enclosed in it.

The new larval skin is a delicate white or creamy colour, its surface flecked with glistening particles, and showing the typical hexagonal pattern very distinctly. It assumes a brownish tinge only very slowly, and is still light in colour at the end of several weeks. Older larvae show the more normal grey-brown colour, which tones very well with the soil in which they live. The coating of particles of dirt which invests most of them increases this resemblance to their environment.

Pupation.

During the period of pupation the larval skin becomes much darker, and assumes a dry, rigid appearance, by which the condition is easily recognised, although there is no change in outward form. Larval skins of male pupae measure from 7 to 8 mm., those of females from 10 to 11 mm. For some time before the emergence of the adult fly the pupating larva is quite motionless, and to all appearances dead. One found in this condition on the 13th April, did not emerge until the 30th April, so that the pupal stage occupies at least eighteen days. This is a longer period than is given by Jusbaschjanz, who states that the pupal stage lasts eleven to thirteen days.

Larval habits.

The larvae are all extremely sluggish in their movements. Usually they remain quite immobile for five or ten minutes after being disturbed; then begin slow movements of contraction, and, if lying ventral side uppermost, roll over, and crawl slowly and stiffly along, seeking to take cover beneath the soil, a process which occupies half an hour or more. On a hard surface, or a layer of soil too thin to burrow into, their rate of progression is of the order of 5 to 10 mm. in ten minutes. Larvae confined in glass pots in the laboratory are usually found wedged among the roots of grass soon after the fresh sods are put in with them, and sometimes adhering to a root by the head capsule. It is evident that their main, if not only, source of nourishment is in the juices of the living plant. But I have never been able to detect any scars, or perforations, or other evidences of injury on the roots, and, even where the larvae are very numerous, the grass which harbours them shows no ill-effects from their presence. While living normally in soil in which a fair degree of moisture is present, they are able to sustain life in much drier conditions. Individuals left for twenty-four hours or more, without soil, in a dry Petri dish, showed no ill-effects from the experience. Others, covered with a thin layer of sandy soil, which, owing to evaporation, soon became quite dry, were still alive, and quite healthy after several days. But larvae which had been placed in small porous flower pots, planted with grass, were found quite dead, dry and shrivelled, together with the grass, when, owing to a week's enforced neglect, the soil had been allowed to become dry and caked hard. Returned to damp conditions none of them showed any signs of reanimation. In their powers of resistance to desiccation, therefore, they are strikingly different from the aquatic species of *Stratiomyia* observed by Cros (1911), and by Laker (1880). The former records having kept larvae of *Stratiomyia anubis* in a phial containing 15 mm. depth of completely dry sand for seven months before the emergence of the imago. And Laker found a living larva of a *Stratiomyia* sp. in the dry sand at the bottom of a box formerly used as an aquarium, after it had been emptied of water, and stored in a cellar for fully three months.

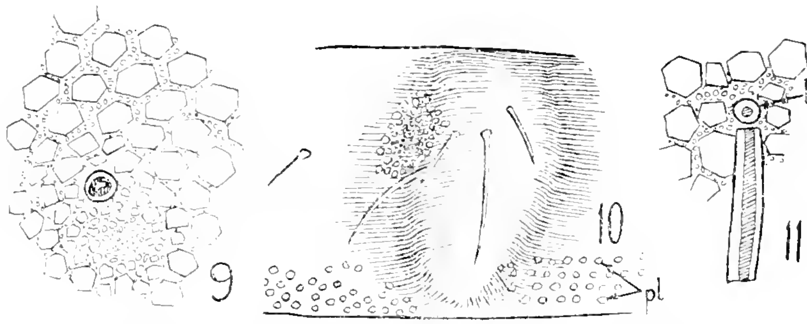
Description of the larva.

The larvae are very similar in general appearance to those of the genus *Sargus* Fabr., as described by Brauer (1883), and Lundbeck (1907). But the *Sargus* larva, like those of all other Stratiomyids, is said to have only eleven post-cephalic segments, whereas a lateral view of *Metoponia rubriceps* shows that twelve segments are actually present. From a dorsal aspect only eleven segments are seen (Text-fig. 1), and in ventral view another segment is not readily distinguishable. But, when viewed laterally, it is seen that what appears to be the terminal segment, consists, really, of the imperfectly fused eleventh and twelfth, the twelfth segment being directed ventrally, and divided off from the eleventh by a very oblique line (Text-fig. 6).

The segments are all much broader than long, and of uniform width from the second to the tenth; the terminal segments are slightly narrower. The body is elongate, and, in the older larvae, flattened dorso-ventrally. Younger larvae are more nearly cylindrical, larvae of 4 mm. length having a lateral diameter of 1.0 mm., and a dorso-ventral of .93 mm., whereas the corresponding proportions in a larva of 9 mm. length are 2.0 and 1.6 mm. In transverse section the segments have the shape of a bi-convex lens, with the lateral edges expanded into tumid ridges, marked off from the main body, on both surfaces, by a shallow groove. The eleventh segment is somewhat spatulate, with a median and two lateral convexities on the dorsal surface (Text-figs. 1 and 15). Between the segments, the body is slightly constricted, and, in contraction, the segments are imbricated, overlapping from behind forward in front of the fourth segment, and in the reverse direction from the fourth backward. The incisure between the tenth and eleventh segments is strongly arched forwards (Text-fig. 1).

At the anterior extremity is situated the dark brown, strongly chitinised head, which can be retracted into the first thoracic segment.

Integument.—The whole body is invested in a thick, firm integument of the typical stratiomyid type, consisting of large hexagonal plates, separated by granular areas, which cause a grating sound when scratched with the point of a needle (Text-fig. 9). This armoured coat is strongly impregnated with carbonate of lime. Fixation in Carl's fluid, containing glacial acetic acid, gives rise to a rapid and long continued evolution of gas, proved, with baryta water, to be CO_2. Along the posterior margin of each segment (Text-fig. 10) are two or three transverse rows of specially differentiated amber-coloured plates (*pl*), which probably mark the points of insertion, internally, of the segmental muscles, as described by Viallanes (1882, p. 7). Similar plates are numerous on the eleventh segment, and in the region of the anus. The latter is in the



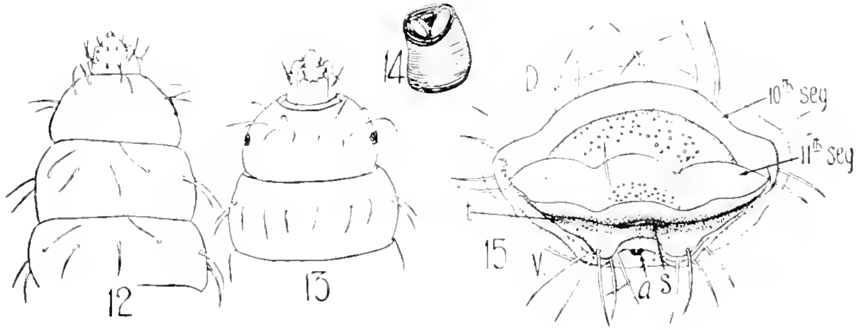
Text-fig.9. Spiracle of abdominal segment, and portion of the integument surrounding it. (x 210).
Text-fig.10. View of lateral ridge of a segment, showing spiracle on dorsal side, and arrangement of lateral bristles. (x 18).
Text-fig.11. Portion of a bristle, broken off its base (*b*). (x 210).

form of a longitudinal slit, with thick, strongly chitinised lips, situated medianly on the ventral surface of the end segment. From it a deep groove runs backwards to connect with a terminal transverse split (Text-figs. 2, 8).

Bristles.—Long, stiff, black hairs, or, rather, bristles, are present on all the segments. They are very brittle, and are easily broken off at the base, so that their regular arrangement on the body is best seen on a freshly-moulted specimen. In cross-section they are circular, and each consists of an outer brownish-coloured sheath enclosing a dark solid core, which extends almost to the tip (Text-fig. 11). Most of them taper to a fine point. As in the larvae of the genera *Sargus*, *Chloromyia*, *Microchrysa*, and in *Pachygaster minutissima* Zetr., and *Xylomyia maculata* Wied., each abdominal segment from the first to the seventh bears a transverse row of six, equally long, backwardly directed bristles on each surface. The dorsal hairs are slightly longer than the ventral, the average lengths in larvae of 2 mm. width being about 0.7 and 0.6 mm. respectively. On the dorsal surface they all slope inward, towards the mid-dorsal line; those on the ventral surface form groups of three on each side, the three converging posteriorly (Text-fig. 8). On each of the lateral ridges of the same abdominal segments is a group of four bristles, in two rows, set diagonally across the ridge, and sloping upwards and backwards from the dorsal side (Text-fig. 10). The two of the anterior row are short and blunt; the other two, which are arranged alternately with them, are more than twice as long, and sharply pointed. They are usually longer than the other body bristles, and increase in length posteriorly, the longest of them, on the seventh abdominal segment, measuring 0.8 or 0.9 mm. There is a pair of short pointed bristles on the middle of the dorsal surface of the eighth segment, a longer pair on its lateral ridges, and a transverse row of four on the ventral surface. The lower of the two lateral bristles is inserted just at the end of the terminal split.

Close to the anus, on each side, and directed towards it, is a single short bristle. Further back a pair of bristles is situated on the ridge on each side of the anal groove, and another pair on the terminal apex of the ridge, where it bounds the transverse split (Text-fig. 8).

Among these large bristles there occur on the body a few very small colourless bristles, about 0.05 mm. long. Eight of them are in constant association with the bristles bounding the transverse split, in which the aperture of tracheal chamber opens. Two are inserted above and two below the aperture, one close beside the bristle at the angle of the split, and one between each pair of apical bristles (Text-fig. 7). A similar hair occurs laterally on both surfaces of every segment, just beyond and below the outermost bristles of the transverse rows.



Text-fig.12. Anterior end of larva. Ventral view. (x 12).
Text-fig.13. ,, ,, Dorsal view. (x 12).
Text-fig.14. Prothoracic spiracle. Surface view. (x 112).
Text-fig.15. View looking down on posterior end of larva. (x 22). *t*, terminal groove; *s*, spiracular aperture; *a*, anus; D, dorsal surface; V, ventral surface

The arrangement of the bristles on the thoracic segments is somewhat different. On the dorsal surface of the first segment there are two transverse rows, with four small bristles in the first row, six in the second (Text-fig. 13). Meso- and meta-thoracic segments each bear the usual row of six on the dorsal surface. But on the ventral surfaces of the three segments there are only four. On the prothoracic segment these are arranged in two rows, on meso- and meta-thorax in a single row, with the two outer bristles directed forwards instead of backwards (Text-fig. 12). The lateral ridges bear each only a single pair of long bristles, but a small colourless hair, similar to the other microscopic hairs on the body, is also present.

Except in the relative length of the bristles, the smallest larvae found (2 to 3 mm.) are exactly similar to the fully-developed larvae. The bristles are proportionally much longer in the younger larvae, and give them a distinctly hairy appearance. The two long bristles of the lateral ridges are specially well developed, while the two smaller ones are very minute.

The Head. The head is short, and broadly conical, having a basal width of 0.48 mm., and a length of 0.57 mm. in larvae of 8 mm. length. It is deep yellowish-brown in colour, darkest in front, where it is most strongly chitinised, and divided into a median and two lateral lobes (Pl. xxvii., figs. 1, 2). The median lobe terminates in a small, cylindrical process, with smooth surface, and bluntly rounded tip. The lateral lobes are situated some distance further back, 0.15 mm. behind the median process. They are short, broad, rounded "bosses," with rugose surface, composed of thick, dark chitin. Behind them, in the posterior third of the head, there is, in the clear, membranous area on each side, a prominent eye-swelling, bounded by a semi-circular membrane. The greater part of the upper surface of the head is covered by a broad sclerite, presenting an irregular series of transverse ridges, with two specially prominent ones on each side (Pl. xxvii., fig. 1). In front of each of these is a small bristle. Another very small bristle is situated on each side of the median process. At the base of the eye-swelling on both dorsal and ventral sides is a stout prominent hair, about 0.32 mm. long. The ventral hair is accompanied by another very small one. Two smaller bristles, of unequal length, are situated in front of them, close to the ventral base of the lateral "boss." On either side of the mid-ventral line, on a level with the lateral "bosses," is another small bristle, and a similar pair is situated further back, towards the base of the head. There are, thus, six pairs of bristles on the ventral surface, and four pairs on the dorsal surface. All the bristles appear to be sensory in character, but none of them correspond to the jointed antennae which are said to be present on the heads of Stratiomyid larvae. If true antennae exist I have not been able to detect them. In the figure which Brauer gives of a *Sargus* larval head, he marks the lateral lobe "Fuhler," but in the *Metoponia* head this is clearly a portion of the chitinous skeleton. However, there is, on the ventral base of each lateral lobe, a curious structure having much the appearance of a spiracle. It is in the form of a shallow, cup-shaped projection, with a row of tooth-like processes projecting from its inner margin, into its cavity (Pl. xxvii., fig. 2).

The mouth parts are small, and difficult to distinguish, on account of the dark colour and density of this part of the chitinous skeleton. They consist of the median process, which probably corresponds with the structure called by Becker (1910) the upper lip, and two pairs of small, pointed scale-like processes lying close against its under side (Pl. xxvii., fig. 2). The two inner processes are bent over towards each other at the tip, and so are somewhat hook-shaped; the outer are sharply pointed. In structure and arrangement, these mouth parts differ considerably from those described by Becker and others for Stratiomyid larvae, and will be considered more fully in a later paper.

Stigmata.—The two prothoracic spiracles, situated close to the lateral margins of the segment, are large and prominent, dark brown in colour, and slightly salient. They appear to be exactly similar to those of *Pachygaster minutissima*, as described by Tragardh (1914). Two narrow oval slits open on a flat surface, with a regular rounded outline, below which lies a larger area of chitin, of distinctive shape, shown in Text-fig. 14. A pair of very small spiracles is situated on the meta-thoracic and the first to the seventh abdominal segments, in the lateral grooves, a little in front of the middle of the segment. They are of simple structure, having a triangular aperture, bounded by a dark brown circular area (Text-fig. 9). The two main tracheal trunks terminate internally, in the last segment, in large spiracles, which open into a median pear-shaped air chamber. This communicates with the exterior by a narrow aperture with chitinous lips, situated at the bottom of the deep transverse split at the posterior end (Text-fig. 15). If the supposition that a twelfth segment is really present, is correct, this split would represent the dorsal incisure between the eleventh and twelfth segments, and the position of the posterior spiracles would correspond with that in which they are usually found in dipterous larvae having twelve segments.

Pupal metamorphosis.

In this paper I do not propose to do more than indicate in a general way the external features of the development of the pupa.

Jusbaschjanz (1910) has studied, in great histological detail, the metamorphosis of various internal organs in the larva, but says very little about the pupa, and, so far as I am aware, no description exists of the stages in the gradual change of form during its growth from the larva.

As the pupa is hidden inside the old larval skin during the whole course of its development, it is necessary to remove the skin in order to study it. At a very early stage in its metamorphosis, the pupa comes to lie free inside the skin, surrounded by a watery fluid, and retaining its connection with the skin only by means of the stigmata on each segment Its removal, therefore, is an easy matter, and is rendered still easier by the existence of lines of weakness in the skin at the points where it is subsequently split open by the emerging fly. Old, empty larval skins show the lines of cleavage very well. By a clean, circular cut round the upper part of the second thoracic segment, the portion of the case anterior to this is separated off in the form of a sort of "head-cap." In the mid-dorsal line, the circular cut dips to form a slight angle, and from this point a straight split extends down to the upper part of the first abdominal segment, where it meets a second transverse split extending nearly across the full width of the dorsal wall. After the emergence of the fly, the edges of these splits fit closely and evenly together, owing to the rigidity of the walls, so that the skin has the appearance of an entire case, with a circular aperture at one end (Text-fig. 4)

These natural lines of cleavage are found to be present from the earliest stages of pupation. The "head-cap" is easily removed by light pressure with the point of a needle, and a similar pressure opens up segments two to four, mid-dorsally, in a longitudinal direction, then circularly round the fourth segment (Text-fig. 16), so that this portion of the skin, forming a "thoracic band" can be stripped off in a single piece. By carefully cutting along the mid-dorsal line of the abdominal larval skin, the pupa can be removed, still enclosed in a delicate transparent pupal membrane.

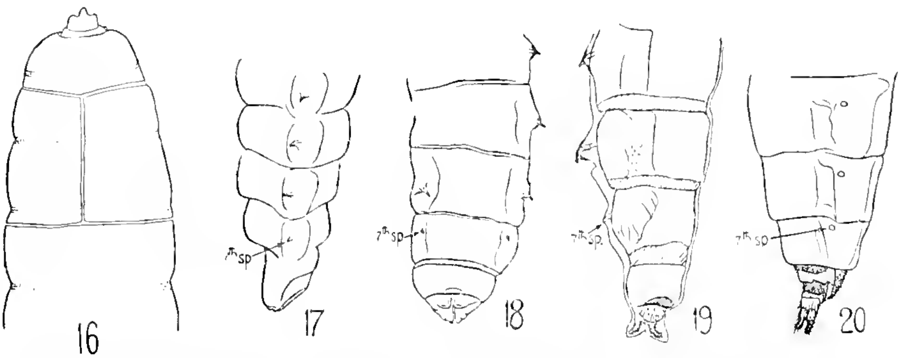
In the earliest stage of a female pupa removed in this way (Pl. xxvii., fig. 3) pupal head and thorax have become differentiated, but the abdominal segments still retain the larval shape, and differ from those of the larva only in the character of the integument, and in the presence of stout, projecting spiracles with brown chitinised tips. With this exception, the entire pupa is very soft, and pure white. No trace remains of the hexagonal armoured plates of the larval skin, or of the bristles, or other integumental structures. The enclosing membrane fits closely over the body, and, except where it is raised into "blisters" over developing appendages, it is not apparent.

The position of the mouth parts is indicated by blister-like swellings of this character. Already well defined at this early stage, they form, at later stages, much more conspicuous features of the pupal head, than do the mouth parts on the adult.

The three thoracic segments are still distinct, and the appendages of each are folded closely against its ventral surface, and do not extend beyond the segment from which they originate. In the specimen shown in Pl. xxvii., figs. 3 and 4, the appendages had been stretched out for examination, and had not completely resumed their normal closely-packed condition when figured. The segments of the antennae and the limbs are indicated only by faint grooves in the uniform, finely-granular, white matter of which all the appendages are composed at this stage.

The halteres are relatively much larger than in the imago, and appear clearly as the rudiments of meta-thoracic wings (Pl. xxvii., fig. 4).

The first appearance of colour on the body is in the region of the eye rudiments. These soft, white, rounded prominences assume a yellowish tinge about the same time that the thoracic appendages, still white and indistinctly divided into segments, unfold, and extend down over the ventral surface of the body. As the eyes deepen in colour, the yellow tinge extends over that part of the head which is orange-coloured in the adult female.



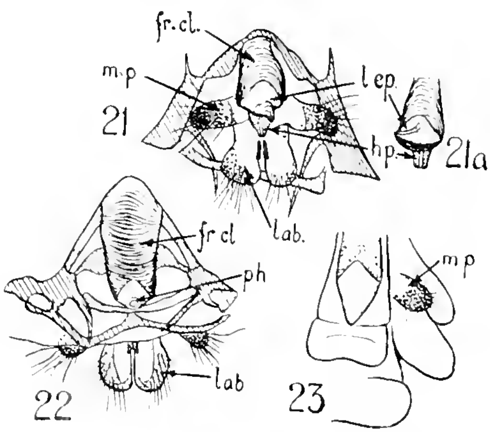
Text-fig.16. Diagram showing way in which larval case of pupa is opened up. (x 11).
Text-figs.17–20. Metamorphoses of posterior end of larva during pupation. (x 12).
Fig.17. Lateral view of early stage. Fig.18. Ventral view of later stage. Figs.19–20. More advanced pupae, lateral views. 7th sp., spiracle of 7th abdominal segment.

At this stage the terminal abdominal segment loses its larval character, and becomes slightly bilobed at the tip (Text-fig. 18), while a bilobed protuberance grows out from its ventral surface. The latter probably originates from the upper, or eighth abdominal segment, while the bilobed tip belongs to the ninth (fused) segment.

The development of this terminal, or fused eighth and ninth segment, into the external genitalia of the adult fly, is the most noticeable feature of later pupal growth. It has been followed out in more detail in the female than in the male, and is shown in Text-figs. 17 to 20. The male pupae secured did not show the same range of developmental stages, but eight distinct abdominal segments are present in all.

Other changes take the form of depositions of colouring matter, and of chitin in various parts of the body, as the segments of the appendages become more clearly defined; and the outgrowth of hairs on these segments, and of a fine pubescence on the abdomen (Pl. xxvii., fig. 6). The wing sheaths lie flat against the ventral surface of the body, and cover the first and second abdominal segments. Within them the much crumpled and folded wings can be seen, very dark in colour. The first pair of legs extends down to the tip of the wing, the second pair to the middle of the third segment, and the third pair almost to the fifth segment. The limb sheaths fit loosely over them, and are slightly constricted at the level of each joint.

The form of the sheaths for the mouth parts is shown in Pl. xxvii., fig. 7. They consist of four thin-walled vesicles, two central, upper and lower, with enlarged bilobed extremities, and a narrower one on each side, bluntly rounded at its extremity, and with a small secondary lobe attached to its upper surface. Through their walls it is possible to see portions of the developing mouth parts, at first pale yellow in colour, later darkening to a deep brown. There is a certain amount of rigidity in the pupal skin, so that the vesicles retain their shape unsupported by the underlying organs, these being much smaller than their covering. When the latter is removed it is found that the lateral vesicles enclose the maxillary palps, and the lower median vesicle the "proboscis," its bilobed extremity forming the sheath for the labellae. The parts enclosed by the upper vesicle are very small and inconspicuous, but a careful examination of them



Text-fig.21. Mouth parts of pupa dissected out from pupal sheath, surface view. (x 57).
Text-fig.21*a*. Labrum epipharynx of same.
Text-fig.22. Back view of the same.
Text-fig.23. Portion of sheath of mouth parts, showing enclosed labrum-epipharynx, and palp.
fr.cl., fronto-clypeus; *l.ep.*, labrum-epipharynx; *hp.*, hypopharynx; *m.p.*, maxillary palp; *ph*, pharynx; *lab*, labella.

when dissected out (as shown in Text-figs. 21, 22) reveals the presence of most of the structures described by Peterson (1916), and shown in his figures of *Stratiomyia apicula*. Within the proximal end of the vesicle is a small saddle-shaped piece of chitin, the fronto-clypeus, which supports, on its lower, inverted V-shaped margin, a triangular, beak-like process, projecting outward from the face, the labrum-epipharynx (Text-fig. 21*a*). In the pupa, the line of junction between the constituent parts is still visible, and the underlying epipharynx is clearly distinguishable from the labrum. Lying below this structure, and still quite separate from it, is the thin grooved hypopharynx. In the imago (Pl.

xxvii., fig 8) its basal portion is united with the labrum-epipharynx, to form the basi-proboscis, and the free distal end is scarcely distinguishable.

The tip of the labrum-epipharynx, in the pupa, does not reach beyond the proximal half of the sheath enclosing it (Text-fig. 23), and the existence of the enlarged, bilobed, distal portion is puzzling. No structure is contained within it at any stage of development. The double nature of the sheath enclosing the maxillary palp is also peculiar, but seems to suggest the presence, originally, of well-developed maxillae, with their galeae and laciniae.

Between the lateral sheaths, just below the upper median one, there are, in the very early pupal stage figured in Pl. xxvii., figs. 3 and 4, two small, thin, needle-like, chitin pieces, which are not enclosed in sheaths. These structures, which do not appear in later stages, would seem, from their position, to represent rudimentary mandibles, though no trace of mandibles exists in the imago.

Other swellings of the pupal skin, for which no apparent reason exists, occur on the head. A small double vesicle is situated between the base of the antennae, and the sheaths for the mouth parts (Pl. xxvii., fig. 7). Just below the eye on each side, in the position of the gena, is a prominent, downwardly-projecting, hollow vesicle.

Stigmata.—A pair of lateral spiracles is present on each abdominal segment from the first to the seventh. The first six pairs are very prominent from the earliest stages of pupal development, and are of complicated structure. The greater portion of each one lies outside the body wall, in the region between it and the pupal skin, which is here raised into a sharp peak, and strengthened by a funnel-shaped piece of chitin. The wide mouth of the funnel faces inwards, and serves to protect the underlying stigmatic apparatus. This consists of a pear-shaped bulb with thick muscular walls, penetrated by a fine lumen, and terminating in a long slender tube, with strongly chitinised walls, which runs through the neck of the funnel, and extends out to the larval skin (Text-fig. 19). The tip of the spiracle appears on the outer surface of the larval skin as a dark brown projection in the region of the larval stigma. A slender tracheal tube, given off from the base of the bulb, and opening independently on the pupal skin, is probably the original larval tracheal tube, the pupal spiracle being a secondary growth. These structures will be considered more fully in a later paper, dealing with the tracheal system of larva and pupa. A trachea of the ordinary type connects the base of the stigmatic bulb with a circular aperture in the body wall. Shortly before the emergence of the imago, this tube becomes detached from the body, and the whole stigmatic apparatus is left behind in the pupal skin (Pl. xxvii., fig. 9). The only trace of it which remains on the body, is a wide, deep hole, with chitin rim, on the lateral margin of each segment (Text-fig. 20).

The spiracles of the seventh pupal segment differ from the rest. They project very little beyond the body, and are of simple structure, lacking the great development of chitin supports. The reason for this is seen when the larval skin is dissected away from the dorsal wall of the pupa (Pl. xxvii., fig. 5). The first six abdominal segments correspond exactly with the segments of the larva, and are in close contact with the larval walls in the region of the spiracles. But the terminal segments undergo a considerable change in size and shape during metamorphosis, becoming telescoped to a certain extent, and reduced in width; so that a wide space is left round the posterior end of the pupa, and the seventh pair of spiracles is not opposite the corresponding pair in the larval skin, and cannot reach the exterior to function in breathing.

All the figures, for both Plate and Text-figures, were drawn at stage level, with the help of Zeiss camera lucida, and Zeiss and Reichart ocolars and objectives.

Type specimens of larva, and male and female pupae and bred specimens of both spring and autumn broods have been deposited in the Australian Museum, Sydney. [Specimens Nos. K 43304—08.]

Figures of bred specimens, both male and female, are shown on Plate xxviii.

List of the Species of Stratiomyiidae which have been Observed in the Earlier Stages, with References to the Literature Relating to These.

[To avoid unnecessary repetition the authors are quoted here only with date and page of work. The complete reference will be found in the literature list at the end, which is arranged in chronological order. The names of the species are those given in the descriptions referred to. No attempt has been made to deal with synonymy.]

Beris chalybeata Forst.—Walker, 1851, pp. 11, 12; Schiner, 1864, p. 24; Brauer, 1883, p. 58; Lundbeck, 1907, p. 69.

Beris spp.—Williston, 1908, p. 165; Verrall, 1909, p. 199.

Chloromyia formosa Scopoli.—Lundbeck, 1907, pp. 65-66, fig. 26; Verrall, 1909, p. 189.

Chorisops (*Actina*) *tibialis* Meigen.—Handlirsch, 1883, pp. 243-245, figs. 1-4; Brauer, 1883, p. 58; Lundbeck, 1907, p. 70; Verrall, 1909, p. 204.

Chrysomyia formosa Zett.—von Roser, 1834, p. 267; Cornelius (*Sargus formosus* Schrank), 1860, pp. 202-204, t. ii.; Brauer, 1883, pp. 58 and 23.

Chrysomyia polita Linnaeus.—Réaumur, 1742, t. 14, fig. 6; von Roser, 1834, p. 267; Bouché, 1834, p. 49; Scholz, 1848, pp. 1-3, 10; Beling, 1882, p. 188; Brauer, 1883, p. 58.

Clitellaria ephippium Fabricius.—Meigen, 1818, iii., p. 130; von Roser, 1834, p. 267; Westwood, 1840, p. 533, fig. 127, 8; Zeller, 1842; Markel, 1844, pp. 266, 478-480; Scholz, 1848 (?); Jaennicke, 1866, p. 226; Brauer, 1883, p. 58 (*Ephippium thoracicum*); Verrall, 1909, p. 83.

Ephippium albitarsis (?) Bigot.—Froggatt, 1896, p. 84, Pl. ix., figs. 12, 13.

Geosargus (*Sargus*) spp.—Williston, 1908, p. 165.

Hermetia albitarsis Fab.—Brauer, 1883, p. 58.

Hermetia illucens L.—Bellardi, 1861, p. 26; Brauer, 1883, p. 58; Dunn, 1916, pp. 59-61.

Hermetia spp.—Williston, 1908, p. 165.

Hoplodonta viridula Fabricius.—Lundbeck, 1907, pp. 57-58.

Microchrysa polita Linnaeus.—Lundbeck, 1907, p. 67; Verrall, 1909, p. 192.

Microchrysa spp.—Lundbeck, 1907, p. 67.

Myiochrysa spp.—Williston, 1908, p. 165.

Nemotelus pantherinus L.—Lundbeck, 1907, p. 26, fig. 7.

Nemotelus uliginosus Linnaeus.—Haliday, 1857, p. 191; Brauer, 1883, pp. 58, 23.

Nemotelus spp.—Lundbeck, 1907, pp. 23-24; Williston, 1908, p. 165.

Odontomyia angulata Panz.—Lundbeck, 1907, p. 56.

Odontomyia argentata Fabricius.—Zeller, 1842, col. 807; Zeller, 1846, iii.; Lundbeck, 1907, p. 51.

Odontomyia hydroleon Linnaeus.—De Geer, 1778, vi., Pl. 9, fig. 4; Brauer, 1883, pp. 58, 22.

Odontomyia ornata Meigen.—Réaumur, 1742, Pl. 25; Zeller, 1842; Jaennicke, 1866, p. 218; Brauer, 1883, p. 58, fig. 23*c*; Lundbeck, 1907, p. 54, figs. 20-21; Verrall, 1909, p. 143.

Odontomyia tigrina Fabr.—Lundbeck, 1907, p. 50; Jusbaschjanz, 1910, p. 685.

Odontomyia viridula Fabricius.—Scholz, 1848, p. 34; Brauer, 1883, p. 58; Jusbaschjanz, 1910, p. 685.

Odontomyia spp.—Lundbeck, 1907, p. 48; Williston, 1908, p. 165; Verrall, 1909, p. 130.

Oxycera meigenii Staeg.—Heeger, 1856, p. 335; Brauer, 1883, p. 58.

Oxycera morrisii Curtis.—Haliday, 1857, p. 193; Verrall, 1909, p. 102.

Oxycera triliniata Linnaeus.—Heeger, 1856, p. 335; Brauer, 1883, p. 58; Lundbeck, 1907, pp. 31-32, 34, fig. 14.

Oxycera spp.—Bremi, 1846, col. 164; Haliday, 1857, p. 193, Pl. 11; Brauer, 1883, p. 23.

Pachygaster ater Panz.—Meigen, 1818, vi., p. 344; vii., p. 104; Macquart, 1823; St. Fargeau, 1825, p. 779; Schilling, 1829, p. 94; Scholz, 1848, p. 1-3, 19; Dufour, 1841, p. 264; Heeger, 1853, fig.; Brauer, 1883, p. 58; Verrall, 1909, p. 71.

Pachygaster leachii Curtis.—Perris, 1870, p. 212; 1876, p. 180; Verrall, 1909, p. 78.

Pachygaster meromelas Dufour.—Dufour, 1841, pp. 264-266, figs. 17-19.

Pachygaster minutissimus Zett.—Zetterstedt, 1851, viii., p. 2961; Brauer, 1883, p. 58; Lundbeck, 1907 (*P. minutissima*), p. 21; Tragardh, 1914, pp. 192-196, figs. 3-5; Verrall, 1909, p. 68.

Pachygaster orbitalis Wahl.—Verrall, 1909, p. 75, fig. 99.

Pachygaster pini, Perris.—Perris, 1870, p. 210, ten figs.; Brauer, 1883, p. 58.

Pachygaster tarsalis Zett.—Lundbeck, 1907, pp. 20, 22, fig. 4; Verrall, 1909, p. 72, fig. 100.

Pachygaster spp.—Westwood, 1840, p. 532, figs. 127, 129; Zetterstedt, 1851, viii., p. 2961; Brauer, 1883, pp. 58, 23; Williston, 1908, p. 165; Verrall, 1909, p. 66.

Sargus bipunctatus Scopoli.—Réaumur, 1742, p. 59, Pl. 14, fig. 4, Pl. 22, figs. 5-8; Brauer, 1883, p. 58, fig. 24.

Sargus cuprarius Linnaeus.—Lyonet, 1832, Pl. 17, figs. 21-24, 29; Bouché, 1834, p. 48, Pl. 4, figs. 31-36; von Roser, 1834, p. 267; Westwood, 1840, p. 533, fig. 127, 10; Dufour, 1846 (Comptes rendus), p. 318-319; Beling, 1882, p. 187; Brauer, 1883, p. 58; Lundbeck, 1907, p. 61; Verrall, 1909, p. 184.

Sargus flavipes Meigen.—Lundbeck, 1907, p. 64.

Sargus formosus Schrank.—Cornelius, 1860, pp. 202-204, Pl. 2.

Sargus iridatus Scop.—Lundbeck, 1907, p. 62, fig. 24.

Sargus spp.—Perris, 1870, p. 206; Lundbeck, 1907, p. 60; Verrall, 1909, p. 165.

Stratiomyia anubis Wiedem.—Cros, 1911, pp. 99-103, figs.

Stratiomys chamaeleon Linnaeus.—Frisch, 1720, p. 10; Swammerdam, 1737, Pls. 39, 40, 41; Réaumur, 1742, Pl. 22; Sparmen, 1801; Schrank, 1793, pp. 7-25, Pl. 3, figs. 1-9; Geoffroy, Entom., ii., p. 17; Westwood, 1840, p. 532; Leydig, 1860, p. 157, fig.; Leydig, 1861, p. 39; Brauer, 1883, p. 58, figs. 22, 24; Mik, 1896, pp. 110-111; Florentin, 1899, p. 274; Jusbaschjanz, 1910, p. 685; Fanthom and Porter, 1913, pp. 609-620, Pl. xli.; Verrall, 1909, p. 152.

Stratiomyia potamida Meigen.—Fanthom and Porter, 1913, p. 609-620, Pl. xli.
Stratiomyia spp.—Lundbeck 1907, pp. 14-15, 41, 74.
Stratiomys furcata Fabr.—Zetterstedt, 1851, i., p. 135; Brauer, 1883, p. 57, fig. 23*a*; Lundbeck, 1907, p. 44, fig. 17.
Stratiomys longicornis Scop.—Scholz, 1848, p. 34; Friedenfels, 1880, p. 164; Brauer, 1883, p. 57, fig. 23*b*; Henneguy and Binet, 1892, lxi., pp. 309-316, Pl. 6; Lundbeck, 1907, p. 43; Cros, 1911, p. 101.
Stratiomys strigata Meigen (*nec* Fabricius) = *S. riparia.*—Kawall, 1867, p. 124.
Stratiomys strigosa.—Henneguy and Binet, 1892, cxiv., pp. 430-432.
Stratiomys spp. (Habitat).—Packard, 1871, p. 102; also in Amer. Nat., ii.; Lucas, 1879, p. 142; Laker, 1880, pp. 167-168; Brongniart, 1881, p. 419; Griffith and Packard, 1882, pp. 599-600; Pearson, 1884, p. 1287; Johnson, 1895, p. 229; Williston, 1908, p. 165.
Stratiomys spp. (Morphol.). Kunckel d'Herculais, 1879, pp. 491-494; Viallanes, 1885, pp. 75-78; Vaney, 1900, p. 360.
Stratiomys spp.—Sharp, 1901, p. 479.
Subula citripes Dufour.—Dufour, 1846, (Soc. Ent. Fr.), p. 47; Dufour, 1847, pp. 7-8, vi., Pl. xvii., fig. 12.
Subula maculata Sald.—Wesmael, 1837, Ann. Soc. Ent. Fr., vi., p. 89; Westwood, 1840, p. 534; Dufour, 1847; Zetterstedt, 1851, i., p. 130; Brauer, 1883, p. 59; Austen, 1899 (*Xylomyia maculata*), pp. 181-190; Lundbeck, 1907, p. 82; Gorham, 1899, (Ent. Mo. Mag.), p. 71; Verrall, 1909, p. 223.
Subula (*Xylophagus*) *marginata* Meigen.—Wesmael, 1837 (Bruxelles), pp. 320-322; 1837 (Ann. Soc. Ent. Fr.), p. 90; Froriep, Notizen, 1838, vi., col. 39-40; Scholz, 1848, pp. 1-3, 8-19, 49; Dufour, 1847, p. 13, Pl. xvii., fig. 13; Verrall, 1909 (*Xylomyia marginata*), p. 227.
Subula pallipes Loew.—Townsend, 1893, p. 163.
Subula (*Xylophagus*) *varia* Meigen.—von Roser, 1828, p. 188; Westwood, 1840, p. 534, fig. 127, 14; Heeger, 1858, p. 307; Brauer, 1883, p. 59.
Xylomyia (*Subula* Meig.) spp.—Lundbeck, 1907, pp. 79-80.
Zabrachia polita Coquill.—Johnson, 1906, Pl. 1, fig. 8.
Zabrachia spp.—Williston, 1908, p. 165.

Literature Dealing with the Biology of the Stratiomyiidae.

Arranged in chronological order.

1720. Frisch, J. L.—Beschreibung von allerly Insecten in Teutchland, nebst nutzlichen Anmerkungen . . . . von diesen . . . . inlandischen Gewurme. Berlin. i., 5, p. 10.
(*Stratiomys chamaeleon*, larva).

1737. Swammerdam, J. Bibha naturae. 1737-1738. London, 1758, Pls.
(*Stratiomys chamaeleon*, larva. Structure and biography described accurately and in detail with figures under the name *Asilus*).

1742. Reaumur, R. A. F. Mémoires pour servir à l'histoire des insectes. 4 vols. Paris, iv., pls.
(*Stratiomyiidae*, larvae).

1778. De Geer. Mémoires pour servir à l'histoire des Insectes. 7 vols. Stockholm. vi., Pl. 9, fig. 4.
(*Odontomyia hydroleon*, larva).

1793. SCHRANK.—Beitrag zur Naturgeschichte der *Stratiomys chamaeleon*. *Naturforscher Stuck*, xxvii., pp. 7-25, tab. iii., fig. 1-9.

1804. SPARMAN.—Schrift d. schwedischen Akad.
(*Stratiomys chamaeleon*, larva).

1822. MEIGEN, J. W.—Systematische Beschreibung der bekannten Europaischen Zweiflugeligen Insekten. Hamm, iii., p. 130; vi., p. 344; vii., p. 104.
(*Ephippium thoracium*, *Pachygaster* spp.)

1823-1827. MACQUART.—Dipt. du Nord de France. Lille, Travaux, 1823-24, pp. 59-244; 1825, pp. 324-499; 1826-27, pp. 213-291. *Lille, Mem. Soc. Sci.*, 1827-28, pp. 149-371; 1833, pp. 137-368.
(*Pachygaster* sp. larva).

1825. ST. FARGEAU and SERVILLE.—Les larves du Vappon Lat. Fabr. [*Pachygaster* Meig., Macq.] *Encyclopédie méthodique*, x., p. 779.
(Larvae received from Carcel by Macquart and described by him. His description quoted).

1828. VON ROSER.—Beitrage zur Naturg. d. Gatt. *Xylophagus*. *Naturwiss. Abhandl.*, Stuttgart u. Tubingen, ii., Heft. 2, p. 188.
(Larva of *Xylomyia varia* (*Xylophagus varius*) described).

1829. SCHILLING.—Entomol. Beitrg., i., p. 94. Tab. 8, fig. 8.
(Larvae of *Pachygaster ater* under the bark of *Pinus silvestris*).

1832. LYONET, PIERRE.—Recherches sur l'Anatomie et les Métamorphoses de différentes espèces d'Insectes. Ouvrage posthum. publié par M.W. de Haan, Paris, J. Ballière, 580 pp., 54 Planches.
(*Sargus cuprarius* larva, t. xvii., figs. 21-24, 29).
(*See* also *Paris, Mus. Hist. Nat., Mém.*, xviii., 1829, pp. 233-312, 377-457; xix., 1830, pp. 57-131, 341-455; xx., 1832, pp. 1-41.)

1834. BOUCHE, P. F.—Naturgeschichte der Insekten, besonders ihrer ersten zustande als Larven und Puppen. Berlin.
(*Chrysomyia polita*, larva, i., p.49. *Sargus cuprarius*).

1834. VON ROSER.—Wurttemb. Correspondbl., i., p. 267.
(Larvae of *Chrysomyia polita*, and *Ch. formosa* under stones; *Ephippium thoracium* larva; *Sargus cuprarius* larva).

1837*a*. WESMAEL, CONSTANTIN.—Sur les métamorphoses d'un Xylophage. (*Subula marginata*). *Bull. Acad. Sci. Bruxelles*, iv., pp. 320-322.
(Also in Froriep, *Notizen*, vi., 1838, col. 39-40.)

1837*b*. WESMAEL, CONSTANTIN.—*Ann. Soc. Ent. Fr.*, vi., Bull. Entomol. p. lxxxix-xc.
(*Subula (Xylomyia) marginata* Mg., or *Subula maculata* larva).

1840. WESTWOOD.—Introduction to the Modern Classification of Insects, ii., pp. 532-534
(Preparatory stages of *Subula maculata* found in dry rotten tree in the New Forest and imago reared. *Ephippium thoracium* larva, p. 533, fig. 127, 8. *Pachygaster* spp., p.532, fig. 127, 9. *Sargus cuprarius*, p. 533).

1841. DUFOUR, LEON.—Note sur la larve du *Pachygaster meromelas*, insecte de l'ordre des Diptères. *Ann. Sci. Nat.*, Zool., ser. 2., xvi., pp. 264-266, figs. 17-19.

1842. ZELLER.—"Dipterologische Beitrage." Oken, *Isis*, xi., col. 807-847.
(*Odontomyia argentata*, Larve in feuchten Erlengehölzen, Herbst, Winter und Frühjahr unter faulem Laube, Taubnesseln u. a. Vegetabilien. *Ephippium thoracium* larva, *Odontomyia ornata* larva).

1844. Markel, Friedrick.—Beitrage zur Kenntniss der unter Ameisen lebeden Insekten. *Germar's Zeitsch. f. Ent.*, iii., 1841, pp. 203-225; *Ibid.*, v., 1844 pp. 193-271. Ueber die Larve von *Clitellaria ephippium. Ibid.*, v., pp. 478-480.
(*Ephippium thoracium* with *Formica fuliginosa*).

1846. Bremi.—Beitrag zur Kunde der Dipteren. Oken, *Isis*, iii., col. 164-175.
(*Oxycera* spp. larvae).

1846*a*. Dufour, Leon.—Sur une colonie d'insectes vivant dans l'ulcère de l'Ormeau. *Comptes rendus Acad. Paris*, xxii., pp. 318-319.
(Larvae of *Sargus cuprarius*).

1846*b*. Dufour, L.—Quelque chose sur le *Brachyopa bicolor* et le *Subularia citripes*. *Ann. Soc. Ent. Fr.*, sér 2, iv., p. xlvii.
(*Subula citripes* larva).

1847. Dufour, L.—Histoire des Métamorphoses du *Subula citripes* et de quelques autres espèces de ce genre de Dipteres. *Ann. Sci. Nat.*, Zool., sér. 3., vii., pp. 5-14, Pl. xvii.

1848. Scholz, H.—Ueber den Aufenthalt der Dipteren wahrend ihrer ersten Stande. *Ent. Zeit. v. Breslau*, iv., pp. 1-34.
(*Stratiomys longicornis*, larve in Pfützen, p. 34; *Chrysomyia polita* larve in Kuhdünger, p. 1-3, 10; *Ephippium thoracium*, ? *Odontomyia viridula*, *Pachygaster ater*).

1851. Walker.—Dipt. Brit. i. [probably Insecta Britannica. Diptera, 3 vols.].
(Larva (?) of *Beris chalybeata*, pp.11-12).

1851. Zetterstedt J. W.—Diptera Scandinaviae. Lund., i., viii.
(Larvae of *Stratomyiidae*).

1853. Heeger, Ernest.—Beitrage zur Naturgeschichte der Insecten—Als Beitrage zur Fauna Oesterreichs. *Sitz. k. Akad. Wiss. Wien*, x., pp. 7-30, 161-178, 460-481.
(Figure of *Pachygaster ater*).

1856. Heeger, E.—Neue Metamorphosen einiger Dipteren. *Sitz. k. Akad. Wiss. Wien*, xx., pp. 335-350.
(*Oxycera meigenii*, *Oxy. triliniata*).

1857. Haliday, A. H.—*Nat. hist. review*, iv., pp. 177-196. On some remaining blanks in the natural history of the native Diptera (Larvae). List of the genera and species of British Diptera, the earlier stages of which are more or less perfectly known, with references to the principal authorities, pp. 188-195. Additional note on the metamorphosis of some species of Diptera, hitherto undescribed, or known but imperfectly. Proc., pp. 192-196.

1858. Heeger, E.—Beitrage zur Naturgeschichte der Insecten. *Sitz. k. Akad. Wiss. Wien*, xxxi., pp. 295-309. (*Subula varia*, p. 307.)

1860. Leydig, Franz. Über Kalkablagerung in der Haut der Insecten. Larve von *Stratiomys chamaeleon*. *Arch. f. Naturg.*, xxvi., pp. 157-160.

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1861. Leydig, Franz. *Berlin. Ent. Zeit.*, v., p. xxxix.
(*Stratiomys* spp. larvae).

1861. BELLARDI, LUIGI.—Saggio di Ditterologia Messicana. *Mem. Accad Torino*, xix., pp. 201-278.

(*Hermetia illucens* larvae numerous in closets).

1864. SCHINER.—Fauna Austrica. (Diptera). Vienna. 2 vols.

(Larva of *Beris chalybeata*,i., p. 24).

1866. JAENNICKE.—Beitrage zur Kenntniss der europaischen Stratiomyiden, Xylophagiden, und Coenomyiden, sowie Nachtrag zu den Tabaniden. *Berl. Ent. Zeit.*, x., p. 218.

(*Odontomyia ornata* bred from a larva found in water near Frankfort. Larva of *Ephippium thoracium* taken by von Heyden in a nest of *Formica fuliginosa*, p. 226).

1867. KAWALL.—Miscellanea entomologica. *Stett. Ent. Zeit.*, xxviii., pp. 117-124.

(Transformations of *Stratiomys strigata* briefly described, p. 124. Larva found among black ants in an old fallen *Pinus sylvestris*).

1870. PERRIS.—Histoire des Insectes du Pin maritime. *Ann. Soc. Ent. Fr.*, sér. 4, x.

(*Pachygaster pini* larva, p. 210).

1871. PACKARD.—The larvae of an unknown *Stratiomys* found in salt water, Clear Lake, California. Amer. Jour. Sci. Arts, New Haven, (3), vii., p. 102. (*See* also Amer. Nat., ii.).

1876. GANIN.—Materialen zur Kenntniss der post embryonalen Entwickelungsgeschichte der Insekten. *Protokolle der Sitzungen der Sektion fur die Zoologie und vergleichende Anatomie der 5. Versammlung russischer Naturforscher und Aerzte in Warschau*, Sept. 1876, Mitgeteilt von Hoyer.

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1879. KUNCKEL d'HERCULAIS, J.—Recherches morphologiques et zoologiques sur le système nerveux des Insectes diptères. *Comptes Rendus*, lxxxix., pp. 491-494.

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(Larvae of *Stratiomys* in winter. Habits).

1880. FREIDENFELS, E. VON.—Ueber *Artemia salina* und andere Bewohner der Soolenteiche in Salzburg. *Mitth. d. Siebenburg Vereins f. Naturw. in Hermannst.*, xxx., pp. 112-178, Pl.

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1881. BRONGNIART.—Note sur les Tufs quaternaires de Bernouville, près Gisors. *Bull. Soc. Géol. France*, (3), viii., p. 419.

(Larva of *Stratiomys* found).

1882. VIALLANES, H.—Note sur les terminaisons nerveuses sensitives des insectes. *Bull. Soc. Philom.*, (7), vi., pp. 94-98.

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1882. VIALLANES, H.—Recherches sur l'Histologie des Insectes, et sur les phénomènes histologiques qui accompagnent le développement postembryonnaire de ces animaux. *Ann. Sci. Nat.*, (Zool.), xiv., 1, pp. 1-348. Pl. iv.

(Includes an account of integument, nerve terminations, etc., of *Stratiomys* larvae).

(*See* also *Bibl. Ecole*, xxvi., 3, p. 348, Pl. xviii.).

1882. GRIFFITH and PACKARD.—Larvae of *Stratiomyia* sp. found in a hot spring in Colorado. *Amer. Nat.*, xvi., pp. 599-600.

1882. BRAUER, F.—Die Zweiflüger des Kaiserlichen Museums zu Wien. ii. *Denkschr. k. Akad. Wiss. Wien*, xliv., pp. 59-110, Taf. i., ii.
(Discusses classification for *Xylophagus* and *Subula*, based on study of the larvae, pp.61–62).

1882. OSTEN-SACKEN.—On Professor Brauer's paper: Versuch einer Characteristik der Gattungen der Notocanthen 1882. *Berlin. Ent. Zeit.*, xxvi., p. 365.
(From arguments drawn from the imagines, larvae, mode of pupation, and nervous system of the larvae, determines the correct classification of *Subula*, etc.).

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(Includes larva of *Sargus cuprarius* and *Chrysomyia polita*, p.118).

1883. BRAUER, F.—Die Zweiflüger des Kaiserlichen Museums zu Wien. iii. Systematische Studien auf Grundlage der Dipterenlarven, nebst einer Zusammenstellung von Beispielen aus der Literatur über dieselben und Beschreibung neuer Formen. *Denkschr. k. Akad. Wiss. Wien.*, xlvii., pp. 1-100, Pls. i.-iv.
(A detailed statement of the characters of the larvae of the various sections in *Stratiomyiidae*, even to genera, pp.22-23).

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(*Stratiomys* larva occurring in sea water).

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(*Subula pallipes* larva described).

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1896. FROGGATT.—The entomology of the grass tree (*Xanthorrhoea*). *Proc. Linn. Soc. N.S.W.*, 1896, pp. 71-87, Pl. ix.
(Larva and metamorphosis of *Ephippium albitarsis*, p.84, figs. 12 and 13).

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1899. FLORENTIN.—Etudes sur la Faune des Mares salées de Lorraine. *Ann. Sci. Nat.*, (Zool.), x., pp. 209-349. Insects, pp. 274-276.
(Larval habits of *Stratiomys chameleon*, p.274).

1899. AUSTEN, E. E.—On the preliminary stages and mode of escape of the imago of the Dipterous genus *Xylomyia* Rond. (*Subula* Mg. *et. auct.*) with special reference to *Xylomyia maculata* F., and on the systematic position of the genus. *Ann. Mag. Nat. Hist.* (vii.), iii., pp. 181-190.

(*Xylomyia* represents a primitive, ancestral form of *Stratiomyiidae* given off from the common stem after the evolution of the characteristic type of larva and mode of pupation, but before the assumption on the part of the imago of the equally characteristic features (venation, spurless tibiae) exhibited by the more specialised types of the family).

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(Larva of *Stratiomyiidae*).

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1904. PLOTNIKOW.—Ueber die Hautung und uber einige Elemente der Haut bei den Insekten. *Zeitschr. f. Wiss. Zool.*, lxxvi.

1906. JOHNSON.—Notes on some dipterous larvae. *Psyche*, Boston, Mass., xiii.
(Larva of *Zabrachia polita*, pl. 1, fig. 8).

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Eggs, larvae and pupae of *Stratiomyiidae*. Habitat.

1909. VERRALL, G. H.—British flies, Vol. v. *Stratiomyidae* and succeeding families of the *Diptera brachycera* of Great Britain. London. (1-780). "Metamorphoses" by D. Sharp. pp. 31-39.

1910. BECKER.—Zur Kenntniss der Mundteile und des Kopfes der Dipteren Larven. *Zool. Jahrb. Anat.*, xxix., pp. 281-314. Pl. 18, figs. 19, 20.

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1914. TRAGARDH, I.—Skogsentomologiska bidrag 1-5. *Entom. Tidskrift*, Uppsala, xxxv., pp. 188-209. *Pachygaster minutissima* Zett., en under bark levende stratiomyid, pp. 192-196, figs. 3-5. English summary, p. 208.

1916. PETERSON, ALVAH.—The head-capsule and mouth parts of Diptera. *Illinois Biol. Monog.*, iii., 2. pp. 1-112.

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EXPLANATION OF PLATES XXVII.-XXVIII.

Plate xxvii.

Metamorphosis of *Metoponia rubriceps* Macq.

Fig. 1. Head of larva, dorsal view. × 45.
Fig. 2. The same, ventral view. × 45.
Fig. 3. Pupa; early stage. Ventral view. × 14.
Fig. 4 The same, lateral view. × 14.
Fig. 5. Dorsal wall of larval case cut away to show the enclosed pupa. × 7.
Fig. 6. Pupa; Fairly advanced stage. × 14.
Fig. 7. Head of pupa, enveloped in pupal sheath. × 28.
Fig. 8. Mouth parts of imago. × 28.
Fig. 9. Posterior end of pupal sheath, removed from larval case. × 9.

Plate xxviii.

Metoponia rubriceps Macquart.

Fig. 1. Bred specimen of male. Emerged April. Natural size, 5.3 mm. long from head to tip of tail.

Fig. 2. Bred specimen of female, drawn two days after emergence, in November. Abdomen extended to much greater length than is found in most captured specimens. Natural size, 14 mm. long from head to tip of tail.

Fig. 3. Abdomen of a captured female, dorsal view, showing the more usual appearance.

ORDINARY MONTHLY MEETING.

24TH NOVEMBER, 1920.

Mr. J. J. Fletcher, M.A., B.Sc., President, in the Chair.

Dr. JIRI VICTOR DANES, Consul General of the Czeckoslovak Republic, 40 Bayswater Road, Darlinghurst, Miss MARGUERITE HENRY, B.Sc., "Derwent," Oxford St., Epping, and Miss MARGARET HELENA O'DWYER, B.Sc., "Elstorie," Copeland St., Beecroft, were elected Ordinary Members of the Society.

Candidates for Linnean Macleay Fellowships, 1921-22, were reminded that applications must be lodged with the Secretary not later than Tuesday, 30th inst.

The Donations and Exchanges received since the previous Monthly Meeting (27th October, 1920) amounting to 6 Vols., 188 Parts or Nos., 42 Bulletins and 5 Reports, received from 40 Societies and Institutions and 3 private donors, were laid upon the table.

NOTES AND EXHIBITS.

Mr. Fred Turner exhibited and offered observations on a specimen of *Lolium temulentum* Linn., which he had received for determination from Mr. R. Baird, Multagoona, Darling River, who had never hitherto seen it growing in the district. The seeds of this exotic grass are considered injurious, and if eaten are said to produce drowsiness, headache, and vertigo. According to Sir J. D. Hooker and the Revd. Canon Tristram, "this species is identical with the 'Tares' of Scripture, and is one of the worst weeds in the wheat crops of Palestine, and the only grass with a poisonous seed."

Mr. W. W. Froggatt exhibited specimens of the Bag Shelter or Boree Moth, *Teara contraria*, showing the masses of eggs covered with the down off the tips of their bodies. One of the egg masses contained a number of eggs of a parasitic moth, the larvae of which feed upon the eggs of the Boree Moth and pupate under the cover of the egg down. The larvae of this Bag Shelter Moth every year strip the foliage from thousands of Boree trees, *Acacia pendula*, one of the most valuable fodder trees in Australia.

Mr. G. A. Waterhouse exhibited *Tisiphone rawnsleyi* ♂ and *T. abeona* ♀ which he had paired, together with 3 ♂ and 2 ♀ obtained from this cross and also two small families obtained by pairing these first generation specimens. One family consisted of 2 ♂, 1 ♀, and the other of 1 ♂, 2 ♀. Also four specimens of the first generation obtained by crossing *T. abeona* ♂ with *T. rawnsleyi* ♀. Also *Heteronympha mirifica* and *H. paradelpha* reared from larvae, together with dead pupae of both species.

Mr. H. J. Carter exhibited (i) specimens of each of the six Australian genera of *Chalcophorinae* (*Buprestidae*). These six genera were at an earlier period all classed as *Chalcophora* though they are clearly differentiated in modern work: (ii.) specimens of three closely allied *Cyphogastra*, concerning two of which there is some confusion in Kerreman's "Monographie": (iii.) *Cyrioides sex-spilota* Carter recently collected by Mr. H. W. Brown on the Johnstone River, Q.: (iv.) an example of a new genus taken by Dr. E. W. Ferguson at Port Macquarie and (v.) a new species of *Stigmodera* from the Blue Mts.

Dr. A. B. Walkom exhibited a number of seeds associated with *Glossopteris* in rocks of Permo-Carboniferous age from Three-mile Creek, on the Bowen Coalfield, Queensland.

Mr. J. J. Fletcher exhibited specimens of *Persoonia lucida* R.Br., from the Lane Cove district, being portions of the only two plants, both solitary, he had ever seen growing. The opinion was expressed that this species needs further investigation.

A REVISION OF THE CHIROMYZINI (DIPTERA).

By G. H. Hardy

(Plates xxix.-xxx.)

Miss Irwin Smith's paper on the larva of *Metoponia rubriceps* Macquart, has made it necessary to study the genus and its allies in a more comprehensive manner than has been done hitherto, so that the position of the species may be adequately determined and the genus may be distinguished from the allied genera of the world.

The literature on the group of *Stratiomyiidae*, here placed in the tribe Chiromyzini, shows considerable disagreement of ideas concerning the relative value of characters hitherto used for grouping the species into genera, so the system independently adopted here was based on the study of Australian forms only.

Attention is drawn to the fact that various genera hitherto proposed were founded upon venation characters, in accordance with the usual custom of grouping the *Stratiomyiidae*, but such a treatment is not only impossible with the species under discussion, as shown in this study, but also will have to be abandoned as a main factor in grouping other species of *Stratiomyiidae* before a natural classification of the family can be attained.

It is scarcely to be expected that any alteration will be made upon the principles underlying the present scheme of treating the genera under the tribe Chiromyzini, but it is possible that the genus *Chiromyza* is divisible into two groups, formed according to whether the eyes of the male are contiguous or separated, but this development, for obvious reasons, cannot be undertaken in this paper.

A list of species placed in this tribe is as follows:—

Metoponia Macquart. (Synonyms.—*Inopus* Walker; and *Criptoberis* White.

rubriceps Macquart. [Syn. *flavicaput* Walker, *despectus* Walker, *berbescens* White.] (New South Wales, Victoria and ? Tasmania). *gemina*, n.sp. (New South Wales).

Chiromyza Wiedemann. (Synonyms. *Xenomorpha* Macquart; ? *Nonacris* Walker; *Hulorus* Philippi; *Lagarus* Philippi; *Lagaronus* Enderlein; and *Metoponia* White, *nec* Macquart.)

vittata Wiedemann (Brazil), *ochracea* Wiedemann (South America), *fuscana* Wiedemann (Central and South America), *leptiformis* Macquart (Brazil), *australis* Macquart (Australia), *prisca* Walker (Tasmania), ? *transequa* Walker (South America), *vicina* Bigot (? Australia), *krausei* Philippi (Chile), *paulseni* Philippi (Chile), *paradoxa* Enderlein (Chile).

UNCERTAIN GENERIC POSITION.

grandicornis Hardy (*Xenomorpha*), (Tasmania).

BOREOIDES, n.gen.

subulatus n.sp. (New South Wales, Victoria, and ? Tasmania).

ALLOGNOSTA Osten-Sacken. (Synonyms.—*Metopania* Loew, *nec* Macquart and *Anacanthoberis* Brunetti.)

fuscitarsis Say [Syn.—*dorsalis* Say, *brevis* Walker, *lata* Walker, *pallipes* Wiedemann] (United States of America), *obscuriventris* Loew (Canada), *similis* Loew (United States of America), *vagans* Loew [Syn.—*inermis* Brunetti] (Europe and Asia), *crassitarsis* de Meyere (Java), *crassa* de Meyere (Java), *barbiellinii* Bezzi (Brazil), *assamensis* Brunetti (Assam).

Of the above twenty-three species the first fifteen belong to the Chiromyzini, and the eight species under the genus *Allognosta* probably belong to the same tribe.

I desire to record my thanks to Mr. J. A. Kershaw, of the National Museum, Melbourne, for the loan of specimens of Chiromyzini under his charge, which included the manuscript species, *Boreomyia subulata* Walker also to Miss Irwin Smith and Dr E. W. Ferguson who have afforded me every opportunity to examine specimens in their collections.

Tribe CHIROMYZINI.

Definition.—The antennae are situated low down on the head, are short, and are composed of three short joints, the third of which consists of several segments which are fused or almost fused, so that they are found not to form independent segments when dissected; the face recedes. The scutellum is without spines and its contour is smooth. The abdomen contains seven segments*; the male has the genitalia exposed, and the female has a protensive ovipositor containing a pair of cerci. The wings, when at rest, lie horizontally and partly overlap above the abdomen; they have a venation which is variable in each species; at most the wings contain a full complement of veins occurring in the family *Stratiomyiidae*, or certain veins consisting of the upper branch of the cubital fork, the third posterior vein, and the cross-vein between the second and fourth posterior veins may be partly or completely obsolete. The fifth posterior vein issues from the second basal cell and joins the anal vein considerably before it reaches the wing margin. The female is apterous in one genus.

Notes.—The tribe Chiromyzini is adopted here as the characters of the genera placed under it are not of sufficient importance to warrant their isolation from the subfamily *Beridinae*. Osten-Sacken made a family of the genus *Chiromyza*, and Kertesz, in his catalogue, treats it as a typical form of a subfamily under the family *Coenomyiidae* but does not associate the genus *Allognosta* with it. The genus *Allognosta* is not known to me but judging from the characters published it appears that the species placed under it belong to the tribe defined above.

Key to the genera of the tribe Chiromyzini.

1. The eyes separated in both sexes; the two basal joints of the antennae equal in length, the third joint of the male four times the length of the second and of the female only twice the length; the male with wings, the female apterous .. .. *Boreoides*, n.gen.

*All the works dealing with *Beridinae* seen by the writer state that the abdomen has seven visible segments; actually, however, there are eight visible in the female, not including the apical one, usually referred to as the ovipositor and which contains the cerci.

Both sexes with wings, other characters variable. .. ..2.

2. The male with contiguous or separated eyes; the antennae with the basal joints about equal in length, the third joint about twice the length of the second. *Chiromyza* Wiedemann.

The male with contiguous eyes; the antennae with the basal joints variable in proportion, the third joint four times the length of the second. *Metoponia* Macquart.

Genus METOPONIA Macquart.

Metoponia, Macquart, Dipt. Exot., suppl. 2, 1847, p. 28; Walker, List Dipt. Brit. Mus., v., suppl. 1, 1854, p. 112; Osten-Sacken, Berl. Ent. Zeit., xxvii., 1883, p. 297; White, Proc. Roy. Soc. Tas., 1914, p. 46; and 1916, p. 260; Hardy, Proc. Roy. Soc. Tas., 1920, p. 34.

Inopus, Walker, Ins. Saund. Dipt. 1850, p. 2; List Dipt. Brit. Mus., v., suppl. 1, 1854, p. 112; Osten-Sacken, Berl. Ent. Zeit., xxvii., 1883, p. 296.

Cryptoberis, White, Proc. Linn. Soc. N. S. Wales, xli., 1916, p. 73.

Definition.—The eyes are contiguous in the male and widely separated in the female. The antennae do not exceed the length of the head; the first joint may be ⅔ the length of the third or considerably less, the second joint is short; the third joint is rather long, at least four times the length of the second. The abdomen is depressed in both sexes, and normal in shape. The venation is variable; the radial vein may issue from the first basal cell, or it may branch off the cubital vein at a little distance from the basal cell; the upper branch of the cubital vein is usually present, but may be absent in isolated specimens; the discal cell has three posterior veins issuing from it, all of which reach the wing border. The first and second posterior veins may issue separately from the discal cell or from a point, or they may be stalked; these characters are variable within a species. The third posterior vein is never present; the fourth is normal; the fifth issues from the second basal cell and joins the anal cell considerably before it reaches the wing margin.

METOPONIA RUBRICEPS Macquart. (Plate xxix., figs. 5, 6.)

Metoponia rubriceps, Macquart, Dipt. Exot., suppl. 2, 1847, p. 28, Pl. i., fig. 4; and suppl. 3, 1848, p. 15; Walker, List Dipt. Brit. Mus., v., suppl. 1, 1854, p. 113; Osten-Sacken, Berl. Ent. Zeit., xxvii., 1883, p. 297; White, Proc. Roy. Soc. Tas., 1914, p. 46; and Proc. Linn. Soc. N.S. Wales, xli., 1916, p. 75; Hardy, Proc. Roy. Soc. Tas., 1920, p. 34, text-fig. 1; Smith, Proc. Linn. Soc. N.S. Wales, xlv., 1920, p. 505, Pl. xxvii.-xxviii.

Chiromyza flavicaput, Walker, Ins. Saund. Dipt., 1852, p. 163.

Cryptoberis herbescens, White, Proc. Linn. Soc. N.S. Wales, xli., 1916, p. 97, text fig. 1.

? *Inopus despectus*, Walker, Ins. Saund. Dipt., 1850, p. 2, Pl. i., fig. 7; List Dipt. Brit. Mus., v., suppl. 1, 1854, p. 112 (*dispectus*).

Synonymy. The reasons for considering that *Cryptoberis herbescens* White is identical with *Metoponia rubriceps* Macquart have been dealt with in my paper in the Proceedings of the Royal Society of Tasmania, 1920, and no further comment is needed here. The illustration of *Inopus despectus* Walker shows that the upper branch of the cubital vein is missing, which character is rare in *Metoponia rubriceps*, but the other characters agree so well with this common species that the generic position is beyond dispute; the basal joint of the antennae, which is about as long as the third and the radial vein issuing from the first basal cell, agree with this species.

Characters.—This species, in which the female is usually black and the head red and the male brown or somewhat blackish, never with red, has the antennae with the first and second joints together about equal in length to the third, the first rather long, and the second joint about one quarter the length of the third. The radial vein invariably issues from the first basal cell.

Description.—♂. The head is black, the eyes are contiguous and have a little pubescence. The antennae are black, the first joint is long, about three times the length of the second, the second joint is about as long as broad, the third joint is four times the length of the second. [The text-fig. 1, in the Proc. Roy. Soc. Tasm., 1920, p. 35, shows the antennae drawn from a micro-slide.] The thorax and scutellum are black and have some black pubescence and depressed yellowish tomentum. The abdomen is black and contains denser pubescence; there are seven segments and exposed genitalia which conform in shape with those of other species of *Beridinae*. The anterior coxae are black, and the remainder of the legs are yellowish, slightly stained fuscous. The wings are obscurely fumed and the halteres are similarly coloured.

♀. The head is red with some short pubescence, the ocelli and the eyes are black; the latter have a little pubescence. The antennae are black, sometimes red at the base, and conform in proportions to those of the male. The thorax and scutellum are black with short pubescence, and sometimes tracings of lighter markings can be seen laterally. The abdomen is depressed, black, and usually with a thin light border at the extreme lateral edges. There are seven abdominal segments, the ovipositor (the eighth segment) bearing a pair of cerci; in the specimen described and illustrated here the ovipositor contains a small, inflated, yellow, ventral sack which can be detected bulging on each side. The abdomen contains short pubescence. The legs are variable in colour, they are usually reddish and much stained with black; in the specimen illustrated the anterior coxae are red—the intermediate and posterior coxae black; the trochanters are reddish, the basal half of the femora is black, the apical half red; the middle third of the tibiae is black, the base and apex reddish; the tarsi have the base of the first and second joints red, the pulvilli and the basal half of the claws red, the remainder black. The wings are rather strongly fumed and the halteres are similarly coloured.

Hab.—New South Wales: Sydney. (51 ♂, 20 ♀.) Specimens have also been seen from Victoria, but are not available for study at the time of writing this paper. Macquart adds Tasmania as a locality, but specimens from this State do not seem to be represented in recent collections.

METOPONIA GEMINA, n.sp. (Plate xxix., figs. 1-4.)

Characters.—In this species the female has a red head and the remainder is usually blackish, with a brownish scutellum; the male is brown or blackish with a lighter brown scutellum, and also often the second and third abdominal segments are of a lighter brown dorsally. The first joint of the antennae is but little longer than the second, and the third joint four times the length of the second; the radial vein of the wing branches from beyond the base of the cubital vein. The head differs in shape from that of *M. rubriceps* when seen dorsally, the face appears to be more prominent.

Description.—♀. The head is red, with the ocellar tubercle and the eyes black. Seen dorsally the head is conspicuously more prominent between the eyes than in *Metoponia rubriceps* Macquart. The first joint of the antennae is about twice the length of the second, and the third joint is missing.

The thorax, scutellum and abdomen are as in *M. rubriceps;* they are black with a dull yellowish tinge on the post-alar callus, which character is also often present in *M. rubriceps;* this colour extends on to the scutellum and forms an apical margin in the holotype only.

The legs as in *M. rubriceps*, are red and much stained with black.

The wings are fuscous and have the radial vein branching from the base or slightly beyond the base of the cubital vein, which is forked at, or beyond, the middle of its length. The first and second posterior veins issue from the discal cell separately.

♂. This sex is blackish in colour and has a yellowish tomentum; the eyes are contiguous, the ocellar and antennal triangles are very small, the latter reddish; the epistoma is yellowish. The antennae are reddish or yellowish and much stained with fuscous. Seen dorsally, the shape of the head anteriorly is arched and not flat as in *M. rubriceps*.

The thorax is black and has depressed yellow hairs, the humeral and post-alar calli and the scutellum are ochraceous.

The abdomen is black, but the first and second segments may contain a conspicuous area of yellowish brown; the genitalia are yellowish.

The legs are yellowish and similar to those of the male of *M. rubriceps*.

The wings are fuscous and have the radial vein branching from near the base to about one-sixth the length of the cubital vein which is forked at about two-thirds of its length. The first and second posterior veins issue from the discal cell separately or from a point, or they may be stalked.

Length.—♂. 6–7 mm.; ♀. 10 mm.

Hab.—New South Wales: Leura, Blue Mountains, March, 1920, collected by Dr. A. Maclean.

Type. The holotype ♀ and the allotype ♂ were presented to the Australian Museum by Dr. E. W. Ferguson. The paratypes, (3 ♂, 1 ♀) are in Dr. Ferguson's collection.

Genus CHIROMYZA Wiedemann.

Chiromyza, Wiedemann, Nova Dipt. Gen., 1820, p. 19; and Auss. zweifl. Ins., i., 1828, p. 237; Bigot, Ann. Soc. Ent. France, (5), ix., 1879, p. 185.

Xenomorpha, Macquart, Dipt. Exot., i., 1, 1838, p. 193; and i., 2, 1839, p. 190; Hardy, Proc. Roy. Soc. Tas., 1920, p. 37.

Lagarus, Philippi, Verh. z.-b. Ges. Wien., xv., 1865, p. 728 (preoccupied); Osten-Sacken, Berl. Ent. Zeit., xxvi., 1882, pp. 366, 368 and 380.

Hylorus, Philippi, *loc. cit.*, p. 728; Osten-Sacken, *loc. cit.*, pp. 368 and 380.

Lagarinus, Enderlein, Zool. Anz., xlii., 1913, p. 251; Kröber, Wytsman's Gen. Ins., fasc. 161, 1914, p. 13.

Metoponia, White, (*nec* Macquart), Proc. Linn. Soc. N.S. Wales, xli., 1916, p. 74.

? *Nonacris*, Walker, Ins. Saund. Dipt., i., 1850, p. 7; Osten-Sacken, Berl. Ent. Zeit., xxvii., 1883, p. 296.

Synonymy.—The genus *Chiromyza* Wiedemann was founded upon a Brazilian species, *C. vittata*, in which the upper branch of the cubital fork and the third posterior vein are obsolete, and the discal cell is complete.

The genus *Xenomorpha* Macquart was founded upon a species, *X. leptiformis*, in which only the upper branch of the cubital fork was obsolete, that is, the third posterior vein was present, otherwise the characters are identical with Wiedemann's species. Australian specimens show variations in which the upper branch of the cubital vein may be present or absent and the discal cell may be partly open, and finally the third posterior vein may be absent, but such an occurrence is rare.

The genus *Hylorus* Philippi was founded on a Chilian species, *H. krausei*, in which the third posterior vein is absent. Australian specimens conform to this and individual specimens with the discal cell partly open are rather common, thus showing a connecting link with *Lagarus*; the upper branch of the cubital fork is also sometimes absent and in this way unites *Lagarus* with the typical *Chiromyza*.

The genus *Lagarinus* Enderlein was proposed for a Chilian species, *L. paradoxus*, which conformed in the characters to *Lagarus* (preoccupied). Enderlein placed *Lagarus* as a synonym of his new genus *Lagarinus* and erroneously removed the group to the family *Scenopidae*. Krober copied Enderlein's description and appended it to the end of his revision of the genera of *Scenopidae* without comment.

The characters of the genus *Metoponia*, given by White, conform to the *Xenomorpha* of Macquart.

The following key will make the relation between these various species clear.—

1. Species with four posterior veins. .. .. 2.
   Species with five posterior veins, the third of which is stunted .. *Xenomorpha.*
2. The discal cell open, all traces of the cross vein closing the discal cell obsolete. *Lagarus* and *Lagarinus.*
   The discal cell closed, or at least the vein that closes the discal cell is indicated. .. .. 3.
3. The cubital vein forked. .. .. *Hylorus.*
   The cubital vein simple. .. .. *Chiromyza.*

These differences of character are variations that grade into each other and are of less than specific value.

In the original description, the genus *Nonacris* Walker is described as having the antennae seven segmented and the second joint much longer than the first, but Osten-Sacken states that the type, *N. transequa*, from South America, appears to be a *Chiromyza* as he could not find any difference.

Definition.—The eyes are contiguous or separated in the male and widely separated in the female; the antennae are shorter than the head, the first joint is short, the second about the same size, and the third scarcely exceeds the length of the two basal joints united; a species described as *Xenomorpha grandicornis* Hardy, has the third joint considerably longer and does not belong to this genus as defined here. The abdomen of the male is depressed; the genitalia conform to those of other genera of the *Beridinae*. The female has the basal segments of the abdomen distended and the apical segments attenuated; there are four distended segments and three narrow elongate segments, at the apex of which is the protensive ovipositor, the true eighth segment, which bears a pair of cerci. Both sexes have wings; the venation is very variable within a species, more so than in the genus *Metoponia*. The radial vein invariably issues from the first basal cell; the upper branch of the cubital vein may be present or obsolete; the discal cell may be open or closed and is short; three posterior veins issue from the discal cell and often another, but stunted vein, the true third posterior vein, is also present; the first and second posterior veins may issue from the discal cell separately, or from a point, or they may be stalked; these characters are variable within a species. The fifth posterior vein issues from the second basal cell and joins the anal vein considerably before it reaches the wing margin.

Chiromyia vittata Wiedemann.

Chiromyia vittata, Wiedemann, Nova Dipt. Gen., 1820, p. 20, fig. 8, ♀. (For further references *see* Kertesz, Cat. Dipt., iii., 1908, pp. 144-5.)

Note.—Schiner gives *X. leptiformis* Macquart as a synonym of this species.

Chiromyza ochracea Wiedemann.

Chiromyza ochracea, Wiedemann, *loc. cit.*, p. 20, ♂. (For further references *see* Kertesz, *loc. cit.*)

Chiromyza fuscana Wiedemann.

Chiromyza fuscana, Wiedemann, Dipt. Exot., 1821, p. 115, ♀. (For further references *see* Kertesz, *loc. cit.*)

Chiromyza leptiformis Macquart.

Xenomorpha leptiformis Macquart, Dipt. Exot., i., 1, 1838, p. 193, Pl. xxiii., fig. 1 (♀); and i., 2, 1839, p. 190 (♂); Walker, List Dipt. Brit. Mus., v., suppl. 1, 1854, p. 66.

Note.—Schiner gives this as a synonym of *C. vittata* Wiedemann.

Chiromyza australis Macquart. (Plate xxx., figs. 12-16.)

Xenomorpha australis, Macquart, Dipt. Exot., suppl. 4, 1850, p. 54, Pl. iii., fig. 7; Williston, Trans. Ent. Soc. Philad., xv., 1888, p. 244; Hardy, Proc. Roy. Soc. Tas., 1920, p. 38, text-fig. 2.

Characters.—This species has already been fully described, but it is subject to considerable variation in wing venation and colour markings. The eyes are separated in both sexes; the wings have a very complete venation, but the upper branch of the cubital fork may be partly or completely absent; the third posterior vein is almost invariably indicated by a stunted vein which is variable in length, and in one specimen the cross-vein between the second and third posterior veins is obsolete. The illustration is taken from one of the series of specimens from Gisborne already described by me.

Macquart described the male as having rather thick posterior tarsi, which character applies better to *Ch. prisca*, whilst the drawing shows the eyes separated in the male, and a stunted third posterior vein which conforms to the species identified here.

Hab.—New South Wales and Victoria. (6 ♂, 8 ♀.)

? Chiromyza transequa Walker.

Nonacris transequa, Walker, Ins. Saund. Dipt., 1852, p. 7.

Chiromyza transequa, Osten-Sacken, Berl. Ent. Zeit., xxvi., 1882, p. 368.

CHIROMYZA PRISCA Walker. (Plate xxix., figs. 7-11.)

Chiromyia prisca, Walker, Ins. Saund. Dipt., 1852, p. 162.
Metoponia prisca, Hardy, Proc. Roy. Soc. Tas., 1920, p. 36.

Characters.—Eyes contiguous in the male, separated in the female; the wings have a variable venation, in which the upper branch of the cubital vein is present or obsolete, the first and second posterior veins may be stalked, or issue from the discal cell from a point or independently; the third posterior vein is obsolete; the transverse vein between the second and fourth posterior veins may be incomplete, making the discal cell partly open, and in one case which is illustrated (Plate xxix., fig. 7) the second basal cell is also partly open by a similarly incomplete cross-vein. In the male the posterior tarsi are thickened.

Note.—Walker's type from Tasmania is evidently a male and is not adequately enough described for its identity to be positively determined; the only species known from that State that appears to approach Walker's description was subsequently identified and described as *Metoponia prisca*, but the identification is not a satisfactory one.

CHIROMYZA VICINA Bigot.

Chiromyza vicina, Bigot, Ann. Soc. Ent. France, (5), ix., 1879, p. 200 (♀).
Metoponia vicina, Kertesz, Cat. Dipt., iii., 1908, p. 145.

Note.—The position of this species is open to doubt, but as it was described from a female, it cannot belong to the genus *Boreoides*, and its colour does not agree with the known species under the genus *Metoponia*. The inadequate description reads like that of a typical female *Chiromyza*, and its habitat is queried Australia.

CHIROMYZA KRAUSEI Philippi.

Hylorus krausei, Philippi, Verh. z.-b. Ges. Wien., xv., 1865, p. 728, Pl. xxvi., fig. 33 (♂); Osten-Sacken, Berl. Ent. Zeit., xxvi., 1882, p. 368; Hunter, Trans. Amer. Entom. Soc. Philad., xxvii., 1901, p. 133.

CHIROMYZA PAUSLENI Philippi.

Lagarus pausleni, Philippi, Verh. z.-b. Ges. Wien, xv., 1865, p. 728 (♀); Hunter, Trans. Amer. Ent. Soc. Philad., xxvii., 1901, p. 132.
Lagarinus pausleni, Enderlein, Zool. Anz., xlii., 1913, p. 253.

CHIROMYZA PARADOXA Enderlein.

Lagarinus paradoxus, Enderlein, Zool. Anz., xlii., 1913, p. 252, figs. 1 and 2 (♂).

Species of uncertain generic position.

XENOMORPHA GRANDICORNIS Hardy.

Xenomorpha grandicornis, Hardy, Proc. Roy. Soc. Tas., 1920, p. 39, text-fig. 3.

Genus BOREOIDES, n.gen.

Boreomyia, Walker, MS. name.

Definition.—The eyes are separated in both sexes; the antennae have the two basal joints of equal length and the third joint about twice the length of the basal joints united in the male, and about the same length as the basal joints united in the female. The abdomen is depressed in the male, and in the female the four basal segments are distended and the apical segments attenuated. The wings of the male contain a complete or almost complete venation; the upper branch of the cubital fork and the stunted third posterior vein may be absent. The female is apterous.

Etymology.—A female specimen in the National Museum, Melbourne, bears a label in Walker's handwriting identifying the species as *Boreomyia subulata*, and, in consequence, the species has been rather well known under that name. It appears that the name has not been published, and Dr. Ferguson informs me that he failed to find a specimen of the species in the British Museum, on which account it is reasonable to suppose that the specimen labelled by Walker and now before me, was intended to be the type of a new species. The name *Boreomyia* is preoccupied by *Boriomyia* Banks, 1906, a North American Neuropteron of the family *Hemerobiidae*, and, moreover, the strict meaning of the name is scarcely applicable to the species under discussion. *Boreomyia* would mean "northern fly" according to its derivation, and this does not appear to be the meaning intended by Walker, who evidently noted the shape superficially resembling the Panorpid genus *Boreus* and intended in his name to convey the meaning Boreus-fly. The name is modified here to *Boreoides*, meaning "like *Boreus*."

BOREOIDES SUBULATUS, n.sp. (Plate xxx., figs. 17-22.)

Boreomyia subulata, Walker, MS. name.

Description.—The female is much inflated and apterous; the male is winged, more or less uniformly coloured brownish, and is slender in build.

♂. The front is one fifth the width of the head, parallel-sided and bulges slightly; the ocellar tubercle is very slightly raised, and anterior to this a median depression reaches the antennae. The antennae have their two basal joints equal in length, and the third joint twice the length of the basal joints united, and obscurely annulated. The face is small and the oral aperture is shallow and wide, and beneath it can be detected the minute mouth between the small palpi. The thorax and scutellum are normal, the former often stained with fuscous. The abdomen is rather long and slender, depressed, and consists of seven segments. The exposed genitalia conform in shape to those of other species of the *Beridinae*. The legs are light brown in colour, long and slender.

♀. The front is about one-third the maximum width of the head, is uniformly wide, and bulges considerably. The ocellar tubercle is but slightly raised, and anterior to this there is a pair of large prominences divided by a deep median depression which reaches the base of the antennae; the front contains conspicuous yellowish pubescence anteriorly. The antennae are situated low on the head and close together; the two basal joints are about equal in length; the third joint is equal to the basal joints together; the apical half of the third joint is obscurely annulated and three or four divisions can be seen. The oral aperture is shallow and wide, and it contains a tubercle occupying a larger portion of its area; below the tubercle, a minute mouth can be detected between the small palpi.

The thorax anteriorly is as wide as the head, but widens considerably towards the abdomen; it is glabrous and shining, but contains a little golden tomentum dorsally. The scutellum is flattened so that it lies like a plate upon the metanotum, which is also depressed but wrinkled, and separates the scutellum from the abdomen. Laterally the thorax is normal, and ventrally it is almost entirely concealed by the coxae. The wings and halteres are obsolete, but there are minute prominences indicating the position where these appendages should be.

The abdomen normally is large and distended, but in some specimens it is shrivelled and no larger than that of the head and thorax combined. There are four distended segments followed by three elongate narrow segments, at the apex of which the ovipositor (the eighth segment) protrudes and contains a pair of cerci. In all the specimens the abdomen shows tendencies to shrivel, and in some specimens dark bands are to be seen on the three basal segments and dark longitudinal stripes on the apical segments. In the holotype the apex of the first dorsal segment has a thin transverse apical band, the second and third segments have a broader central band and the fourth to seventh segments have a pair of black stripes. The ventre has tracings of corresponding bands and stripes more or less visible; in dark specimens these markings are more or less obliterated.

The legs are long and have their anterior coxae very broad, covering half the length on the ventral side and almost touching the intermediate coxae which are normal The posterior coxae are situated at the distance of their own width from the intermediate coxae and are normal; the legs contain a minute pubescence.

Length.—♂, 8-10 mm.; ♀ 15-25 mm.

Hab.—There are 35 ♂ and 24 ♀ from New South Wales and Victoria. Victoria: the labelled specimens invariably indicate May as the month of occurrence and the localities are Western District, Myer's Creek, Brighton, Mordialloc and Portland; and Mount Buffalo, males only, taken by Miss Irwin Smith, 19th February, 1920. New South Wales specimens are from Mount Kosciusko, females only, taken by Dr. E. W. Ferguson, February, 1920; females from Bago Forest, in the Australian Museum, taken by C. Rosegger; and males labelled Moonbar and Kosciusko, 3000ft., taken by Helms in March, 1889, are also in the Australian Museum. Tasmania: specimens from this State taken on the summit of Mt. Wellington, and one taken by Mr. C. E. Cole near Bellerive, Hobart, undoubtedly belong to this species, but unfortunately they are not available for study at the time of writing this paper.

Type.—The holotype ♀ and the allotype ♂ are in the National Museum, Melbourne; paratypes will be found in various collections, including that of the Australian Museum.

Genus ALLOGNOSTA Osten-Sacken.

Metoponia, Loew, *nec* Macquart, Dipt. Faun. Sud. Afr., i., 1860, p. 1.

Allognosta, Osten-Sacken, Berl. Ent. Zeit., xxvii., 1883, p. 297; Bezzi, Deut. Ent. Zeit., 1908, p. 470; Coquillett, Proc. U.S. Nat. Mus., xxxvii., 1910, p. 505; Brunetti, Faun. Brit. Ind., Dipt. Brachy., i., 1920, p. 93.

Anacanthoberis, Brunetti, Rec. Ind. Mus., vii., 1912, p. 456.

Characters.—A definition of this genus has been published by Brunetti, 1920, who, apparently, based it on the two species known to him. The illustration given by Brunetti in the same work represents *A. vagans* Loew, and the figure of the antennae shows the third joint to be four times the length of the second; both the figure and the description give eight annulations to the third joint. The abdomen of the male is shown to be considerably wider than the thorax, but the text states "slightly wider." The female specimen is described as having the sixth abdominal segment distinctly narrower than the fifth, and the seventh and eighth narrower than the sixth, which character is typical of the Chiromyzini.

The genus *Allognosta* can be distinguished from the genus *Metoponia* by the abdomen of the male which is wider than the thorax and also relatively shorter than in all other genera of the Chiromyzini.

In *Metoponia* there are only seven annulations to the third antennal joint (Macquart gives eight); in *Allognosta* these annulations are stated to be eight, but the character requires confirmation.

The following list contains the references to the original descriptions of the species placed under the genus *Allognosta* to which are added the references from works published subsequent to those given in Kertesz's catalogue.

fuscitarsis, Say, Journ. Acad. Nat. Sc. Philad., iii., 1823, p. 29 (*Beris*); Bezzi, Deut. Ent. Zeit., 1908, p. 474. [United States of America.]
  dorsalis, Say, in Long's Exped. St. Peter's River, ii., appendix, 1824, p. 377 (*Sargus*)
  pallipes Wiedemann, Auss. Zweifl. Ins., ii., 1830, p. 41 (*Sargus*).
  lata, Walker, List Dipt. Brit. Mus., i., 1848, p. 127; v., suppl. 1, 1854, p. 10 (*Beris*).
  brevis, Walker. List Dipt. Brit. Mus., i., 1848, p. 127 (*Beris*); v., suppl. 1, 1854, p. 10 (*Beris*).

similis, Loew, Berl. Ent. Zeit., vii., 1863, p. 299, ♂ (*Metoponia*); Bezzi, Deut. Ent. Zeit., 1908, p. 474. [United States of America.]

obscuriventris, Loew, Berl. Ent. Zeit., vii., 1863, p. 299, ♀ (*Metoponia*); Bezzi, Deut. Ent. Zeit., 1908, p. 474. [Canada.]

vagans, Loew, Beschreib. Europ. Dipt., iii., 1873, p. 71 (*Metoponia*); Bezzi, Deut Ent. Zeit., 1908, p. 474. Brunetti, Faun. Brit. Ind., Dipt. Brachy., i., p. 94, Pl. 1 figs. 25-26, ♂. [Europe, Asia.]
  inermis, Brunetti, Rec. Ind. Mus., vii., 1912, p. 455, ♂. (? *Allognosta—Anacanthoberis*) [India.]

barbiellinii, Bezzi, Deut. Ent. Zeit., 1908, p. 472. [Brazil.]

crassitarsis, de Meyere, Tijdschr. Ent., lvi., suppl., 1913 (1914), p. 19. [Java.]

crassa, de Meyere, Tijdschr. Ent., lvi., suppl., 1913 (1914), p. 20. [Java.]

assamensis, Brunetti, Fauna Brit. Ind., Dipt. Brachy., i., 1920, p. 95. [Assam.]

Explanation of Plates xxix.-xxx.

Plate xxix.

Figs. 1-4. *Metoponia gemina*, n.sp. 1. female, from holotype; 2. male, from allotype; 3. head of female holotype; 4. antenna from a paratype male.

Figs. 5-6. *Metoponia rubriceps* Macquart. 5. head, male; 6. antenna.

Figs. 7-11. *Chiromyza prisca* Walker. 7. female; 8. head of female seen anteriorly; 9. antenna of female; 10. male; 11. head of male seen anteriorly.

Plate xxx.

Figs. 12-16. *Chiromyza australis* Macquart. 12. female; 13. head of female seen anteriorly; 14. antenna of female; 15. male; 16. head of male seen anteriorly.

Figs. 17-22. *Boreoides subulata*, n.sp. 17. female; 18. head of female seen anteriorly; 19. antenna of female; 20. male; 21. head of male seen anteriorly; 22. antenna of male.

SOME NEW BRACHIOPODS FROM THE MIDDLE PALAEOZOIC ROCKS OF NEW SOUTH WALES.

By John Mitchell, late Principal of the Technical College and School of Mines, Newcastle.

(Plate xxxi.)

The fossils dealt with in the present paper represent seven genera and as many separate species of brachiopods. One genus and four of the species are new. Three of the genera are typically Silurian; one (*Merista*) is characteristic of Middle Devonian, and the range of the proposed new genus *Molongia* remains to be ascertained. Two of the species have previously been recorded from this State, viz., *Retzia salteri* Sowerby, by de Koninck from Yarralumla, and *Orthis striatula* Schloth. by W. S. Dun. From a palaeontological point of view, perhaps the most important of the species under notice is *Merista plebeia*, because it is so typically an index of middle Devonian age in Europe, and in North America; in these countries it has but a limited vertical range For this reason it should be very helpful in correlating the sedimentary rocks in which it occurs, however distant apart they may be. With regard to this fossil it is to be noted that, although its existence was, apparently, only a short one geologically, its distribution was world-wide, and these remarks apply to its associate *Orthis striatula* Schloth.; in Australia, just as in Europe, these two fossils are associates, and help to confirm the assumption that the rocks in this State, from which they have been collected in association, are approximately of Devonian age, and, in that case, they would appear to form an inlier surrounded by rocks of Carboniferous age, portions of which have recently been discussed and described (These Proceedings, xlv., 1920, Pt. 2, pp. 285-316). From the same limestone have been gathered a few *Spirifers*, one of which is near if not identical with *S. pittmani* Dun and considered by him to be of Devonian age. The pentamerid, *B. molongensis*, resembles in shape juvenile forms of *Barrandella linguifer* var. *wilkinsoni* Eth., but in the latter the umbo of the ventral valve is always much more strongly developed and overhanging than it is in the former; and in the latter, too, the length always, at all stages of growth, exceeds the width, while in the former the values of these dimensions are reversed. The Molong fossil occurs with *Atrypoidea australis* and *A. angusta* Mitch. and Dun. Etheridge's species occurs with these same Atrypids at Hatton's Corner in the Bounyongian Beds but the Hatton's Corner species has not yet been obtained from the Molong Beds.

Spirifer bowningensis is very characteristic of the Lower Trilobite Beds of the Bounyongian Series, and is also one of the few individuals of the fauna of these lower beds which survive to appear in the Middle Trilobite Beds.

If the suspected occurrence of the genus *Seminula* should be proved an actuality in this Gunnenbene limestone patch, an unusual commingling of Devonian and Carboniferous genera would be the result.

It may not be out of place here to remark how very important a help it would be towards the completion of a satisfactory geological survey of the State, if full and systematic palaeontographies were made of the stratified rocks of Molong, Wellington, and Orange in conjunction with those of the Bounyongian Beds. Besides, a work of this kind would without doubt result in many valuable palaeontological discoveries being made; for the stratified rocks of these localities are not to be surpassed for fossiliferous wealth.

Family MERISTELLIDAE Waagen.

Merista plebeia Sowerby. (Plate xxxi., figs. 1-3.)

Spec. Char.—Shell biconvex, subtriangular, valves about equally convex, smooth. Pedicle valve a good deal deeper than the brachial one, strongly convex especially in front of the umbo; anteriorly depressed umbone prominent, incurved apically, truncated by a circular foramen. Brachial valve slightly more convex than the pedicle valve; in some specimens a very inconspicuous fold is present; umbo moderately prominent, strongly incurved, and overhung by that of the pedicle valve; a well developed septum present. Hinge line mildly arcuate. Cardinal angles blunt. Lateral and front margins very mildly sinuate. Only a small portion of the brachidium has been observed in one specimen.

Dimensions. Four individuals gave the following measurements:—

Length 18.7 mm.	Width 18.7 mm.	Depth 11.7 mm.
" 17.3	" 17.3	" 10.2
" 15.6	" 15.2	" 9.4
" 15.6	" 15.2	" 9.4

But while these four specimens yielded fairly constant proportions for the three dimensions the following did not:—

Length 21.9 mm.	Width 17.2 mm.	Depth 12.5 mm.
" 20.85	" 18.23	" 12.5
" 21.9	" 21.9	"

These variable dimensions do not afford information of much value in determining its specific position.

Obs.—The form now dealt with bears close relationship externally to *M. plebeia* Sow. sp. and to *M. tennesseensis* Hall and Clarke, yet differs in some respects from both.

Dimensionally, the adult specimens of *M. plebeia* and the local form closely agree in size as is shown by a comparison of the measurements of the two forms. The dimensions of *M. plebeia* given by Davidson for two specimens are (Brit. Foss. Brach., iii. 1864-71. Pl. iii., figs. 2-10)

Length 18.75 mm.	Width 20.8 mm.	Depth 10.4 mm.
" 20.8	" 19.5	" 12.5

The length and depth of the latter specimen are practically identical with the similar measurements of one of the two large specimens of the local forms given above. In the case of the former species sometimes the length is greater than the width and sometimes the reverse; in the latter, the length is always greater than or equal to the width, as far as may be determined from the specimens at present available. In outline and external features, adult specimens of the two shells are not separable, and if the specific determination of the local shells were to be made after a comparison with the adult specimens of *M. plebeia* Sow., I would without hesitation place it with that species, but the youthful forms of the British (Plymouth) species, as represented in figs. 7-8 (*loc. cit.*) are unlike any of the youthful specimens of our form. Further the umbo and beak of the pedicle valve of the local form seem more prominent than are these parts of the British species. These slight differences may hardly justify the separation of the two.

The relationship between *M. tennesseensis* Hall and Clarke, and ours is also close. The largest specimens figured by Hall and Clarke (Nat. Hist. N.Y., Pal. 1894, Vol. iii., Brach. ii., Pl. xlii., figs. 1-6) have length 15.6 mm., width 14.75, depth 9.4 mm.

In figure 5 the length and width are 15.6 mms. for each dimension. By referring to the dimensions given above for local shells, the close agreement of some of them will be plain. Therefore, from dimensional evidence, these two might be placed together; but *M. tennesseensis*, judging from the figures, was smaller, and possessed a more conspicuous sulcus in the pedicle valve than the New South Wales type. The valve margins, lateral and anterior, of the latter are more sinuous than they are in the former.

After full consideration it seems to me that the Australian type might be placed with either the British *M. plebeia* or the American *M. tennesseensis* Hall and Clarke, but appears to be nearer the former than the latter; therefore it is placed with that species, though the immature specimens of our form do not appear to exactly agree with the similar British ones.

As far as I am aware this brachiopod has not previously been recorded from this State. In England it occurs plentifully in rocks of middle Devonian age.

The specimens here described and figured were collected from a mass of limestone within an extrusion of trachyte at the base of Bulga Hill, Tulcumbah, near Carroll, on the property of Mr. John Tydd. The geological age is, doubtless, middle Devonian. A brachiopod which, outwardly, bears a strong resemblance to the shells above described, was collected by the writer from Cave Flat, near the junction of the Murrumbidgee and Goodradigbee Rivers, from rocks which are referred to as lower to middle Devonian.

Family SPIRIFERIDAE.

SPIRIFER BOWNINGENSIS, n.sp. (Plate xxxi., figs. 21-22.)

Spec. Chars. Shell transversely subelliptic, radially strongly ribbed, and finely and densely striated. Pedicle valve strongly convex, possesses ten to twelve folds, sulcus deep and very wide anteriorly, umbo prominent, beak pointed, incurved, and somewhat obscuring the area; folds abutting the sulcus very prominent. Brachial valve mildly convex, has ten folds exclusive of the medial one which is prominent, and medially traversed by a shallow wide sinus; beak not conspicuous. Hinge line long, straight, almost as long as the greatest width of the shell; area short, narrow, and usually contracted by pressure; cardinal angles mildly rounded. Front margin strongly sinuate.

Dimensions.—Length 18 mm., width 29.7 mm., depth 12.5 mm.
Length 21.9 mm., width 32.8 mm., depth 15.6 mm.

The first of these measurements is of a very perfect specimen three-fourths grown. The other is of an adult specimen. The different dimensions do not seem to bear proportional relations in either case.

Obs.—This *Spirifer* belongs to Hall and Clarke's group 1. Radiati, and section 1, Pauciplicata of that group, approaching closely to *S. radiatus* and *S. plicatellus* Sowerby externally; but more to the latter than the former, more especially to the Swedish representatives of the species. In a less degree it resembles *S. eudora* Hall, from the Niagara formations; but dimensionally is very different. Both *S. radiatus* and *S. plicatella* differ from the local species in the absence of a medial sinus on the fold of the brachial valve. The radial ribs of the former are not prominent, and diminish in this respect as they approach the umbo in the latter; they are very prominent throughout their length, except in the case of the outer rib or two on each valve. The hinge lines and areas of the two species are much alike. In adult specimens of the Bowning one there are constantly six ribs on each side of the sulcus on the pedicle valve; and on each side of the medial fold of the brachial valve the ribs are five. In the case of *S. plicatella* Sow. the ribs on the similar parts seem to be more variable in number and in prominence. The two are easily separable from each other, and the same may be said of *S. radiatus* and the local one.

This *Spirifer* is very characteristic of the Lower Trilobite Beds of the Bowning Series, where it is common and has very few other *Spirifers* for associates, but instead, numerous trilobites, among which are *Odontopleura bowningensis* E. and M., *O. parvissima* E. and M., *Ceratocephala vogdesi* E. and M., *Sphaerexochus mirus* Beyrich, *Staurocephalus murchisoni* Barr., etc.

It is one of the few representative members of the fauna of the Lower Trilobite Beds that pass upward into the Middle Trilobite Beds; and probably survives to the lower Devonian period, for some fragments of a *Spirifer* near to, if not identical with it, have been collected from the limestones near the junction of the Goodradigbee and Murrumbidgee Rivers.

Loc. and horizon.—Lower and Middle Trilobite Beds, Bowning, Parish of Bowning, County Harden, N.S.W. Upper Silurian—Wenlock or Barrande's étage E.

MOLONGIA, n.gen.

The Bowning and Molong districts of New South Wales yield a Spiriferoid Brachiopod which I have been unable to place in any of the genera of this large group. It possesses a well-defined smooth sulcus in the pedicle valve and an equally distinct median fold in the brachial valve; the spiralia too are very like those of true Spirifers. But they have no cardinal area, neither is an open delthyrium present; but, instead, there is a foramen truncating the apex of the pedicle beak. It seems not distantly related to Hall's genus *Trematospira*, but it lacks some of the essential features of that genus, for instance, its shell is imperforate and within the sulcus of the pedicle valve there are no folds. Failing to be satisfied that it can be placed in any existing genus, a new genus is proposed for its reception.

Gen. char.—Shell imperforate; umbo of pedicle valve prominent, incurved, depressed, and truncated by a circular foramen; cardinal area absent; hinge-line straight or nearly so; spiralia spiriferoid. Other internal structures not observed.

Genotype, *Molongia elegans*, n.sp.

MOLONGIA ELEGANS n.sp. (Plate xxxi., figs. 6-8, 12.)

Spec. char.—Valves strongly convex, the pedicle valve more so than the other. Pedicle valve subrhomboidal, sulcus deep, smooth and wide, and on each side of it are four radial ribs, all of which are prominent, except the one on each side adjacent to the cardinal angles. Umbo prominent, incurved, truncated by a circular foramen and resting on the umbo of the brachial valve, or nearly so. Brachial valve subquadrate, medial fold prominent and medially traversed by a narrow, shallow sinus; the lateral folds agree in number and character with those of the ventral valve, and alternate with them, thus giving to the lateral margins a zigzag outline; umbo moderately prominent, and fills up the delthyrium. Hinge-line straight, or almost so, and reaches to the cardinal angles which are nearly rectangular in perfect and mature specimens. Hinge-line elevated. The whole surface of the shell is traversed by faint, undulating, concentric growth-lines.

Obs.—This fossil in several respects is very spiriferoid, and in other features it approaches forms of *Trematospira.*

Loc. and horizon.—About eight miles west of Molong, Parish of Bomey, County Wellington; Bowning, Parish of Bowning, County Harden. In both localities it is associated with *Atrypoidea australis* Mitchell and Dun. Apparently Upper Silurian.

Family RETZIIDAE.

RETZIA SALTERI Davidson. (Plate xxxi., figs. 4-5.)

Terebratula salteri, Dav., Bull. Soc. Geol. France, 2nd ser., vol. v., 1848, p. 331, Pl. iii., fig. 31; *Retzia salteri*, Schmidt, Sil. Form. Ehsland, etc., 1858, p. 212; Salter, Siluria, 2nd. edit., 1859, p. 250, Foss. 57, fig. 7; *R. baylei*, Lindstrom, Gottlands Brachiop., Ofvers. K. Vet.-Akad., Forhandl., 1860, p. 337; *R. salteri*, de Koninck, Mem. Geol. Surv. N. S. Wales, Pal., No. 6, 1898, p. 27.

Spec. char.—Shell equally and strongly convex, oval; valves almost of equal size and each medially depressed. In the depressed part of the pedicle valve are two less robust ribs than those on the lateral parts of the valve, and, in the corresponding depression of the brachial valve, there is one such rib even less distinct than those of the pedicle valve. On each side of these depressed ribs, in each valve there are ten, simple and relatively strong ribs, making a total of twenty two and twenty one on the pedicle and brachial valves, respectively. The umbo of the pedicle valve is only moderately prominent, incurved and apically truncated by a foramen. The umbonal parts of each are strongly inflated. Hinge line short and arcuate. Deltidial plates obscured. Margins practically non-sinuate. On one side of our solitary specimen which is weathered the spiral lamellae are sufficiently exposed to show that they possess the characteristics of the genus. The concentric growth lines are fine, numerous and asperate.

Dimensions.—Length, 5.25, width, 6 and depth, 3 lines respectively. These measurements agree fairly closely with those given by Davidson for *R. salteri* and its varieties, *R. bouchardii* and *R. baylei* (Brit. Foss. Brach., iii., pp. 126-128.).

Obs.—The form here described agrees with *R. salteri* Dav. in (i.) valves equally convex; (ii.) small incurved beak; (iii.) medial radial ribs finer and at a lower level than the lateral ribs; (iv.) strong convexity of the valves; (v.) having in the ventral valve a low narrow sinus extending from the beak to the front margin; (vi.) valves ornamented with fine concentric lines; (vii.) having the front margin slightly indented; (viii.) having the central ribs smaller and at a lower level than the lateral ones. It differs from that species in the depressed central area having fewer ribs and a smaller number of lateral ribs. With *R. bouchardii*, it agrees in being almost as long as wide, and in the number and character of the lateral ribs. It appears to differ from that species in having only two depressed central ribs in the ventral valve and one in the dorsal valve. The local specimen is smaller; this has little significance when only a single specimen is available for comparison. Were I convinced that *R. bouchardii* was an established variety of *R. salteri* I would not hesitate to place our form with that variety. Salter, Lindstrom, and de Koninck considered that *R. bouchardii* and *R. baylei* of Davidson were inseparable from *R. salteri.*

de Koninck (Mem. Geol. Surv. N.S.W., Pal. 6, p. 27) recorded the species from Yarralumla, N.S.W., and gave an outline of Davidson's description of the species, which he applied to the Yarralumla form; he did not figure it, but stated that it exactly agreed with Davidson's fig. 27*a*, Pl. xii. Our fossil closely resembles fig. 29 of the same plate, that is, the varietal form *R. bouchardii* Dav.

The specimens dealt with by de Koninck were destroyed by fire in 1882. The occurrence of the genus *Retzia* in Australia adds another to the list of brachiopods which have a world-wide distribution which, in the case of this genus, appears to have been accomplished in a relatively short geological period.

Loc. and horizon.—The limestone bed of Limestone Creek, beneath the Lower Trilobite Beds of Bowning-Yass series. Parish of Derrengullen, County King. Upper Silurian (= Wenlock).

This fossil was found associated with *Favosites gothlandica* Linn., *F. basaltica* Gold., *F. multitabulata*, *Sphaerexochus mirus*, *Atrypa reticularis* Linn., *A. pulchra* M. and Dun, etc.

Family PENTAMERIDAE.

Barrandella molongensis, n.sp. (Plate xxxi., figs. 9-11.)

Spec. char. Shell subpentagonal to subtriangular, small, smooth, biconvex. Pedicle valve strongly convex, especially in the umbonal region, umbone prominent, beak short, depressed, gently incurved, but not overhanging the beak of the brachial valve; medial sinus wide and shallow (in some specimens being hardly visible, and in some, where it is more pronounced, there are traces of one or two faint folds within it, and on the shells of young individuals neither sinus nor opposing fold is present); anteriorly mildly to moderately sinuating the brachial valve. Brachial valve relatively small, moderately convex near the umbo, laterally and anteriorly more or less depressed, fold varies much in prominence, corresponding in this respect with the sulcus of the opposing valve in some individuals; anteriorly its prominence is increased by the shell surface on each side of it being depressed (a feature common to *B. linguifera* Sow.), umbo moderately prominent, beak small, always visible. Hinge line straight or very mildly arcuate, cardinal angles rounded. The septa are short.

Dimensions of adult individuals.—

Length 10.5 mm.	Width 13.5 mm.	Depth. 8.3 mm.
„ 8.3	„ 12.	„ 7.
„ 10.4	„ 13.	„ 8.3
„ 10.4	„ 12.	„ 7.8

These measurements are fairly proportional.

Obs.—In some respects this species resembles youthful individuals of *B. linguifera* var. *wilkinsoni* Eth. Jr., and is suggestive of having been derived from that species by the arrest of its development in the early stages of growth, but at no stage of development can the one form be mistaken for the other. Dimensionally they are widely different,—the one seldom reaching a length of 10.5 mm. and only rarely exceeding 13 mm. in width, while the other may reach 25 mm. for each of these dimensions. The width in the Molong species is always much greater than the length, but in the other the width only very slightly exceeds the length. This fossil occurs in clusters, numbering hundreds of individuals occasionally in a cluster in a massive bed of grey limestone associated with *Atrypoidea australis* Mitch. and Dun, *A. angusta* Mitchell and Dun, *Leptaena rhomboidalis* Wilckens, etc.

Loc. and horizon.—Some eight miles west of Molong, Parish of Bomey, County Wellington. Probably Upper Silurian.

SIEBERELLA GLABRA, n.sp. (Plate xxxi., figs. 13-15.)

Spec. Chars.—Shell smooth, thick, subpentagonal or subquadrate according to stage of growth, concentric lines faintly visible on some specimens. Pedicle valve very convex, umbo very tumid and prominent in adult specimens. Beak acutely pointed, incurved and strongly depressed on to that of the brachial valve. Fold only moderately conspicuous, originating just in front of the umbonal region and terminating with a straight edge at the anterior sinus. Hinge line wide, cardinal angles high and rounded. Brachial valve only moderately convex in the posterior half, laterally flat to subconcave; sinus wide, shallow and moderately indenting the opposing valve.

Dimensions (adult specimens).—Length, 21, 21.9 mm.; width, 21, 20.8 mm.; depth, 16.5, 13.0 mm.; (specimen of medium growth), length 15.6, width 18.7 depth 8.8 mm.

From these measurements the development of the shell would appear to have been very variable in different individuals, or rather at different stages of growth.

Obs.—This shell is different from the old *Sieberella* (*Pentamerus*) *galeatus* in several particulars, so evident that their enumeration is unnecessary. The radial ribbing characteristic of the genus is practically absent from the Australian species, for the only traces found on it are very faint folds on each side of the sinus anteriorly, and an equally faint and hardly visible fold on the medial part of this sinus.

Specifically, as far as my knowledge enables me to judge, the species here described has no very close relation among the species occurring in Europe and America.

Up to the stage of medium growth, the umbo of the pedicle valve of *S. glabra* is not prominent, and the beak does not overhang that of the brachial valve; but from that to the adult stage the umbo and umbonal regions strongly develop; and so throw the pedicle valve beak on to that of the brachial valve.

In the classification of this brachiopod I have adopted the divisions proposed by Hall for galeatiform pentamerids (Pal. N.Y., Vol. viii., Brach., ii., 1894, pp. 240 and 247).

Loc. and horizon.—Hatton's Corner, Yass River, Parish of Hume, County Murray, associated with ***Barrandella (Clorinda) linguifera*** var. ***wilkinsoni*** Eth. Junr., *Atrypa reticularis* Linn., *Rhizophyllum interpunctatum* de Kon., *Encrinurus mitchelli* Foerste, etc. Upper Silurian (Wenlock).

Family ORTHIDAE.

ORTHIS (SCHIZOPHORIA) STRIATULA Sowerby. (Plate xxxi., figs. 16-20.)

Spec. Chars.—Outline subcircular or subelliptic, transversely biconvex, surface densely covered with fine radial striae which increase in number anteriorly with the growth of the shell by dichotomy and occasional interpolations; at intervals the larger striae open to the surface and discontinue. All the striae along their whole length are surmounted by slight asperities; concentric growth lines faint except anteriorly. Pedicle valve distinctly convex except anteriorly, where it becomes depressed, and in senile shells a distinct sulcus is formed; beak only slightly incurved and higher than that of the brachial valve. Brachial valve more convex than pedicle, beak incurved. Cardinal area of moderate length, triangular, elevated in each valve. Delthyrium conspicuous. Cardinal angles rounded. Anterior margin in immature shells very mildly sinuate; rather strongly in some of full growth.

Dimensions (mature and nearly mature specimens).—

Length	20.3 mm.	Width	23.4 mm.	Depth	15.6 mm.
,,	20.3	,,	23.3	,,	12.5
,,	17.2	,,	22.6	,,	11
,,	17.2	,,	22.7	,,	12.5
,,	20.7	,,	25.0	,,	12.5

These measurements show proportionate relations more or less, for the three dimensions. The first, which has the greatest thickness, has also the appearance of greatest age; it would appear that depth continued to increase after the other dimensions had reached their full development.

Obs.—Some palaeontologists have contended that *O.* (*Sch.*) *striatula*, is identical with *O.* (*Sch.*) *resupinata;* but a larger number recognise its specific rank. The Australian representatives of the species are of smaller size than the European and North American forms; but agree with them in external features. The local *O.* (*Sch.*) ***striatula*** has only half the width and length of the local *O.* (*Sch.*) ***resupinata*** Martin, but in depth often exceeds the latter, in the case of full grown specimens, and is much more convex. In no instance have I noticed the anterior marginal sinus so pronounced in the latter as it is in the former when the shells are of mature growth. The muscular sears of the former, as far as my observations have enabled me to decide, are less distinct than are those in the latter, and in other respects the scars appear to differ. The local fossil seems nearer in form and dimensions to the North American form than to the British one.

The specimens here dealt with occur in association with ***Merista plebeia*** Sowerby; and in that respect agree with the European and North American associations. Other associates are some *Spirifers*, one of which has a strong resemblance to *S. pittmani* Dun, and with what appears to be a species of the genus *Seminula* which would be an unexpected associate.

Loc. and horizon.—Tydd's farm, Tuleumbah, Parish of Gunnenbene, County Nandewar. If judged from the presence of *Merista plebeia*, the horizon would certainly be declared Middle Devonian; but should the presence of *Seminula* be proved, then the geological horizon of the rocks from which the fossils were obtained will be a matter for reconsideration.

EXPLANATION OF PLATE XXXI.

Figs.1-3.—*Merista plebeia* Sowerby. Ventral, brachial and profile views of mature specimens.

Figs.4-5.—*Retzia salteri* Davidson. Ventral aspect and weathered side of a specimen. In the latter six turns of a spiral are exposed.

Figs.6-8 and 12.—*Molongia elegans* Mitchell. Dorsal, ventral, and profile views of three mature specimens (x 2); Fig.12 has the dorsal valve removed to show the spires, enlarged.

Figs.9-11.—*Barrandella molongenis* Mitchell. Dorsal, ventral, and front views of three nearly mature specimens (x 2).

Figs.13-15.—*Sieberella glabra* Mitchell. Dorsal, ventral, and front views. Figs.13 and 14 are of adult specimens, Fig.15 represents a shell of medium size.

Figs.16-20.—*Orthis (Schizophoria) striatula* Schloth. In figs. 16-19 the ventral, oblique, front and cardinal aspects are shown. Fig. 20 is the part of a cast to show the muscular scars of the pedicle valve. (x 3).

Figs.21-22.—*Spirifer bowningensis* Mitchell. Fig. 22 shows a specimen three-fourths grown (x $\frac{1}{3}$), and fig. 21 is part of a valve (x 3) to show the radial striae, etc.

NEMATODE PARASITES OF THE DOMESTIC PIGEON (*COLUMBA LIVIA DOMESTICA*) IN AUSTRALIA.

By Vera Irwin-Smith, B.Sc., F.L.S., Linnean Macleay Fellow of the Society in Zoology.

(Nineteen Text-figures.)

The only Nematode hitherto recorded from the domestic pigeon in Australia, is *Ascaridia columbae* Gmelin (*Heterakis maculosa* Rud.). T. Harvey Johnston reported the presence of this parasite in New South Wales in 1909 and 1910, and recently (1918) gave a description of specimens found in Queensland. An earlier reference by Krefft (1871) to *Ascaris* sp. is stated by Professor Johnston to refer to the same species.

The material dealt with in the present paper comprises three distinct species, two of which are new for this part of the world. One of them has been found previously, only in America, and the original description of it is contained in a circular of the Bureau of Animal Industry, U.S.A., which is now out of print, and therefore difficult to obtain. In view of this, and of the very varying descriptions and unsatisfactory figures contained in most of the existing records of the other species concerned, I have thought it desirable to give fairly full notes and drawings of the specimens examined here.

The classification adopted is that used by Stiles and Hassall (1905), Railliet and Henry (1914), and Hall (1916), to whose work the reader is referred for super-family, family, and subfamily diagnoses.

For the material examined I am indebted to Dr. S. Dodd, and Dr. J. B. Cleland.

Early in 1919 several pigeons, dying and dead, were sent to Dr. Dodd, at the Veterinary School of the University of Sydney, to ascertain the cause of the mortality among the flock. In the post-mortem examination, small filiform worms were found in fair numbers throughout the length of the intestines; but the walls of the alimentary canal appeared to be in a perfectly healthy condition, and it is doubtful whether the worms were a contributory cause of the deaths. Dr. Dodd informs me that poisoning was suspected, and that there were no more deaths after steps were taken to prevent this.

The small worms found comprised two species of Nematodes, which, on superficial examination, are very much alike, though belonging to two distinct families, *Trichinellidae* and *Trichostrongylidae*. Apparently, Nematodes of the latter family are not at all common in pigeons. None were recorded until 1904, when Stevenson found one species in considerable numbers in the intestines of a flock of fancy pigeons at Washington, and described it under the name of *Strongylus quadriradiatus*. He states that a single specimen contained in the helminthological collection of the U.S. National Museum, which was collected by Hassall at Washington in 1892, belongs to the same species. I have not been able to find any records of later observations of this worm. All the more recent references relate to Stevenson's description. But examination of the specimens found here shows them to be identical with Stevenson's species.

In his original description, Stevenson observed that he retained, merely temporarily, the generic name *Strongylus* (properly limited to the Sclerostomes), pending an extensive revision of the whole group. By means of a diagnostic table he compared the new parasite with the three species *S. pergracilis*, *S. nodularis*, and *S. tenuis*, which he considered closely allied forms. In the following year (1905) Looss established the genus *Trichostrongylus* to include four species separated from the old genus *Strongylus*, and in 1909 Shipley added the species *Tr. pergracilis*, *Tr. nodularis*, and *Tr. tenuis*, and suggested that *Strongylus quadriradiatus* was possibly also a *Trichostrongylus*. But Ransom (1911) pointed out that *Strongylus nodularis*, and *S. quadriradiatus* differed widely from the type, and should be excluded from the new genus, and in 1912 Neveu-Lemaire included the latter in his work under the name *Strongylus ? quadriradiatus*, with the note "Ce strongyle appartient certainement à la sous-famillie des Trichostrongylinae, mais le nom générique de strongylus ne lui convient pas; sa dénomination n'est donc que provisoire."

Stevenson's species certainly does not belong to the genus *Trichostrongylus*, outstanding differences from the type being the relative sizes and positions of the bursal rays, the form of the spicules, and the vesicular swelling of the cuticle of the head. Eight other genera have been included in the sub-family *Trichostrongylinae*, but the present species does not conform to the description of any one of them. It therefore becomes necessary to establish for it a new genus, for which I propose the name *Cephalostrongylus*.

Superfamily *STRONGYLOIDEA* Weinland, 1858.

Family TRICHOSTRONGYLIDAE Railliet, 1915.

Subfamily TRICHOSTRONGYLINAE Leiper, 1908.

Genus CEPHALOSTRONGYLUS, n.g.

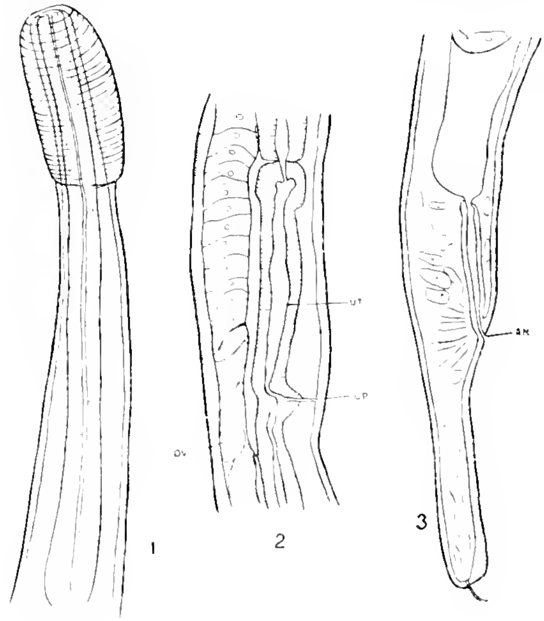
Generic diagnosis.—Cuticle enveloping cephalic end inflated to form a vesicular enlargement. Mouth simple, no papillae. Bursa bilobed, supported by six paired rays and one median unpaired ray; the two ventral rays close together and parallel, curved ventrally at the tips, thicker than any of the other rays; the three lateral rays arising from a common stem, but mutually divergent; externo-dorsal ray thinner and shorter than the lateral rays, given off from the base of the dorsal ray; dorsal ray still shorter, but thicker, shortly bifurcated at the extremity, the outer branches being a little longer than the inner, each of which is again bifurcated. Two three-pointed spicules, short and thick, joined by a membrane to form a tube; a star-shaped chitinous piece with four rays, the two lateral rays curved forward, surrounding the spicules when they are protruded. A pair of prebursal papillae. Anterior half of female body filiform. Vulva in posterior fourth of body.

Type species, *Cephalostrongylus quadriradiatus* Stevenson, 1904.

CEPHALOSTRONGYLUS QUADRIRADIATUS Stevenson.

1904, *Strongylus quadriradiatus*, Stevenson, Bur. Anim. Industry, Washington, Circular 47, 10 figs.—1905, Neumann-Macqueen, Parasites Dom. Anim., 2nd edit., p. 414.—1909, *Trichostrongylus quadriradiatus*, Shipley, Proc. Zool. Soc. London, p. 335.—1911, *Strongylus quadriradiatus*, Ransom, Proc. U.S. Nat. Mus., xli., p. 363.—1912, Neven-Lemaire, Parasit. Anim. Dom., Paris, pp. 718-719.

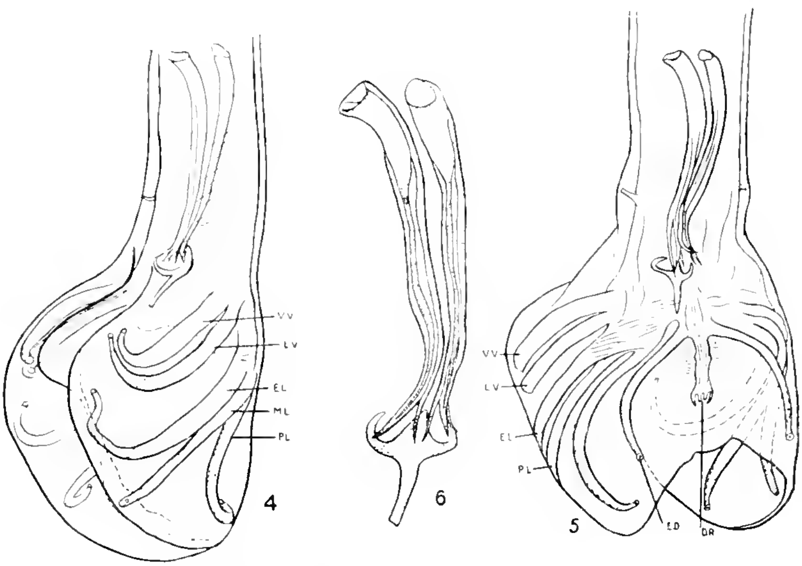
The specimens in this collection agree closely with the description given by Stevenson, though the dimensions are all somewhat smaller. They were reddish in colour when first collected, and many of the females were spirally coiled, especially towards the anterior end, which, being long and filiform, gave them



Text-figs. 1-3. *Cephalostrongylus quadriradiatus*.

1. Anterior end. (x 230). 2. Region of genital pore (*g.p.*) of female, showing ovijector (*ut.*) and oviduct (*ovi.*) (x 140); 3. Posterior end, female. *an.*, anus. (x 322).

a superficial resemblance to the Trichinellids found with them. The peculiar, four-rayed, chitinous piece connected with the spicules, to which the species owes its name, is just as figured by Stevenson. The vesicular swelling of the cuticle at the cephalic end is still visible in most of the preserved specimens, and does not appear to have shrunk at all in the glycerine jelly mounts from which the measurements and drawing (Text-fig. 1) were made. Males measured from 6.2 to 6.8 mm. long, with a maximum width, in front of the caudal bursa, of 0.072 to 0.083 mm.; females, 12.3 to 16.2 mm. long, with a maximum width of 0.143 mm. in the region of the genital pore. Cephalic swelling, 0.093 to 0.104 mm. long and 0.046 to 0.052 mm. broad; oesophagus, 0.352 to 0.400 mm. in the male, 0.430 to 0.510 mm. in the female, with an average width of 0.020 mm.; nerve ring, 0.230 to 0.260 mm., and excretory pore, 0.268 mm. from anterior end. The diameter of the body just behind the cephalic enlargement is 0.040 mm. in males, 0.049 mm. in females. The female genital aperture is situated 2.25 to 3.33 mm. and anal aperture 0.140 to 0.156 mm. from tip of tail. The cuticle is marked by a fine transverse striation at intervals of 0.0015 mm., except on the anterior swelling, where the striae are much coarser. Stevenson describes only longitudinal markings, which are also visible on these specimens. The terminal portions of the two divergent uteri, which form the ovijectors, differ slightly from the figures given by Stevenson. Each consists of three parts (Text-fig. 2); the first, opening at the vulva with very thick muscular walls, is about 0.220 mm. long, and is separated by a sphincter, in the form of a prominent ring, from a



Text-figs. 4-6. – *Cephalostrongylus quadriradiatus.*
4. Posterior end of male, side view. (x 200); 5. The same, dorsal view. (x200). *v.v.*, ventro-ventral ray; *l.v.*, latero-ventral ray; *e.l.*, externo-lateral ray; *m.l.*, medio-lateral ray; *p.l.*, postero-lateral ray; *e.d.*, externo-dorsal ray; *d.r.*, dorsal ray; 6. male spicules and chitinous support. (x 380).

narrower, but still muscular part 0.117 mm. long, which is continuous with the uterus. Eggs contained in this part of the uterus measure 0.067 by 0.039 mm., and are still in the early stages of segmentation. The genital pore is a transverse slit 0.040 mm. wide. The body is 0.044 mm. in diameter at the anus. Behind it the slender tail (Text-fig. 3) ends bluntly; the fine terminal spine which it bears, is about 0.015 mm. long, and penetrates the cuticle to connect with the internal protoplasm. It appears to be hollow, and of a glandular nature.

Each lobe of the male bursa (Text-figs. 4, 5) measures about 0.143 mm. in width, and 0.130 to 0.170 mm. in depth. The tips of the two ventral rays are only 0.006 mm. apart. Of the lateral rays, the externo-lateral is the longest, and is curved ventrally, its tip being some distance from the margin of the bursa, and 0.034 mm. from that of the latero-ventral. The distance between the postero-lateral and externo-dorsal is a little less, 0.028 mm. The distances between the tips of the lateral rays are greater, 0.046 mm. between postero- and medio-lateral, and twice as much between medio- and externo-lateral. The prebursal papillae are 0.013 mm. long, and are situated laterally, 0.052 mm. in front of the base of the bursa. The two equal spicules (Text-fig. 6) measure 0.148 mm. long, and taper distally to end in three slender pointed branches, which are surrounded by the chitinous supporting piece, 0.041 mm. long.

Stevenson states that this worm, when present in large numbers, causes a debilitating diarrhoea, and general disorder of the nutritive functions of the host bird. This he thinks to be due both to a loss of blood, and to the piercing of the mucosa, leaving open channels for fatal infection with bacteria. Shipley (1909) includes the species in his list (p. 335) of those harmful to birds, and Neumann-Macqueen (1905), and Neveu-Lemaire (1912), referring evidently to Stevenson's statement, both record it as producing grave disorders, bacterial infection, catarrh, and profuse diarrhoea.

But in this case there was no evidence that the worm, though present in fairly large numbers, caused any harmful effect. The walls of the intestine were not in an inflamed catarrhal condition, and, as already stated, appeared to be perfectly healthy.

Family TRICHINELLIDAE Stiles and Crane, 1910.

Subfamily TRICHURINAE Ransom, 1911.

Genus CAPILLARIA Zeder, 1800.

Generic diagnosis (from Hall 1916). Body very slender, capillary, anterior, oesophageal portion of body shorter than, or rarely equal to the posterior portion of body. Bacillary band dorsal, ventral, or lateral, or absent. Oesophagus long and slender, gradually increasing in size posteriorly. Spicule long and slender, surrounded by a sheath which may present a smooth outer surface when evaginated, or a surface armed with spines. Tail of male may or may not be provided with membranous wings, and a membranous bursa-like structure, these being usually inconspicuous when present. Vulva located near the base of the oesophagus. Eggs lemon shaped, with the usual opercular plugs.

Type species, *Capillaria tumida* Zeder, 1803 (= *Trichocephalus anatis* Schrank, 1790 = *Trichosoma brevicolle* Rudolphi, 1819).

This genus, established by Zeder to include forms characterised by a filiform body, with a very slender anterior part merging almost insensibly into a rather thicker posterior part, was renamed *Trichosoma* by Rudolphi in 1819. It is under this name that most of its species have since been described, the original name being re-established by Stiles and Hassall only in 1905, when they published their "Determination of Generic Types, and a List of Roundworm Genera."

Most of the descriptions of species are very meagre and unsatisfactory. In 1845 Bellingham remarked that "as the species are all exceedingly small, and resemble each other very closely (almost the only difference being a little greater or less thickness of body), and as the male and female are not always found together, it is very difficult to determine the species accurately." Later helminthologists seem to have experienced the same difficulty, and a good deal of confusion still exists in regard to specific diagnosis.

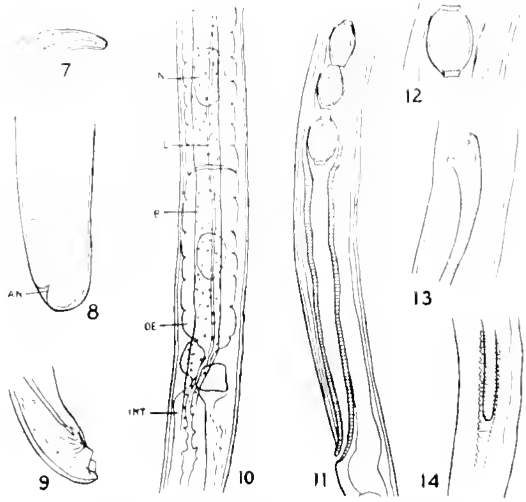
However, only one species of *Capillaria* has been recorded from pigeons, namely, *Capillaria columbae*, and the worms found here have been identified as belonging to this species. Bellingham did not give any name or description to the Nematode which he found in the small intestine of *Columba livia* in Ireland, but it was probably the same worm. Dujardin, who states that several specimens had been sent to the Museum of Paris from the Museum of Vienna, and were described by him for the first time, supplies the description (1845) which has been repeated, or closely followed, in nearly all subsequent records. In Vienna, according to Dujardin, it was found nine times in 245 in the large intestine of *Columba domestica*. Neumann records it as a frequent and abundant species in the small intestine of this pigeon, and quotes Pauly and Zurn as stating that it often determines an intense intestinal catarrh, which leads to anaemia, and consumption. Neveu-Lemaire also refers to a "trichosomosis" of the pigeon caused by its presence, which had been studied both by Tartakowski and Pauly and Zurn. He says that, at an autopsy of an infected bird, the intestinal mucosa was found to be greyish, tumefied, and covered with red striae and petechiae.

None of these symptoms were observed in the bird, from which the present specimens were obtained, though they were found in fair numbers throughout the intestines.

CAPILLARIA COLUMBAE Rudolphi.

Trichosoma columbae, Cat. Ent. Vind. Msc. 1819, Rudolphi, Synops., p. 15. 1845, Bellingham, Ann. Mag. Nat. Hist., xiv., p. 477.—1845, *Calodium tenue*, Dujardin, Hist. Nat. de Helm., p. 28.—1851, *Trichosomum (Calodium) tenuissimum* Diesing, Syst. Helm., ii. pp. 256, 257.—1861, *Calodium tenue*, Molin Il. sottor. d. Aerofalli, Mem. Instit. Veneto, ix., p. 192. 1863, *Trichosomum tenuissimum*, Eberth, Nemat. Untersuch., Leipzig, p. 56, tab. vi., fig. 2. —1878, Linstow, Compend. d. Helm., p. 119. 1883, Pauly and Zurn, Deutsche Zeitschr. f. Thiermed., ix., p. 200.—1886, Leidy, Proc. Acad. Nat. Sci. Philad., p. 310.—1890, Stossich, Boll. Soc. Adriat. Sc. Nat., Trieste, xii., p. 12.—1895, Railliet, Traité Zool. Méd. et Agric., 2nd edit., pp. 485-486.—1898, *Trichosoma columbae*, Stossich, Program. civ. Scuola reale super., Trieste.—1899, *Trichosoma tenuissimum*, Perroncito, Giorn R. Soc. Acad. veterin. ital., xlviii., n. 38, p. 889.—1901, Tartakowski, Archiv. veter. Nauk, p. 1045.—1905, Neumann-Macqueen, Parasites and Par. Diseases Dom. Anim., 2nd edit., p. 414.—1906, Barbagallo, Boll. Soc. culto. sc. med.-natur. Cagliari, ii., n. 4, p. 143.—1912, Parona, L'Elmint. Italiana, ii., p. 118.—1912, *Trichosomum columbae*, Neveu-Lemaire, Parasit. Anim. Dom., Paris, pp. 764-765.—1914, *Capillaria dujardini*, Travassos, Brazil-Medico, xxviii., p. 429.—1915, Travassos, Rio de Janeiro, Mem. Instit. Oswaldo Cruz, vii., pp. 153, 160.

Found in about equal numbers with *Cephalostrongylus columbae* in the intestines of the same bird. The measurements correspond fairly closely with those given by Dujardin. The males are from 8.4 to 11.7 mm. long, and the anterior part, occupied by the oesophagus, is a little less than half the total length, in a specimen 9.7 mm. long the proportions being 4.64 : 5.06. The females measure from 13 to 16.24 mm., and the relative lengths of anterior and posterior portions 6.24 : 10. The diameter at the anterior end is about 0.006 mm. In a male of 11.3 mm., the maximum diameter is 0.049, at the posterior extremity 0.028, at the base of the oesophagus 0.039, and about the middle of the oesophagus 0.026 mm. The spicule, 1.44 mm. long, has an almost uniform width of 0.007 mm., but is swollen at its anterior extremity into a hollow open knob 0.020 mm. wide (Text-fig. 13). At its posterior extremity it is bluntly rounded (Text-fig. 14). It is enclosed in a sheath which is very distinctly marked with transverse striae at intervals of 0.002 mm. in the posterior part, the striae be-



Text-figs. 7-14. *Capillaria columbae.*
7. Anterior end. (x 230). 8. Posterior end of female. (x 230), *an.*, anus; 9. Posterior end of male. (x 230); 10. Region of junction of oesophagus *(oe.)* and intestine *(int.)*. (x 230). *b.*, bacillary band; *l.*, lumen of oesophagus; *n.*, nucleus; 11. Vagina and uterus, containing eggs. (x 140); 12. Egg in terus. (x 230); 13. Anterior end of male spicule. (x 230); 14. Posterior end of spicule, in sheath. (x 230).

coming finer, and more indefinite towards the anterior end. In a few specimens a considerable portion of the sheath is everted, and the spicule is projecting, but in the majority the spicule is withdrawn some distance into the interior of the body. It shows delicate, but irregular, cross markings. The cloacal aperture is terminal, and is provided with a small bursa-like structure, consisting of two lateral lobular projections of the internal protoplasmic substance, connected by a delicate membrane. Travassos states it to be three-lobed, and in side view it has this appearance (Text-fig. 9).

In the females the maximum diameter is 0.060 to 0.067 mm., at the base of the oesophagus 0.019 mm., middle of oesophagus 0.036 mm., and at posterior extremity, which is bluntly rounded (Text-fig. 8), 0.030 mm. The anus is subterminal, and the vulva opens on a very slight prominence 0.026 mm. behind the junction of oesophagus and intestine. The muscular vagina into which it leads is 0.224 mm. long (Text-fig. 11). The eggs nearest to it measure 0.044 by 0.023 mm. There are two lateral bacillary bands extending along the whole length of the body (Text-fig. 10). In both sexes the width is from ¼ to ⅓ the diameter of the body. The spots on their surface, corresponding to unicellular glands, are irregularly distributed, and vary in size. According to Jagerskiold (1901) these glands replace the ordinary Nematode excretory system in this family. The general structure of *Capillaria columbae* corresponds very closely with the description given by Shipley (1909) of *Trichosomum longicolle*. The cells of the "cellular body" or oesophagus (Text-fig. 10) are from 0.096 to 0.143 mm. long, and are marked, by circular constrictions, into a series of from 8 to 12 segments. An oval nucleus (n.) 0.023 by 0.018 mm. in size, is centrally situated in each cell, and the very fine lumen of the oesophagus (Text-fig. 10,*l*) extends through the middle of the single row of cells. Two lobes can be seen of the glandular body situated at the junction of oesophagus and intestine.

In 1914 Railliet and Henry separated the sub-family *Heterakinae* from the family *Ascaridae*, and raised it to family rank, including in it all polymyarian Nematodes in which a pre-anal sucker is present in the male. In this family they included Dujardin's old sub-genus of Ascaris, *Ascaridia*, which had been united by Schneider, and all subsequent workers, with the genus *Heterakis*. The species found in different Columbiformes and commonly known as *Heterakis maculosa* forms one of the thirty-four species enumerated by them as belonging to this genus.

According to this classification, its systematic position is as follows:—

Family HETERAKIDAE Railliet and Henry, 1914.

Genus ASCARIDIA Dujardin, 1845.

Species *Ascaridia columbae* Gmelin, 1789.

Generic diagnosis (from Railliet and Henry 1914).—Mouth with three lips. Oesophagus club-shaped, without bulb. Generally two lateral membranes. Male with feeble caudal wings; spicules equal or sub-equal, without accessory piece; preanal sucker slightly projecting, rounded, with horny ring; papillae relatively large. Female with vulva towards the middle of the body; uteri divergent; eggs with thick shell, with a clear granulation inside the shell, at one of the poles.

ASCARIDIA COLUMBAE Gmelin.

1782, *Ascaris teres*, Goeze, Naturg., p. 84, Pl. 1. fig. 6.—1789, *Ascaris columbae*, Gmelin, Syst. Natur., p. 3034.—1809, *Ascaris maculosa*, Rudolphi, Entoz., ii., 1, p. 158, Pl. 1, figs. 14, 16.—1802, Rudolphi, Wiedem. Arch., ii., 2, p. 22.—1819, Rudolphi, Synops., p. 45.—Bremser, Icones helm., Pl. iv., figs. 25-28.—1842, Civinini, Catal., Lucca.—1844, Bellingham, Ann. Mag. Nat. Hist., xiii., p. 170.—1845, *Ascaridia columbae*, Dujardin, Hist. Nat. d. Helm., p. 219. —1851, Diesing, Syst. Helm., ii., pp. 182-183.—1861, Diesing, Sitz. k. Akad. Wien, xlii. (Revis. d. Nemat.), p. 666.—1857, *Ascaris teres*, Prestal, Allgem. deutsch. naturh. Zeitg., iii., p. 353.—1858, Leuckart, Troschel's Arch., ii., p. 108. —1866, *Heterakis maculosa*, Schneider, Monogr. d. Nemat., p. 72, tab. iii., fig. 11, text-fig.—1871, *Ascaris* sp., Krefft, Trans. Ent. Soc., N.S.W., 2, p. 212.—

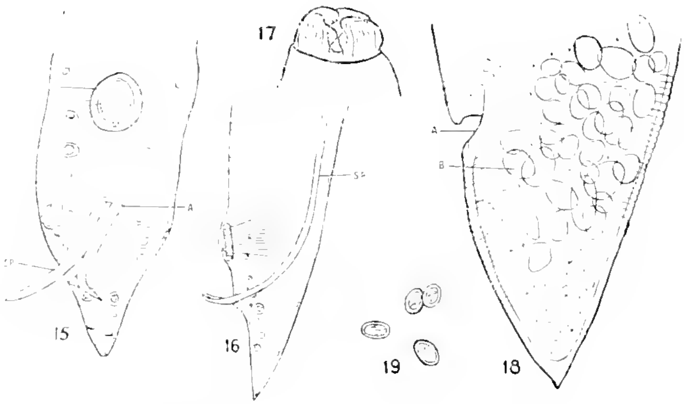
1878. *Heterakis maculosa*, Linstow. Compend. d. Helm., p. 119.—1868. *Ascaris maculosa*, Unterberger. Oest. Viert. f. wiss. Veterin., p. 38 —1877. *Heterakis maculosa*, Ercolani. Mem. accad. sc. istit. Bologna. ser. 3, vii., pp. 465-467.—1877. Bassi. Il. med. veterin., Torino, vi., 4, pp. 232-236, and in Giorn. med. veterin. practica. Torino.—1887, Parona. Ann. Mus. civ. Genova, xxiv., ser. 2, iv., pp. 275, 483.—1889, Linstow, Comp. d. Helm., Nacht., p. 43.—1890, Stossich, Boll. Soc. adriat., Sc. nat., xii., p. 49.—1891, Stossich, Boll. Soc. adriat., xiii., p. 109.—1892, Neumann, Traité d. malad. parasit., 2nd edit.—1893, Stossich. Boll. Soc. adriat., xiv., p. 83.—1895, Railliet. Traité d. zool. med. et. agric., 2nd edit., pp. 406-407.—1898, Stossich, Progr. civ. Scuola reale super., Trieste. —1899, Linstow, Mitt. Zool. Samm. Mus. Berl., 1 (2), p. 11. taf. II. fig. 17.—1896, Galli-Valerio. Manuale parassit., Milano.—1901. Galli-Valerio. Bull. Soc Vaudoise Sc. Nat., xxxvii., p. 343.—1901, Messner. Zeitschr. f. Fleisch u. Milch hygiene. xi., p. 241. 1902. Perroncito. I parassiti. 2nd edit., p. 380.—1902, Lisi, Il nuo Ercolani. Pisa, an. vii., p. 211.—1905, Stiles and Hassall. Bur. Anim. Indust., Bull., 79, p. 118.—1905, Neumann-Macqueen, Parasit., 2nd edit., pp. 413-414.—1904, Sabrazes and Salm, Gaz. hebd. d. sc. méd. de Bordeaux, p. 117.—1906, Barbagallo, Boll. Soc. culto. Sc. med.-natur. Cagliari. an. xi., p. 143.—1907, Neumann, Parasites et mal. parasit. des oiseaux dom., pp. 146-148. —1907. Alessandrini. Boll. Soc. Zool. ital., Roma. ser. 2. viii., pp. 220-221.—1907. Alessandrini. Ann. d'Igiene. Roma. n.s.,xvii., pp.323-329. 1 tab.—1909. Alessandrini. Ann. d'Igiene speriment., Roma, p. 497.—1909. Hautefeuille. Amiens Bull Soc. Linn., xix., No. 392, pp. 429-431.—1912. Neveu-Lemaire, Parasitol. Anim. Dom., Paris, pp. 677-679.—1909, Johnston. Proc. Linn. Soc. N.S. Wales. xxxiv., p. 412.—1910, Johnston. Proc. Roy. Soc. N.S.W., xliv., p. 121.—1911, Wolffhugel, Rev. d. Centro Est. de Agronomia y Vet., Buenos Aires, p. 78.—1912, Johnston, Rep. Gov. Bur. Microbiol. N.S.W., ii., p. 135. —1912. *Ascaridia maculosa*, Railliet and Henry. Bull. Soc. Pathol. exot., v., No. 4, p. 251.—1913. *Ascaridia columbae*, Travassos. Mem. d. Instit. Oswaldo Cruz, v., 3. pp. 289, 291. Pl. 28, fig. 16.—1914 *Ascaridia maculosa*, Railliet and Henry, IXe Congrès Internat. d. Zool., Rennes, p. 678. 1918. *Ascaridia columbae*, Johnston. Mem. Queensland Mus., vi., pp. 171-174.

In the same bird which harboured *Cephalostrongylus quadriradiatus* and *Capillaria columbae* were two large specimens, apparently of this worm. One was inadvertently thrown out with the faeces, and the other consists of the posterior half, only, of a female.

More recently, Dr. Cleland handed me a phial containing a large number of preserved specimens of this species. He informs me that they were found in great numbers, closely packed, in the intestines of some young squabs, sent to the Board of Health for post-mortem examination, and were considered to have caused their death.

Dr. Harvey Johnston says (1918, p. 171): "The parasite was found in several Brisbane pigeons, occurring in some of them in considerable number, many of the worms reaching a large size."

In other parts of the world it is a common parasite of the pigeon, and is well known as the cause of a serious, and often fatal, helminthiasis, especially in the case of young squabs; but it has evidently not been noted, hitherto, as the cause of mortality among pigeons in this State. Inquiries from the manager of a large squab company in Sydney elicited the information that several squabs, ranging in age from three to four weeks, had died within a few months from an unknown cause, and the symptoms described seem to point to the presence of this worm. In view of the importance of the industry of squab raising, and the possibility of successful anti-helminthic treatment, it is desirable that all cases of the occurrence of the worm should be carefully noted. In 1868 Unterberger called attention to the pathological effects of the parasite, and various writers since,



Text-figs. 15-19.—*Ascaridia columbae*. (x 38).
15. Posterior end of male, ventral view; 16. The same, lateral view. *s.*, sucker; *sp.*, spicule; *a.*, anus; 17. Anterior end, showing the three lips; 18. Posterior end of female. *a.*, anus; *b.*, corpuscles in interior of body; 19. Eggs. (x 38).

including Hautefenille and Alessandrini, have dealt with the same subject. The results of their researches, and the treatment adopted to cope with the disease, are given in most modern text-books on helminth parasitology.

It seems probable that the worm is of fairly general occurrence in pigeons, but only occasionally in such numbers as to give rise to morbid conditions. Early helminthologists, describing this Nematode, make no mention of any disease caused by it.

Some measurements of the specimens found here are:—

Males, 29 to 31 mm. long. Females, 31 to 37 mm. Maximum diameter, 1.3 to 1.6 mm. Diameter at base of lips 0.22 to 0.32 mm. Anus in female 1.20 mm. from tip of tail, in male 0.40 to 0.51 mm. Preanal sucker 0.20 by 0.16 mm. Spicules 1.7 to 1.9 mm. long. Eggs 0.048 by 0.072 mm. The number and arrangement of the papillae on the male tail are shown in Text-figs. 15 and 16. The characteristic, large "orbicular corpuscles" in the interior of the female body, mentioned by Dujardin, from which the specific name *maculosa* was derived, are very noticeable (Text-fig. 18 *b*).

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A FEW NOTES ON THE BOTANY OF LORD HOWE ISLAND.

(Sixth paper.*)

By J. H. Maiden, I.S.O., F.R.S., F.L.S., Government Botanist and Director of the Botanic Gardens, Sydney.

Since the publication of my last paper, the following have appeared:—

1. "A revised list of Norfolk Island flora, with some notes on the species," by Robert M. Laing. *Trans. N.Z. Inst.*, xlvii., 1915.

2. "The vegetation and flora of Lord Howe Island," by W. R. B. Oliver. *Trans. N.Z. Inst.*, xlix, 1917, 94. Free access was given Mr. Oliver to the Lord Howe and Norfolk Islands collections in the National Herbarium, Sydney, when he was preparing his paper.

Mr. J. L. Boorman paid a visit to Lord Howe Island from February to April of the present year, on business of the Board of Control of the Island, and took the opportunity of making botanical collections for the National Herbarium, Sydney.

The vast majority of the plants he brought have already been recorded, but the following presumably indigenous species are believed to be new records:—

1. *Malvastrum tricuspidatum* A. Gray. 2. *Erythraea australis* R.Br.

I am aware that there may be a difference of opinion as to whether they are truly indigenous, judging from observations in regard to the Norfolk Island flora (*see* Laing).

He collected *Mesembryanthemum australe* Sol., recorded by Oliver, p. 137; also *Kyllinga monocephala* Rottb. (Oliver, p. 128).

Messrs. H. T. Wilson and E. King brought specimens of *Adiantum formosum* R.Br. (name confirmed by Mr. T. Whitelegge) from the south-west slope of the Island, locally known as the "Little Slope," near the salt water. "Grows 2 ft. 6 inches, and very strong, and not noticed before." This fern does not appear to have been previously recorded from the Island.

Mr. Boorman brought specimens of a variegated Palm, and in view of the fact that variegation is not a common character in the Family, it is worthy of record. The plant is *Howea Forsteriana* Becc., and a pleasing parallel variegation extends throughout the plant, affecting both rachises and leaflets. The tree (the only one on the Island), is about 30 feet high, and probably 30 or 40 years of age. It is growing at Erskine Valley, near the Burnt Hut.

*Previous reference, These Proceedings, xxxix., 1914, p.377.

Oliver (p. 129) draws attention to Hybrids of *Howea*. I have had some of these plants under observation since 1910, but hesitated to publish anything, as I desired to keep them under observation. My original plants came from the holding the late Edward King, who had four trees. Five additional plants (from the same locality) were obtained from the late Rev. W. W. Watts in September, 1916.

Mr. Boorman reports that during his exploration of the more coastal areas of the Island, he met with several additional instances of hybrid *Howeas*, more particularly at the north end of the Island in the vicinity of the rifle-range; also on property occupied by a Mr. Campbell Stevens, and by Mr. Thompson adjacent. They all appeared to be of the same character as those on Deep Creek to the south-west of the Island, already referred to.

I contrasted the hybrids in 1916 with *H. Belmoreana* and *H. Forsteriana* as follows:—

1. *H. Belmoreana.*	2. *H. Forsteriana.*	3. Hybrid.
(*a*) Leaf segments converging upwards.	(*a*) Drooping.	(*a*) and (*b*) Leaf segments and fruiting spikes as in *H. Belmoreana*, and its fruits barely separable from that species. The midrib of the leaf has the leaflets (segments) converging upwards, but not quite so curly as *H. Belmoreana*.
(*b*) Fruit spikes elongated (individual).	(*b*) Fruit spikes shorter than those of *H. Belmoreana* (clustered at the base, from 3 to 8.)	
(*c*) Fruits plump, produced into a shortly truncate apex.	(*c*) Longer and narrower than those of *H. Belmoreana*, the truncate apex not produced.	(*c*) Colour of fruits dull carmine lake (Plate 106, shade 4), with a base of cherry red (Dauthenay's Répertoire de Couleurs, Plate 91, shade 3).

Mr. E. N. Ward (18th August, 1920) reports on these hybrid *Howeas* as follows:—

"They are very variable in size, habit and colour of stem. Five are still in pots in the small bush house. The five planted out in November, 1916 have grown well; two of these are in the palm bed in section 9 in the Lower Garden, one in bed 25 near the *Keteleeria japonica* tree, and one in bed 20 in the Middle Garden. The other is on the western side of the creek, Upper Garden.

Of the four planted eleven months later, only one is alive and that is doing badly in bed A, lawn 22, Lower Garden. These were planted on low lying ground, very wet in winter, and while these conditions suit some palms they did not suit these hybrids."

The following introduced plants collected by Mr. Boorman appear to be new records:—

COMPOSITAE.—*Ageratum conyzoides* L. (Garden escape); *Galinsoga parviflora* Cav.; *Aster subulatus* Michx.; *Eupatorium cannabinum* L.

CRUCIFERAE.—*Sisymbrium officinale* L.

LABIATAE.—*Stachys arvensis* L.

SOLANACEAE.—*Datura Stramonium* L.; *Nicotiana alata* Link and Otto (Garden escape).

UMBELLIFERAE.—*Daucus brachiatus* Sieb.

LILIACEAE.—*Asparagus plumosus* var. *nanus* Baker (Garden escape). (Not in flower or fruit, and therefore subject to confirmation. Its tough stems point it out as likely to become a pest.)

GRAMINEAE.—*Dactyloctenium aegyptiacum* Willd.

SPECIAL GENERAL MEETING.

14TH JUNE, 1920.

IN COMMEMORATION OF THE CENTENARY OF THE BIRTH OF SIR WILLIAM MACLEAY.

Mr. J. J. Fletcher, M.A., B.Sc., President, in the Chair.

Presidential Address,

"THE SOCIETY'S HERITAGE FROM THE MACLEAYS."

Yesterday (Sunday, 13th June) was the centenary of Sir William Macleay's birth. At that time George iv. was King. The Princess Alexandrina Victoria, afterwards Queen Victoria, was an infant about thirteen months old. "Science all over the world" was about to lose "its Nestor," Sir Joseph Banks, whose splendid labours ended six days later (on June 19th, 1820). William Sharp Macleay, cousin of William, had published his first contribution to scientific knowledge, Part i. of the Horæ Entomologicæ, in the preceding year, 1819. Part ii. of the same work was published in the year following (1821), so that William Macleay was born in the interval between the issue of the two Parts.

Coming nearer home—Sydney, the first British settlement in Australia, had been founded a few months over thirty-two years. Major-General Lachlan Macquarie was Governor of New South Wales. Not quite five years before, the explorations of Blaxland, Lawson and Wentworth, and later of Evans, and the subsequent construction of a road over the Blue Mountains by William Cox, had made it possible for the Governor, "accompanied by his lady, and followed by a numerous retinue," including J. W. Lewin, artist, to journey to Bathurst Plains, and fix upon the site for the township of Bathurst. Railways, telegraphs, steamers, penny postage and postage stamps were then unknown.

Of the century now ended, into which William Macleay was born, he spent about eighteen years and nine months in Scotland, his native land, and on the voyage out to Australia. For nearly fifty-three years he resided in New South Wales, except for a few months on his expedition to New Guinea in 1875. His fruitful labours ended somewhat more than twenty-eight years ago.

Sir William Macleay, by his example and influence, and by his own efforts during a period of about seventeen years, and by his benefactions, largely made the Linnean Society of New South Wales possible in its present developed form. The sustained co-operation and help of a long succession of members, extending over a period of more than forty-five years, have contributed to make it what it is to-day. A question in which we are interested, and that may be asked in a legitimate way, is: How came he to be so interested in science as to become first of all a scientific worker; and then later on, to undertake the role of benefactor and promoter of Natural History, in the broad sense, in New South Wales? What were the elemental circumstances which shaped his career, from a scientific standpoint?

Unfortunately we have no autobiographical information, and very little in the way of biographical details, which will supply satisfactory answers to these questions. Nevertheless, there are some records of important facts, which, when one knows how to correlate them, will supply an outline of the story of his scientific life. These will be considered later in their proper place. Just at the present stage, it suffices to say that, when the facts are appreciated, it is realised that William Macleay does not stand alone; but that, primarily, he was largely the product of family influence and example; and the last and youngest of a succession of Macleays interested in science, in which, under the circumstances, it was natural that he should take his place. For this reason alone, the Society is interested in the Macleays. But there are other reasons also.

The Society's Hall, which it owes to the generosity of Sir William, is located on part of the old garden, which was laid out by Alexander Macleay about ninety-two years ago. The old home is in the immediate neighbourhood. Many distinguished visitors, who knew the occupants of Elizabeth Bay House, have left records of their visits and experiences.

Alexander Macleay may be called the "Father of Zoology" in Australia. He brought his collection of insects and his library with him from England in 1825, and ended his days here. When he left England, his collection was considered to be the finest in the possession of a private individual. The amalgamated collections of Alexander Macleay, W. S. Macleay, and William Macleay were presented to the University of Sydney in 1889, to form the nucleus of the Macleay Museum. I may remind you that one of the conditions attached to the gift was—"That the [Macleay] Museum should be made easily accessible to students of Natural History and members of the Linnean Society of New South Wales."

The Macleays were uninterruptedly associated with the Linnean Society of London, as Fellows, for a period of ninety-seven years (1794-1891), and for twenty-seven years Alexander Macleay was Secretary. For about forty-seven years they were Members of the governing body of the Australian Museum or of its forerunner, the Colonial Museum.

The Society has interesting memorials of all of them, as well as of some of their scientific and other friends and contemporaries.

The two branches of the family in which we are interested have now come to an end, in the direct line. In the sense in which I mean it, the Society may be considered to have inherited the family scientific traditions, as well as some of the family possessions.

The original sources of information of a biographical character concerning A. and W. S. Macleay are brief obituary notices which were published in the *Sydney Morning Herald*, and the memorial notices of them, as Fellows, communicated to the Linnean Society of London. Later notes in various Biographical Dictionaries or elsewhere, are based on one or other of these, usually the second. It is possible to amplify these to some extent in respect of matters in which we are specially interested, but the sources of information are fragmentary and scattered. Anything like detailed formal biographies, or even satisfactory biographical sketches, are not possible, from a lack of adequate material.

It is to be remembered, too, that the Macleays were interested in Science for its own sake, and as a study to be cultivated in their leisure hours. Less than a century ago, an interest in Zoology was a good asset for a hobby, especially for a man of means and leisure, but an unfruitful one for embarking on a professional career. One of a later generation who ventured to make the experiment, Edward Forbes (1815-54), almost repented of his choice of Zoology as a profession. Writing to his friend Thompson in January, 1847, he said: "The more I see, the more I am convinced, that no man should take up Science as his profession, unless he has some independence to fall back on." (Memoir of Edward Forbes, F.R.S., by G. Wilson and A. Geikie, p. 410, 1861.)

A lack of uniformity in the mode of spelling the family surname will be noticeable. By the members of the family in the old days, MacLeay was the customary way; but, in their later years, both W. S. and William Macleay signed their names in the manner to which we are accustomed. By writers outside the family, the name was sometimes written McLeay or M'Leay.

W. S. Macleay's Christian names were William Sharp, and not William Sharpe, as so often printed.

Alexander Macleay, F.R.S., F.L.S.

Born in the County of Ross, June 24th, 1767—Chief Clerk of the Prisoners of War Office, 1795—Head of the Department of Correspondence of the Transport Board, 1797—Secretary of the Board, 1806-1818—Colonial Secretary of New South Wales, 1825-1836—First Speaker of the Legislative Council, 1843-46—Died in Sydney, July 19th, 1848.

No definite record of the beginning of Alexander Macleay's interest in Entomology is available. But his election to the Linnean Society, in 1794, offers a suggestive clue. The inaugural meeting of the Society, convened by Dr. J. E. Smith, the possessor of the Linnean collections, was held on 26th February, 1788, seven Naturalists being present, one of whom was Thomas Marsham. At the second meeting, on 18th March, six gentlemen were present. The roll of the foundation members was made up consisting of twenty ordinary Fellows, including the Rev. William Kirby, three Honorary Fellows, including Sir Joseph Banks, and eleven Associates. Dr. J. E. Smith was elected President, and T. Marsham Secretary. At the third meeting, "at the Opening of the Linnean Society," on 8th April, the President delivered a "Discourse on the Rise and Progress of Natural History."

A. Macleay was elected a Fellow of the Society about six years afterwards, in 1794. In the absence of more exact information, his election may be taken to imply an awakening interest in natural history, and particularly entomology. It is probably true that his friendship with Marsham and Kirby spurred his pursuit of entomology; just as, at a later period, "close relations" with Kirby and Spence, and Alexander Macleay, are said to have spurred W. J. Hooker's pursuit of entomology in his early days, before he devoted himself entirely to botany. In 1798, Marsham retired from the position of Secretary, and was appointed Treasurer; while A. Macleay succeeded him as Secretary. His service in this capacity lasted for twenty-seven years, until May, 1825, when he resigned, in consequence of his contemplated removal to Australia, to fill the position of Colonial Secretary of New South Wales.

We have, unfortunately, no autobiographical details of his experiences as Secretary of the Linnean Society, or of the eminent scientific men of the day whom he came to know; and very little can be gleaned from the Society's printed records. Nor, beyond the bare statement of his official connection with the Transport Board, have any details of his work in that direction come down to us.

The obituary notice of Alexander Macleay read at the Anniversary Meeting of the Linnean Society of London, 24th May, 1849, subsequently printed in the Proceedings (Vol. ii., p. 45), brief as it is, is the most complete biographical sketch at present available. In this it is stated that—"As a naturalist, Mr. MacLeay devoted himself almost exclusively to the study of insects, of which he had formed, previous to his quitting England, the finest and most extensive collection then existing in the possession of a private individual. Of this great class of animals he possessed an intimate knowledge, without, however, having published anything on the subject, although he had made preparations for a monograph of the singular genus *Paussus*, in which his cabinet was peculiarly rich."

The history of the collection is briefly but imperfectly given in Barff's "Short Historical Account of the University of Sydney" (1902). To this I shall refer later. I am now able to give a more complete account of it. In outline, but the particulars will be given in chronological order as far as possible, the collection at the time of its arrival in Australia, in 1826, represented the British or European insects collected by Alexander and W. S. Macleay themselves, of the results of exchanges with their friends, of specimens purchased from at least six noted private collections, in one case during the owner's lifetime, or in the others on the dispersal of their collections by sale after the decease of the owners, and of acquisitions of specimens from Brazil, India, North Africa, Australia, and elsewhere, some of them possibly donations, but the details of their acquisition are wanting. The fragmentary history of A. Macleay's collection is the most important source of information we have about the development of his interest in zoology.

Thomas Marsham (ob. 1819), and the Rev. William Kirby (1759-1850), Rector of Barham, near Ipswich, in Suffolk, seem to have been the two earliest scientific friends of Alexander Macleay, who profoundly influenced him. They were both senior in age, and as Fellows of the Linnean Society, keen entomologists, and owners of important collections. Marsham's collection was eventually sold in 1819, a few months before his decease; Kirby's was presented to the Entomological Society soon after its foundation, in 1833. As Kirby lived in the country, when railways were unknown, his visits to London were infrequent; but he corresponded regularly with his scientific friends. His biography, "Life of the Rev. Wm. Kirby," by John Freeman, now a scarce book, was published in 1852. This is the only available source of information about much that relates to Alexander Macleay that is of interest to us. I have been glad to make use of it, and gratefully acknowledge my indebtedness.

A very interesting account of an entomological excursion by Marsham and Kirby into the Isle of Ely, Northamptonshire, and home by Huntingdonshire, Cambridge, and Norwich, in July, 1797, is given in Freeman's "Life." Brief reference is also made to an entomological excursion by Kirby, Marsham, and Alexander Macleay; but neither the date nor scientific details are given.

But a letter, to Kirby, dated "Transport Office, 5th November, 1802," is of the greatest interest, because it is the earliest record, by himself, of his interest in entomology that we have, written after his return from a visit to Scotland: "My dear Friend,—I return you my best thanks for your letter, which I would have answered from Caithness, if I had met with anything worth communicating. But I could only tell you of my being prevented from looking after insects by continued rains, snow, and high winds, during the whole of my stay in the county. Indeed, so bad a season was never known; and a more serious consequence than my entomological disappointment is, that the crop of oats in Caithness has almost entirely failed. Notwithstanding the unfavourable state of the weather, however, I was much gratified by my visit to the north. I had reason to believe that very considerable improvement had been made in my native county during the sixteen years I had been absent; but, I assure you, I found the county improved far beyond my most sanguine expectations." . . . .

"In order that I might see as much as possible of the north of Scotland, I visited the Orkney Islands, and the north coast of Scotland, as far as Cape Wrath." . . . .

"Through the whole of my travels, I lost no opportunity of collecting insects. Indeed, I collected almost every one that I saw. I have, in the whole, about 250 or 300 specimens, but they are not yet arrived here; and I know not whether there be anything new. There are very few Hymenoptera. If there be any duplicates worth your having, they are yours."

The offer of duplicates of Hymenoptera recalls the fact that, in the early part of the year, one of Kirby's many contributions to science had been published, "Monographia Apum Angliæ," Ipswich, 1802.

Alexander Macleay's collection thus probably began with British insects which he himself collected, or obtained by exchange with his entomological friends. The earliest published reference to his active interest in exotic insects known to me is to be found in a "Memoir of Dru Drury," contained in Vol. xv., of "The Naturalist's Library," presumably written by the Editor, Sir William Jardine (1846). The writer says: "An individual to whom Drury showed much kindness, in the hope of being supplied through his means with the insects of New South Wales, was J. W. Lewin, author of a small, but original, and really valuable work, entitled "A Natural History of the Lepidopterous Insects of New South Wales." It appears from Lewin's letters that he was in a great measure illiterate, and had been subjected to many difficulties so that it was a good while before he could do much towards the fulfilment of Drury's wishes. They continued, however, to communicate with each other for a considerable time; Drury supplying goods to no small amount, which were to be repaid in insects. In his necessities, Lewin is not backward in his demands on the liberality of his friend, who supplied him, among many other miscellaneous articles, with the copperplates on which he engraved his insects and birds, and even with the paper for printing them. Thomas Marsham, author of the Entomologia Britannica, and Alexander Macleay, afterwards united with Drury in advancing money to Lewin while he was at Botany Bay, expecting the value to be returned to them in insects."

Dru Drury [1725-1804] was a very remarkable man, a goldsmith, silversmith, and cutler, and one of the "most zealous and successful collectors of insects that ever prosecuted the study in this country." He was also the author of "Illustrations of Exotic Entomology," 3 vols. (1770-82), "in which he made the most interesting objects of his collection known to the public."

After his death the collection was sold, the sale lasting for three days (May 23-25, 1805). Professor J. O. Westwood issued a second edition of the "Illustrations" (3 vols., 1837), and, in the preface, he gives the names of the purchasers of some of the lots, and the prices paid, as an interesting record. Among those given, Mr. Macleay was the purchaser of Lot 64, "*Papilio claviger* and five others (£7 10/)"; Lot 104, "Thirteen species of the Buprestis genus (£8)"; Lot 112, "*Cetonia hamata, nitens, grandis, Scarabaeus festivus,* and 12 others (£17)"; and Lot 123, "A variety of small insects of the *Mordella, Forficula,* and other genera, among which are *Diopsis Ichneumonia,* and also a species of Paussus, 37 specimens (£7)."

The first published reference to Alexander Macleay's collection, that I know of, is to be found in the Preface to "An Epitome of the Natural History of the Insects of New Holland, New Zealand, New Guinea, Otaheite, and other Islands in the Indian, Southern and Pacific Oceans; with Descriptions and one hundred and fifty-three beautifully-coloured Plates of the more splendid, beautiful, and interesting Insects, hitherto discovered in those Countries," &c.: By E. Donovan, F.L.S., published in 1805. Besides specimens in Sir Joseph Banks' collection, and in his own, some of them purchased at the sale of Drury's Collection, "The author has also further to acknowledge the benefit he has derived from inspecting two other cabinets of celebrity in this country, without the assistance of which the present illustration would have been far less copious and interesting than it is at this time: these are the cabinets of Mr. Francillon, and that of A. Macleay, Esq., to both of whom he begs leave to express his warmest thanks for this testimony of their friendship." The copy of this rare book in the Society's library was purchased and presented by Sir William Macleay, the only copy of it which he had seen.

Another letter from A. Macleay to Kirby, dated 20th February, 1805, is of very special interest. The writer says: "I have been describing eighteen Botany Bay Lepidopterous insects which are about to be published by Lewin, with all their changes and natural history. Amongst them there is a most distinct new genus (in my opinion), which I propose to name *Nycterobius* from Νυκτοροβιος *Noctu victum quaerens.* The caterpillars form for themselves holes in the trunks of trees, where they hide themselves in the daytime: at night, they come out and gnaw off leaves, which they drag to their holes; and when they have provided a sufficiency for the next day's consumption, they retire and feed leisurely, with their heads towards the mouth of the hole, which is covered by a curious contrivance. . . . Pray when shall we see you in town?"

The first edition of Lewin's book, entitled "A Natural History of the Lepidopterous Insects of New South Wales. Collected, engraved, and faithfully painted after Nature. By John William Lewin, A.L.S., late of Parramatta, New South Wales. Illustrated with 18 Plates (small 4to)," was published in London in the same year, 1805. Some time before its publication, however, a circular entitled "Proposals for publishing by subscription a small work of Phalæna Insects of New South Wales" had been distributed. A second edition, with an additional plate, was issued in 1822. The book was dedicated to the Right Hon. Lady Arden, "in grateful remembrance of that goodness which gave the author an opportunity of employing his talent, as it were, in a new world." As already mentioned, Drury, Marsham, and Macleay also assisted Lewin.

J. W. Lewin and Thomas Lewin were the sons of William Lewin, F.L.S. (ob. *c.* 1795) the "best zoological painter, and one of the most practical naturalists of his day" (Swainson), and author of "The Birds of Great Britain" (7 vols., 1789-95; second edition, 8 vols, 4to., 1796-1801), "The Insects of Great Britain" (1 vol., 4to., containing the Papilios only, 1795), and of a paper, "Observations respecting some rare British Insects" (Trans. Linn. Soc., Vol. iii., 1797); and a contemporary of Dru Drury, and A. Macleay. Drury was always on the lookout for opportunities of getting into touch with intending travellers and others about to visit foreign countries. In 1771, with the financial co-operation of Sir Joseph Banks, the Duchess of Portland and some others, he had enabled Henry Smeathman to go to Africa as a travelling naturalist and collector. With his knowledge of the Lewin family, he was able to get into touch with J. W. Lewin before the latter left for Australia.

J. W. Lewin arrived in Sydney in 1800. The plates for his book were engraved and coloured by himself in 1803, in Parramatta. They were the earliest engravings produced in Australia. The text was printed in London, bound up with the plates as sent home to his brother Thomas Lewin, and issued as a book in 1805. But with the plates, J. W. Lewin sent home a made-up complete copy, with a title-page and some text in manuscript, as far as he could complete it. This copy, together with the original coloured drawings of some of the larvæ and pupæ, were afterwards acquired by Alexander Macleay, and are now in the Society's possession. Possibly examples of the perfect insects, and a letter of supplementary information may also have been sent; but if so, there is no available record of them. A comparison of the original copy with the book as published, explains what is stated in Macleay's letter to Kirby.

J. W. Lewin was an artist, a good observer, and a practical entomologist, but without technical knowledge, and without books. The text, as he sent it to England, was insufficient, and not in a suitable form for publication. It consisted merely of the explanations of the figures, more or less copious, of the larvæ and their habits, but without descriptions of the perfect insects, to which only fanciful vernacular names were given. The title-page was "Natural History of Eighteen Nondescript Moths with Descriptions," &c.

Thomas Lewin was an artist, and had not quite all the necessary technical knowledge to enable him to supply the deficiencies in the text, as written by his brother, notwithstanding the statement in the last sentence of the Preface: "Of the style of the publication, and the arrangement of the subject, we can only say, being well instructed in the Field of Nature, we have endeavoured to render the book useful." As Editor of the contemplated book, therefore, he sought the advice and assistance of the President and Secretary of the Linnean Society, as narrated in the Preface: "And all that was left for us to do was merely to define the genus, and name the individual in some cases, which we have done sometimes from the plant on which the insect is found; and for the names of those plants we make our acknowledgments to the learned President of the Linnean Society, Dr. Smith, and also acknowledge the kind observations of the Secretary of the Linnean Society, Alexander Macleay, Esq., for whose abilities as an Entomologist, we have the highest respect, though we cannot avoid differing greatly from him on some points." Dr. Smith supplied the names of the food-plants, as well as he could, for some of them were without flowers or fruits. A. Macleay offered, or consented after being asked, to draw up the necessary technical descriptions of the perfect insects, with the addition of binomial names; and, judging from his letter to Kirby, did so. What, then, were the points on which Thomas Lewin, as editor of the book, differed from him?

On the evidence, it seems to be a reasonable conclusion that Dr. Smith and A. Macleay successfully opposed the publication of nondescript insects, and that T. Lewin accepted and made use of the technical descriptions; but that, wishing to keep the naming of the insects as much as possible in his own hands, he did not accept all the binomial names proposed by Mr. Macleay, and altered some at least of them to suit his own ideas. The proposed new generic name did not get into print; and A. Macleay certainly cannot be held responsible for the specific names of *Sphinx Ardenia*, *Tortrix Australana*, and especially that of the insect now known as *Charagia lignivora* Lewin, but described and figured in Plate xvi., and referred to in the index, as *Hepialus Lignivoren*. Nor is the expression "Noctua Hepialus" likely to have been his, in the statement—"The larvæ of this beautiful Noctua Hepialus feeds" (sic), &c. From these, and other peculiarities, T. Lewin seems to have been responsible for the form in which all the text, except the technical descriptions and the sectional names, finally appeared.

Another relic of J. W. Lewin acquired by A. Macleay was what seem to be first impressions of three of the plates of Lewin's "Birds of New Holland," the first edition of which was published in 1808. The plates are roughly bound-up with three pages of text in manuscript, without binomial names, or descriptions which an ornithologist would consider satisfactory. They were perhaps intended as a sort of prospectus for possible subscribers to the work.

Some very interesting information about Alexander Macleay's entomological acquisitions are given in a letter from Kirby to his friend Spence, in a letter of date September 24th, 1806: "I have boxes [of insects] from Haworth and [W. J.] Hooker to name. . . . . In London, I went over Sir Joseph's [Banks] *Staphylini;* but there was nothing very remarkable among them, except *S. aureus*, which is of the same family with *S. murinus*, &c. I found several nondescript species in Mr. M'Leay's cabinet, which he purchased from the Leverian Museum, and one large and blue one from old Drury's cabinet. And the piece of entomological news I can tell you—that M'Leay has purchased all Donovan's foreign insects, a most valuable addition to his collection, which, in value, falls not far short of Francillon's." [p. 281.] These are the only records of purchases from the two collections mentioned that I know of. Sir Ashton Lever, who lived at Alkington, near Manchester, brought his collection to London about 1775, where it was opened to the public. It was subsequently disposed of by lottery in 1785, and came into the possession of Mr. Parkinson. It was eventually sold by auction in 1806, the sale lasting about a month. It was a celebrated collection in its day, and the sale attracted much attention. Some of the specimens had been presented to Lever by Captain Cook.

Alexander Macleay's Collection was supplemented by extensive purchases from the collections of Mr. Francillon and Mr. Marsham, in the years 1818 and 1819. We have, in the Society's library, Mr. Macleay's copies of the sale-catalogues of these collections, with MS. notes, possibly representing his purchases. I have been unable to find any biographical details respecting these two entomologists.

The Francillon Collection, a celebrated one in its day, was sold by auction, in June, 1818, shortly after the owner's decease. Charles Lyell, the geologist, was interested in entomology in his younger days. In a letter to his father, written from Yarmouth, on July 20th, 1817, after a visit to London, he says: "I visited the cast of Phidias and (talking of things on a grand scale) the elephant at Exeter Change; also Bullock's Museum. . . . . Saw the whole of Francillon's collection of British and foreign insects, the finest in the world . . . . Let those who wish to have an idea of the magnificence of Nature, visit the elephant, those who wish to judge of her *varietas insatiabilis*, see Francillon's collection" [Life, Letters, and Journals, Vol. i., pp. 40-41, 1881]. The Catalogue speaks of it as undoubtedly "the most magnificent Cabinet of Insects that has ever been brought to sale in this country; containing many unique and remarkable Specimens, and generally in a high state of Preservation." The sale lasted eight days, and realised £725/11/6. The collection was offered in 122 lots, contained in 72 drawers, in three cabinets, of 64, 36, and 24 drawers. One feature of the collection of interest is, that it contained specimens collected and presented to the owner, by Surgeon-General John White, who came out to Australia with the First Fleet, under Captain Phillip, in January, 1788.

Freeman, Kirby's biographer, gives some very interesting details about the sale of Francillon's collection. Kirby attended the sale: "He made some considerable additions to his treasures, though not nearly to the extent of his friend Mr. [A.] McLeay, who purchased little short of half the collection. Mr. W. [S.] McLeay thus notices the circumstances [in a letter to Kirby]—'I understand, from my father, that you are one of the *souls* of the sale of Mr. Francillon's cabinet, giving it life, activity, and, above all, value. I suppose you have added extensively to your collection: as for my father, he has made his as brilliant for the amateur as it is instructive for the entomological student, but to arrange it, 'hic labor, hoc opus est.' The French Museum has been prevailed on to let my father have one of the Hexodons; so that now he will have every described genus of Latreille's family of Lamellicornes' " [p. 349].

Mr. Marsham's collection was sold by auction in September, 1819, about two months before his decease on 26th November following. The owner was a foundation member of the Linnean Society, the first Secretary (1788-98), and Treasurer from 1798-1816. He was the author of the "Entomologica Britannica," of which only the first volume (Coleoptera) was published (1802); and of nine entomological papers contributed to the Transactions of the Linnean Society. His collection was an important one, though not so extensive as Francillon's. The sale lasted for three days. The collection was offered in 115 lots, contained in 36 drawers, in two cabinets, each of 24 drawers. The cabinet of British insects, described in the Ent. Brit. was offered separately in one lot. Twenty-eight additional lots, including the two cabinets, five boxes of insects, a microscope, and sundries, were also offered. But beyond some pencil entries of prices in A. Macleay's copy of the catalogue, no further information is available.

Another important collection, from which Alexander Macleay purchased specimens, was that of General Thomas Davies, of the Royal Artillery, "well known as a most accurate observer of nature, and an indefatigable collector of her treasures, as well as a most admirable painter of them" [Kirby and Spence, Introd. to Entom., i., 108]. W. S. Macleay, in his paper on the "Annulosa of South Africa" (p. 74), published in London in 1838, shortly before he left for Australia, says of *Cerapterus latipes* [Paussidæ]—"The original specimen which General Davies sent to Swederus for description is now in my collection, my father having purchased it at the sale of the General's museum." But neither the sale-catalogue nor any further information are available.

General Davies was interested in birds as well as insects; and he described, with a coloured figure, the Lyre-bird of Australia, in his paper "Description of *Maenura superba*, a Bird of New South Wales," Trans. Linn. Soc., Vol. vi., 1802, p. 207.

Another important addition to the Macleay Collection was the specimens of insects and some miscellaneous invertebrata collected by Captain P. P. King. These are referred to by W. S. Macleay in his paper, "On the Structure of the Tarsus in the Tetramerous and Trimerous Coleoptera" [Trans. Linn. Soc., Vol. xv., p. 68] in these words:—"I had scarcely, however, corrected the press of the first number of that work [Annulosa Javanica], when Captain King of the Navy, one of those enterprising and accomplished navigators who at the present moment confer so much honour on our country, requested me to examine the insects which he had collected during his late expedition to explore the coasts of New Holland." The record of this collection, comprising 192 species of insects, of which 81 were described as new, four species of Arachnida, and about 30 of marine invertebrata, collected, under great drawbacks, by Captain P. P. King during his survey of the Intertropical and Western Coasts of Australia between the years 1818 and 1822, is given in King's "Narrative of a Survey," &c. [Vol. ii., Appendix, p. 438, 1827]. The collection was apparently presented to W. S. Macleay by Captain King. In his paper on "The Genera and Species of the Amycteridæ," communicated to the Entomological Society of New South Wales, by William Macleay, on 7th August, 1865, the author says that the insects originally described by W. S. Macleay in the work above cited, "are in the late Mr. [W. S.] MacLeay's collection now in my possession" [Trans. Ent. Soc. N.S. Wales, Vol. i., p. 267]. The rest of Captain King's collection was apparently presented either to the British Museum or to the Museum of the Linnean Society [Trans. Linn. Soc., xiv., p. 603].

A. Macleay's collection of sale-catalogues comprises five others besides the two mentioned—one of the "collection of insects of a gentleman well-known for his knowledge of Nat. History" [name not given] sold in June, 1814; two of the three parts of the Catalogue of Bullock's London Museum, sold in April-May, 1819, the sale lasting for eighteen days; the catalogue of the duplicates from Mr. Stephens' collection, sold in May, 1825; and W. S. Macleay's copy of the South African Museum [vertebrates, especially birds, and anthropological specimens] sold in June, 1838. The first and second of these have marginal notes in pencil, and may indicate purchases.

Numerous specimens in Alexander Macleay's collection were described, and, in some cases, figured, while in his possession; but others had become type-specimens before he acquired them. Donovan, in his "Epitome" (1805) described and figured certain species, as already mentioned. At a later date, descriptions, sometimes with figures, of specimens in the Macleay Collection were published by Dr. W. E. Leach in his "Zoological Miscellany" (3 vols., 1814-17); by E. Donovan, in the Naturalist's Repository (Vols. i.-iii., 1823-25); by N. A. Vigors, in a series of papers entitled "Descriptions of some rare, interesting, or hitherto uncharacterized subjects of Zoology," in the Zoological Journal, Vol. i., pp. 413 *et seq.*, 537 *et seq.;* Vol. ii., pp 238 *et seq.;* 514 *et seq.* (1825-26); and especially by W. S. Macleay, in the Horæ Entomologicæ (1819-21).

The specimens, mostly of Australian species, described by Dr. Leach from Alexander Macleay's collection, in addition to birds (one, *Polophilus phasianus*, an Australian species), included a Volute (*V. lineata*) and various insects from Australia, including *Phasma violescens* (figured from the splendid collection of Mr. Macleay); *Myrmeleon erythrocephala, Mantis Australiae, Nymphes myrmeleonides, Hipparchia Banksiae*, and *Papilio Macleayanus*, "named after my much esteemed friend, Alexander Macleay, Esq., Secretary of the Linnean Society, to whom I cannot sufficiently express my full sense of his repeated marks of kindness and friendship"; one species from New Caledonia; and one or two from uncertain localities.

The insects described by Vigors included specimens collected in the vicinity of Madras, and brought to England by Major Sale, of the East India Company's service; others from North Africa, collected by Captain Lyon, R.N., the companion of Mr. Ritchie, who died at Mourzouk, on 20th November, 1819; and some from Brazil, collected by Mr. Such.

In the first part of the Horæ Entomologicæ (1819), W. S. Macleay mentions that his father possessed a cabinet containing nearly 1800 species of the Linnean genus *Scarabaeus;* and the study of these, mainly, resulted in his first contribution to knowledge. Specimens were described or recorded from Northern and Southern Europe, North Africa, Cape of Good Hope, Mauritius, Isle of Bourbon, India, East India, China, Java, North America, Georgia, South America, Brazil, Demerara, Cayenne, Trinidad, Jamaica, Australasia, New Holland, and Van Dieman's Land. The material studied in the second part was in other collections, chiefly that of the British Museum.

As evidence that Alexander Macleay's official connection with the Linnean Society had broadened his interest in Natural History, it is interesting to note that this was not wholly confined to insects. At one time he seems to have had a collection of South American bird-skins. This is referred to by two writers. Dr. Leach says of *Lanius lineatus*: "This elegant bird, which is figured from Mr. MacLeay's collection, inhabits Berbice" [Naturalists' Miscellany, Vol. i., p. 22, 1817].

Mr. G. Such, of Magdalen Hall, Oxford, who had resided for some time in Brazil, in describing a new species of the family *Laniadae, Thamnophilus maculatus*, says of it: "I had originally conceived that my specimen was the first which had been brought to England; but I found a second in Mr. MacLeay's collection. . . . . Its chief difference, as has been pointed out to me by Mr. W. S. MacLeay," &c. [Zoological Journal, i., p. 557]. In both these cases the specimens referred to were probably included in the first two of Alexander Macleay's donations to the Museum of the Linnean Society—"34 Birds from Berbice [Trans. Linn. Soc., vol. x., p. 413, 1811]; and "11 specimens of Birds from New South Wales, not before in the Society's collection" [Vol. xii., p. 598, 1818]. This and his third donation of "Two specimens of Quadrupeds, and six Birds from New South Wales," as recorded in Vol xiii., p. 636, 1822, show that he was in receipt of specimens from Australia, other than insects, from undisclosed sources, even at this early period.

Except for a few specimens which W. S. Macleay needed to retain for study, the Macleay Collection, as it was brought out to Australia by Alexander Macleay, in 1825, comprised British insects collected by A. Macleay; British or other European insects collected by W. S. Macleay; gifts from or exchanges with their friends; specimens purchased from at least six important private collections [Dru Drury's, Ashton Lever's (Parkinson's), E. Donovan's, Francillon's, Marsham's, General Davies', and possibly some others]; and acquisitions of specimens from Brazil, India, North Africa, Australia, and elsewhere, possibly some of them donations, but the records of them are indefinite. As mentioned later, some specimens were left with W. S. Macleay to enable him to continue his work on them. These were afterwards brought to Australia by him in 1839.

With the removal of the Macleay Collection to Australia, the most important private entomological collections in England seem to have been the Rev. F. W. Hope's, Kirby's, Stephen's, Haworth's, Westwood's, and Melley's.

Kirby and Spence, authors of the well-known "Introduction to Entomology," thus express their appreciation of the Macleay Collection and of the owner's encouragement: "To Alexander MacLeay, Esq., they are under particular obligations for the warm interest he has all along taken in the work, the judicious advice he has on many occasions given, the free access in which he has indulged the authors to his unrivalled cabinet and well-stored library, and the numerous other attentions and accommodations by which he has materially assisted them in its progress" [first ed., p. xxi., 1815].

Alexander Macleay's official connection with the Linnean Society must have stimulated and widened his interest in Natural History, and, at the same time, have brought him into personal contact with many of the eminent men of the day. He was elected a Fellow of the Royal Society in 1809, when Sir Joseph Banks was President; and to the Council in 1824, when Sir Humphry Davy was President. Sir Stamford Raffles, first President of the Zoological Society, was also a member of the Council at this time. Macleay's friends of whom we have records, besides the entomologists Kirby and Marsham, included Robert Brown, and Sir James E. Smith, Founder and President of the Linnean Society.

Robert Brown (1773-1858) had collected zoological specimens, including insects, as well as botanical material, during his visit to Australia and Tasmania. We may be sure, therefore, that before accepting the offer of an appointment in Australia, A. Macleay had discussed the prospects with the great botanist. The fact that he brought his collection with him seems to show that the fauna was one of the attractions to migrate. The records of their friendship are meagre, but indicative of warm regard. R. Brown named the new genus, *Macleaya*, in honour of his much valued friend, in 1826. Our Society is fortunate in having in the library four reprints of papers by Robert Brown, with inscriptions to Alex. McLeay, Esq., from his "affectionate friend" or from his "attached friend."

A pleasing record of Alexander Macleay's friendship with Sir James E. Smith is given in the Proceedings of the Linnean Society, 1872-73, p. i. At the meeting of the Society held on November 7th, 1872, Mr. G. Bentham, President, in the chair—"The President read two letters, in her own hand, from Lady Smith (now in her 100th year), offering for the acceptance of the Society, seventy-four letters, addressed to its Founder by the late Alexander M'Leay, Esq., Secretary to the Society from 1798-1825. The letters were accompanied by a photograph from the portrait of Lady Smith, taken by Opie in 1798, signed, and bearing the date of her birth, May 11, 1793. Resolved, that the Special Thanks of the Society be presented to Lady Smith for this very valuable and acceptable donation." The number of the letters is perhaps to be accounted for by the fact, that Sir James Smith's home was in Norwich, though for some time he occupied a house in London.

After the death of W. S. Macleay, in January, 1865, his brother, George Macleay, inherited the family heirlooms. At a meeting of the Linnean Society, on

December 16th, 1886—"The President [W. Carruthers, F.R.S.] announced that Sir George MacLeay, K.C.M.G., F.L.S., had presented to the Society a framed water-colour portrait of the Rev. William Kirby, F.L.S., the distinguished entomologist; also the manuscripts and correspondence of his father, Alexander MacLeay (elected F.L.S. 1794), for many years Secretary to the Society" [Proceedings, 1886-87, p. 6]. But these have not so far been utilised for biographical purposes.

In anticipation of this evening's meeting, I wrote to the Council of the Linnean Society of London some time ago, pointing out the scanty documentary details of the early scientific life of Alexander and W. S. Macleay available to us here in Australia, and that we were without a portrait of any kind of W. S. Macleay; and, at the same time, asking if the Council would be good enough to spare me copies of any documents that would be of special interest in connection with our celebration of the centenary of Sir William Macleay's birth. I have pleasure in recording my indebtedness, and cordial thanks, both to the Council and to Dr. B. Daydon Jackson, General Secretary, who has kindly sent me copies of five very interesting letters, and a photograph of the bust of W. S. Macleay in the Society's possession.

One of the letters referred to, from Sir James E. Smith [1759-1828] to Alexander Macleay, dated "Norwich, March 13th, 1825," was apparently written in reply to a letter announcing the writer's acceptance of the appointment of Colonial Secretary of New South Wales, and of his contemplated departure to the antipodes. The portion of the letter of most interest to us is as follows:—

"My dear Friend,—Now that I have got through the irksome correspondence that so much opprest me—(rendered most irksome, I assure you, by the continual association of your departure, which weighed like a millstone upon my heart), I may indulge in more pleasant writing. I am not a man of compliments, but your wide removal, as it were to another world (and it may really be so with respect to me), seems to excuse and indeed require an opening of heart between us. I am happy to recall the 31 years [1794-1825] to which you advert, and to say with all sincerity, that so far from misunderstanding or *coolness*, I have ever felt the *warmest* estimation for your character, the most grateful sensibility to your constant active friendship and attention. I have always known where to find you, and was always sure you would do the kindest and most judicious thing. Judge then if I can part with you unmoved, or if I can avoid being warmly interested for all that belongs to you!—I speak now not with much reference to our Society, for which you have done so much. I trust we shall choose no unworthy successor to you—and as to yourself, I would not suggest gloomy ideas of your great undertaking, which I trust will be advantageous, as it is certainly highly honourable. It must on some accounts be delightful to you, and as a naturalist I almost envy you. For the sake of the public I am well persuaded I ought to rejoice. May God preserve your life to do all the good you can, and to benefit your family, who I am confident will be worthy of you. Let me, my valued friend, urge one thing especially. Take the utmost care of your health—do not work too hard, or expose yourself to anything which experienced people think hazardous. If you feel well and strong, *spare yourself*, that you may do the more good. . . . . I hope your portrait will be well done. We shall gratify ourselves by it, more than we honour you. . . . . Farewell my excellent friend—I need not say how often I shall think of you, nor how entirely I am ever yours, J. E. Smith."

The portrait referred to was painted in oils by Sir Thomas Lawrence, P.R.A., and presented by subscribing Fellows to the Linnean Society. A steel engraving reproduced from this portrait by C. Fox was subsequently issued. The late Lady Macleay was good enough to give me three copies of the engraving. One is hung in the Society's Hall. The other two, I presented to the Australian Museum and the Public Library.

A report of the Anniversary Meeting of the Linnean Society, held on 24th May, 1825, concludes thus: "The Society afterwards dined at the Freemason's Tavern, where the presence of Sir J. E. Smith in improved health added much to the enjoyment of the day. Addresses on subjects interesting to cultivators of Natural History were delivered by various members, and other men of science; amongst others, by the venerable Bishop of Carlisle, Lord Stanley, the Rev. Dr. Fleming, and the respective Presidents of the Horticultural and Geological Societies. Numerous expressions of respect and cordial esteem were called forth towards the late Secretary of the Society, Alexander MacLeay, Esq., F.R.S., on the occasion of his quitting this country for a time, to occupy the important station of Colonial Secretary in New South Wales" [Zoological Journal, Vol. ii., p. 278].

At the next meeting, on June 7th, 1825, it is recorded that—"On the retirement of Alexander MacLeay, Esq., F.R.S., &c., from the office of Secretary of the Society, the following Minute, recommended by the Council was adopted by the General Meeting of the above date, viz.—The Linnean Society of London take the earliest opportunity after the retirement of Alexander MacLeay, Esq., from the Secretaryship of the Society, to record upon their Minutes the high estimation in which he is held by them on account of twenty-seven years of unremitted and unrequited labour devoted to the interests of science; and that in quitting for a time this sphere of usefulness to fill an honourable station in a distant country, he carries with him the cordial esteem and sincere regret of this Society."

There is very little, in the way of records of his own, of Alexander Macleay's interest in the fauna and flora after his arrival in Australia in January, 1826. But evidence of it is afforded by his donations of zoological and botanical specimens to the Linnean Society's Museum, and a donation to the Zoological Society; and, locally, by his active interest in the Colonial Museum, later the Australian Museum. Vigors and Horsfield had completed the first part of an important paper, entitled "Catalogue of the New Holland Birds in the Collection of the Linnean Society" [read on June 21st, 1825], shortly before A. Macleay left London. "In the introductory remarks to this paper, the authors express their confident expectation that the deficiency of our knowledge of the habits of the Birds of Australia, will be in great measure supplied by the researches of Mr. A. MacLeay during his future residence in that interesting country" [Zool. Journ., ii., p. 279]. Mr. Macleay's official duties and other engagements left him little time for studying the habits of Australian birds, as was afterwards done by John Gould and Gilbert; but he did what he could in the way of sending specimens for the Linnean collection, as follows:—"41 skins of Birds from New Holland; 54 skins of Birds. 2 spp. of Squalus, and a skull of a third, and of a species of Delphinus [Trans., Vol. xv., p. 533 (1827)]—34 skins of Birds, one Bat [Trans., Vol. xvi., p. 794 (1829-33)]—A Collection of Bird-Skins and Insects from New Holland [Trans., Vol. xvii., p. 597]—Specimens of 126 species of Fruits and Seeds indigenous to New South Wales [Trans., Vol. xx., p. 505].

At a meeting of the Zoological Society of London, on May 12th, 1835—"A letter was read, addressed to the Secretary by A. MacLeay, Esq., Colonial Secretary, New South Wales, dated Sydney, October 25, 1834. It stated that the writer had, in consequence of the application made to him, set on foot inquiries respecting that interesting *Bird* of New Zealand, the *Apteryx Australis* Shaw, and that he had succeeded in obtaining a skin of it (destitute, however, of the legs), which he had forwarded to the Society. The specimen was exhibited, and further particulars given [Proc. Zool. Soc., iii., p. 61]. The notice ends thus:—"He concludes by expressing his intention of forwarding to the Society the white-fleshed Pigeon of the Colony, which, he conceives, would be a great acquisition in England: it is certainly, he says, far superior to Partridge."

Shortly before his decease, the late Mr. R. Etheridge, Junr., Director and Curator of the Australian Museum, completed his inquiries into the early history of the Museum, from official and other records. His paper, in two Parts, is entitled "The Australian Museum: Fragments of its early History," for unfortunately the earliest records are not as complete as could be wished. But he was able to show that "a Museum, therefore, was evidently resolved on as early as 1827," and "that a Museum of some kind was established between the years 1827-9." He also says: "Whatever connection the Honbl. Alexander Macleay had with the inception of the Australian Museum, there can be no doubt of his long and lasting interest in the establishment; the old minutes prove this'" [Records of the Australian Museum, Vol. xi., p. 67 (1916); xii., p. 339 (1919)].

In the obituary notice of Mr. Alexander Macleay, which appeared in the *Sydney Morning Herald* of July 26th, 1848, the day after the funeral, it is stated that—"He was always active in the management of colonial institutions: he was President of the Australian Subscription Library, of the Benevolent Society and the Infirmary; and was the founder of the Australian Museum." This statement is repeated in Flanagan's "History of New South Wales [Vol. ii., p. 192 (1862)].

In regard to the location of the Colonial Museum in its early days, Mr. Etheridge says: "It has been stated that the Museum occupied 'a small room attached to the Legislative Council' [quoted from Fowles, "Sydney in 1848," p. 83], but like other of Fowles' statements, lacks confirmation, as I have been unable to find any evidence in support" [p. 342]. Confirmatory evidence is to be had however. For example, *The Sydney Herald*, No. 19, November 21st, 1831, p. 4, records the fact that—"The Sydney Museum has been removed from the Old Post Office in Bent-street, to the spacious rooms over the Council Chamber in Macquarie street." And it was there that Dr. George Bennett first saw it, in August, 1832—"In company with a friend, I visited the Colonial Museum, which is arranged for the present in a small room, assigned for the purpose, in the Council-House, and which had been recently established in Sydney."

From Mrs. Boswell's narrative, it appears that Alexander Macleay spent his eightieth birthday (June 24th, 1847) at Port Macquarie, during a visit to Major and Mrs. Innes. It is mentioned that the visitor could speak Gaelic quite well, that he was much pleased at being musically welcomed, on his arrival, by a piper, who used to play for the special delectation of the guest as opportunity offered, and that Mr. Macleay was entertained at luncheon on his birthday.

Mrs. Macleay, born 13th March, 1769, died a few weeks later, on 13th August, 1847, after a happy union of more than fifty years. Her husband's long and useful life ended less than a year afterwards, on 19th July, 1848, in his eighty-second year. His end was hastened by a severe shock received in a carriage accident, when returning from a visit to Government House. The horses took fright, and got out of control just as they were about to pass through the entrance-gates to Macquarie street, and the carriage collided with one of the stone pillars. By his own request, Mr. Macleay was removed to "Tivoli," Rose Bay, the residence of his son-in-law, Captain W. J. Dumaresque; but, at his advanced age, his recovery was hopeless. In the obituary notice in the *Sydney Morning Herald* of July 26th. 1848, the day after the obsequies, it is stated that—"There was a very large attendance at the funeral, the number of carriages being fifty. Among those present were—the Commander of the Forces, the three Judges, and nearly the whole of the Government officers, and a large number of old colonists of all classes. The pall-bearers were the Colonial Secretary, the Colonial Treasurer, Colonel Gordon, Mr. Baker, Attorney-General, Mr. Macpherson, Mr. Mitchell, and Mr. Campbell. . . . Mr. M'Leay was a man almost universally respected, and has descended into the grave full of years and full of honour; and from his consistent character, we may feel sure he has gone to his reward."

Alexander Macleay seems to have been a man of an attractive personality, and to have had many warm friends, both in England and in Australia. He did not escape hostile criticism in party political matters in this part of the world, at a time when the Emancipist question, among others, evoked much bitterness. But as a man of probity, who had the welfare of the infant Australia at heart, there are numerous eloquent tributes to his ability and worthiness, on record. On his retirement from the office of Colonial Secretary, he was the recipient of two addresses expressive of esteem and regret—one from 556 of his fellow-colonists, who also requested his acceptance of a piece of plate, in further proof of personal regard; the other, from twenty-five gentlemen who had been officially associated with him in public life, and who asked "that you will do us the favour to allow your portrait to be taken at our expense, for the purpose of being placed in some appropriate situation in the colony, as a lasting memorial of our regard and esteem for your private worth, and of the grateful sense entertained by us, of the co-operation we have always experienced from you, in conducting the business of our respective departments." The order for the piece of plate was sent to England; and a very handsome centre-ornament for the dinner-table was selected, on which were engraved the Arms of the Colony, and of the Royal Burgh of Wick, by the special permission of the respective Authorities, as well as the Arms of the recipient. This was sent out to Australia and presented in due course. There is a copy of a rare pamphlet in the Mitchell Library, giving the details of the gift, with an illustration; and bound up with it is a lithographic plate of the plant *Macleaya cordata* R.Br. The piece of plate was probably taken to England by Sir George Macleay, after the death of W. S. Macleay. I have not been able to ascertain the history of the contemplated portrait, or, if painted, where it was or is located unless it be in some Government building. Or it may be the portrait now hanging in the Curator's room at the Australian Museum, whose history is unrecorded. If so, it may have been presented to the Museum by George Macleay when he revisited Australia (before 1876).

The family tomb without inscriptions save the surnames Macleay and Harrington in large letters, and the family crests, is in the same enclosure with that of Captain W. J. Dumaresque in what used to be known as the Camperdown Cemetery—which was opened when the Devonshire-street Cemetery was closed—

in proximity to St. Stephen's Church, Newtown. But there are cenotaphs to the memories of Alexander and Mrs. Macleay, of Mrs. Harrington, eldest daughter and wife of Mr. T. C. Harrington, Assistant Colonial Secretary, and of W. S Macleay, as well as of Captain Dumaresque, in St. James' Church, King-street.

Elizabeth Bay House and the Garden.

After his arrival in Sydney on January 3rd, 1826, Mr. Alexander Macleay occupied the middle one of the three official residences on the south side of Bridge-street. The late Judge Forbes contributed a letter to the *Sydney Morning Herald* of March 17, 1899, entitled "Old Government House, Sydney," in which he recorded his recollections of old Sydney. He was the son of the first Chief Justice of New South Wales, and came to Sydney, a child of four years, with his father in 1823. The Judge wrote: "My father lived in a house which stood in the centre of the site of the present Lands Office. . . . . Bridge-street, which ran from George-street up to Government House gate (the gate of that time), after passing Bent-street (which it joined then at the same place as now) had, on the south side of it, four detached houses, built in a row, and going from George-street towards the Government House gate. The first of these you came to was that in which my father lived, bounded on the south and west by Bent-street; next to it was the house which was the residence of Alexander Macleay, the Colonial Secretary; and next to that was another house, the residence of Mr. Lithgow, Auditor-General and Collector of Internal Revenue; (that house is now standing, having a large native figtree growing in the front of it) [since demolished to make way for the present Education Department Building]; and next to that was the Guard-house close to Government House gate. The first three houses mentioned, viz., my father's, Macleay's, and Lithgow's, had gardens in front and yards at the back, and were divided by walls from one another. The Guard-house was close to the gate of Government House, and Government House was about 30 or 40 yards to the east of it, which fixes the site at the place where the plate with the inscription on it was lately found. I was often at Government House when Sir Thomas Brisbane was there, and also when Darling and Bourke were Governors, and I know the localities well, and remember them perfectly."

Another early notice of the Macleay's first house is to be found in an article entitled "A Journal of Early Australia," contributed to the *Sydney Morning Herald* of August 30th, 1911, by Miss Mary Salmon. This is a review of a small volume, with the title, "Some Recollections of My Early Days. By [Mrs.] A. A. C. D. Boswell," printed for private circulation only among friends and relatives. There is a copy of it in the Mitchell Library. The authoress was born in 1826 at "Yarrows," in Bathurst, and was living in Scotland when Miss Salmon's article was written. Mrs. Boswell was the daughter of Mr. George Innes, who came to Australia in 1823 with his brother, Captain Archibald Clunes Innes. The following is Mrs. Boswell's account:—"Early in 1834, I found myself at school in Bridge-street, under the care of Mrs. Evans and her friend and partner, Miss Ferris. Mr. Evans (he was George W. Evans, who had been deputy surveyor when he made the remarkable discovery of the plains beyond the Blue Mountains, which led to a road to Bathurst) had a bookseller and stationer's shop, and we used the rest of the house, which was thought handsome, and in a fashionable street. Our house faced the old Government stores or depot, and close by flowed the Tank Stream, now arched and made into the main drain of that part of the populous city. We were quite close to the old Government House and Macquarie-place, where lived the leading Government officials. These houses were back from the street, and had pretty gardens and deep verandahs, shaded by climbing roses and other flowering plants. I do not remember ever being in Government House, but I made many happy visits to our kind friends, Mr. and Mrs. Macleay at Macquarie-place. He was Colonial Secretary, and one of his daughters [Margaret] had been married to my uncle, Major Innes, of Lake Innes, Port Macquarie. Miss Macleay (Mrs. Harrington) wanted to adopt and educate me. She died a few weeks after her marriage, in 1836."

Among the relics of W. S. Macleay is a small pencil-drawing of the residence in Bridge-street, made by Miss Macleay, with her signature on the back. This was probably sent to her brother in Cuba, before 1836. I exhibit this, together with the photograph of a pencil-drawing of the same house by the artist Conrad Martens. The original of the latter is in possession of the Royal Society of Tasmania. By the kind permission of the Council, Mr. Clive Lord, the Secretary, has been able to furnish me with the photograph of this interesting drawing.

In a letter from Mrs. Eliza Macleay, in Sydney, to her son, W. S. Macleay, in Cuba, undated but written on paper with watermark 1824 [from internal evidence written about June, 1827] she says: "We have been very unsettled in our house ever since we got in to it, which was the first night of our arrival [January 3rd, 1826]; in the first place, it was much too small for us, which, on proper representation was ordered to have two bedrooms and two smaller rooms built over the library, and eating-room, and a verandah added, which has now been about ten months and not nearly finished, so slow do the prisoner-workmen get on; and when you consider what sort of people they are, you may suppose we cannot feel very comfortable while they are about. They contrived, I must say through the carelessness of our free servants, to carry off sixty pounds' worth of plate, which we could never hear the least account of since. . . . . Your father . . . . . has little time to think of family-affairs, his whole time being occupied with Government business. We have now been here a year and a-half, and, during that time, I think he has not been absent from Sydney above ten days; the very little recreation that he has consists of his going out before breakfast or after five o'clock, sometimes to a place called Elizabeth Bay, of which he has got a grant of between fifty and sixty acres, where he is making a garden, and [hopes at] some future time to build a house; he is now building stabling, and has built a gardener's cottage."

[For the copy of this extremely interesting letter, kindly forwarded by Dr. Daydon Jackson, I am indebted to the Council of the Linnean Society of London.]

Mr. J. A. Dowling has recently given a very interesting account of the early settlement of the eastern suburbs contiguous to the harbour and the city. The author points out that, as shown in Roe's map of Sydney (1822), Darlinghurst, including Woolloomooloo, used to be called Henrietta Town, and was a reserve set apart for the Blacks. The name was given by Governor Macquarie, after the first Christian name of his wife. Elizabeth Bay and Elizabeth Point were also named by the Governor after the second Christian name of the same lady.

Of the grant to Alexander Macleay, Mr. Dowling says: "The Macleay property was fifty-four acres in extent, and was granted to Mr. Alexander Macleay by Governor Darling in 1828, who, in a despatch to the Right Hon. William Huskisson, dated the 28th of March, 1828, stated: 'The land granted to Mr.

Macleay at Elizabeth Bay, a mile and a half from Sydney, was for the purpose of erecting a family house and cultivating a garden. Mr. Macleay's knowledge as a horticulturist is likely to prove beneficial to the colony. He has already spent a considerable sum on the improvement and cultivation of his grounds and in erecting a stable and other offices preparatory to building a house, which it is his intention shortly to commence. From the manner in which he has entered into this undertaking and the scale on which he has commenced to settle and stock the land he has received for agricultural purposes (the usual grant of 2500 acres), he will no doubt prove an important acquisition to the colony. In this respect alone, the capital which he has already vested in stock, and is still continuing to expend, being considerable.' . . . . The formal grant was dated 19th October, 1831." ["Potts' Point, Darling Point and Neighbourhood, in the Early Days," by J. A. Darling, Journ. Proc. Aust. Historical Soc., Vol. ii., 1906, Part 3, p. 55 (1909).]

The conditions on which the grant was made were loyally fulfilled, and there is ample evidence that the expectations of the value of his horticultural knowledge were realised.

Alexander Macleay seems to have been interested in horticulture before he came to Australia. Robert Brown contributed a botanical supplement to the "Narrative of Travels and Discoveries in North and Central Africa, by Denham and Clapperton," published in 1826 [Reprinted in R. Brown's Collected Works, Vol. i., p. 270], from which I quote the following: "Respecting *Bocconia cordata*, though it is so closely allied to *Bocconia* as to afford an excellent argument in favour of the hypothesis in question, it is still sufficiently different, especially in its polyspermous ovarium, to constitute a distinct genus, to which I have given the name (MACLEAYA *cordata*) of my much valued friend, Alexander Macleay, Esq., Secretary to the Colony of New South Wales, whose merits as a general naturalist, a profound entomologist, and a practical botanist, are well known."

Mr. Macleay may have brought out to Australia with him plants or seeds from England, as he certainly did from Rio Janeiro, where the vessel called on the voyage out, as mentioned in Dr. Bennett's account of his visit to Elizabeth Bay in 1832 [*postea*]. We have no family record of the progress of the garden later than Mrs. Macleay's letter written in June, 1827, until about 1836, when Mr. Macleay began to keep separate records, in two small books, of the plants and seeds which he obtained, and of the sources from which they came.

But most interesting references to the garden by three visitors—Allan Cunningham, Dr. George Bennett, and James Backhouse—during the intervening period, are available. These accounts show that much progress had been made in clearing, laying out, and planting the originally sterile area of Hawkesbury Sandstone.

Allan Cunningham visited Elizabeth Bay in 1830, and again in 1831, just before leaving for England in the ship "The Forth" on February 25th, 1831. The following is his account:—"I now left Parramatta, and accompanied by a friend, reached Sydney in the afternoon, where I learnt that the departure of the ship was postponed until the 16th [February, 1831]. This gave me more time to settle certain matters of business in Sydney, as also to call on several friends living at this port, and among them was Mr. Macleay, our worthy colonial secretary, whom I accompanied to his retreat on the shores of Elizabeth Bay, where I was not a little delighted to find so much had been done in planting and improving the sterile ground amidst high sandstone rocks since I visited the Bay last year. . . . . As there were several plants of [*Calostemma album*] in the garden, where it periodically puts forth its small white flowers, Mr. Macleay presented me with four bulbs for Kew, so that the royal gardens will soon boast of possessing a fourth species of this genus, so nearly related to Pancratium. [Hooker's London Journal of Botany, Vol. i., p. 126.]

Dr. George Bennett visited Sydney in 1829, and a second time, in August, 1832. Shortly after he journeyed to Elizabeth Bay, of which he says:—"In company with my friend, Lieutenant Breton, R.N., I visited *Elizabeth Bay*, about two miles distant from Sydney, and the property of the Honourable Alexander Macleay. The situation is beautiful, being in a retired bay or cove of Port Jackson, and the garden and farm is near the sea. This spot, naturally of the most sterile description, has been rendered, at a great expense and perseverance, in some degree productive as a nursery for rare trees, shrubs, and plants, from all parts of the world. We were much gratified with the valuable and rare specimens the garden contained, and surprised that a spot possessed of no natural advantages should have been rendered, comparatively, a little paradise. In the garden, a species of *cactus* was pointed out to me by the gardener, Mr. Henderson, which Mr. Macleay had brought some years ago from Rio Janeiro." Then follow particulars of the teratological fruits of this plant. [Wanderings in New South Wales, &c., Vol. i., p. 71 (1834)].

James Backhouse, the Quaker missionary, in his "Narrative of a Visit to the Australian Colonies" (1843), thus describes his experience: "January 15th, 1835—We [including his colleagues, D. and C. Wheeler, and G. W. Walker] walked to Elizabeth Bay, and met the Colonial Secretary, at his beautiful garden, which is formed on a rocky slope, on the margin of Port Jackson, of which it commands a fine view. Here are cultivated, specimens of many of the interesting trees and shrubs of this Colony, along with others from various parts of the world, intermixed with some growing in their native localities. . . . The walks at this place are judiciously accommodated to the inequalities of the sinuous bay, and are continued round a point covered with native bush. Peaches are ripe in the open ground in abundance, and liberty to partake of them freely was kindly given, by the open-hearted proprietor. *Dendrobium speciosum* and *D. linguiforme*, remarkable plants of the Orchis tribe, are wild here, upon the rocks, and *D. tetragonum* is naturalised on a branch of *Avicennia tomentosa*, covered with oyster-shells, and suspended in a tree near the shore. A fine patch of the Elks-horn Fern, *Acrostichum alcicorne*, retains its native station on a rocky point in the garden" [p. 239].

Returning now to the family records relating to the garden, one of the two books already mentioned, has, on the title-page, the entry "Plants received at Elizabeth Bay." The watermark of the paper of this book is 1833. The first four entries are not dated. The first of these is a list of thirty-three species, including four of Magnolia, and six varieties of *Camellia japonica*, received from the Messrs. Loddige, of Hackney, the well-known nurserymen of that time.—No. 2, three species of *Diplarrhoena morea* and *Sarcochilus falcatus*, from Van Dieman's Land; and *Alsophila australis* from Norfolk Island, received from Mr. J. Backhouse, whose visit to Australia lasted from 1832 to 1838.—No. 3, twelve species, from Messrs. Loddige.—No. 4, eighteen species (two unnamed), from Mr. W. Macarthur, Camden.—No. 5, 6th April, 1836, four species, also from Mr. W.

Macarthur.—No. 6, not dated, thirteen species (five undetermined). "From China, Mr. Jones." Below the last entry appears the date, 1835, followed by a list of twelve additional species from the same source.—No. 7, twelve varieties of Dahlia. "From Mr. J. B. Richards. London, 27th April, 1836."—No. 8, seven species , including three of Passiflora, and five varieties of *Chrysanthemum sinense* from Messre. Loddige, Feb. 7, 1827 [? 1837].—No. 9, thirteen species from Mr. W. Macarthur, March, 1837. This is of interest because it shows that, at this early period, the horticulturists were trying to cultivate native plants in their gardens, three of the plants in the list being *Bauera rubioides*, *Eriostemon* sp., and *Boronia* sp.—No. 10, eight species "From Valparaiso, Mr. [Allan] Cunninghame, March, 1838."—No. 11, nineteen species from Camden and Brownlow Hill, August, 1837, —No. 12, forty-seven species of "Bulbs from Captain Farquand Campbell, from Cape of Good Hope, March, 1838," and three species of *Pelargonium*.—No. 13, nineteen species from Mr. W. Macarthur, May, 1838.—No. 14, not dated, is a single entry of Huon Pine from Capt. Drinkwater Bethune, H.M.S. Conway.—No. 15, also a single entry of Amaryllis, from Miss Macarthur, 27th August, 1838.—No. 16 is very interesting, "From Capt. [Charles] Sturt, December, 1838, a large collection of Bulbs collected on his late journey in South Australia."—No. 17 is a list of "Plants brought by W. S. Macleay, per Royal George, March, 1839," which may have been supplied by Loddige. These comprise forty-six species, beginning with five species of *Magnolia*, and ending with *Verbena Melindris*. A number of "Cape of Good Hope Bulbs" (particulars not given), as well as an assortment of seeds, were also brought from the Cape by W. S. Macleay. At a later date, some of the entries had a line drawn across them, and the word "Dead" written opposite to them.—No. 18, two species from Mr. W. Macarthur, April, 1839.—Nos. 19-21, apparently received in the same month, merely record collections received, without particulars, from Mr. Cloete, Baron Ludwig, and Mr. Gordon.—No. 22, sixteen species received from Dr. Wallich, of Calcutta, May, 1839. All the foregoing records are in the handwriting of Alexander Macleay. The continuation of the records was written by W. S. Macleay.—No. 23, forty-five species from Mr. Wm. Macarthur, August, 1840.—No. 24, seventy-two species from Dr. Wallich, Calcutta, October, 1840.—No. 25, thirty-eight species, including *Macleaya cordata* R.Br., from Loddige, January, 1840.—No. 26, and last, seventy-two species "from Mr. Backhouse, 1843." Mr. Maiden, in his biographical notice of William Carron, says that —"His daughter informs me that he arrived in Sydney in 1843 in charge of plants for one of the Macleays." [Journ. Proc. R. Soc. N.S. Wales, xlii., p. 95.] The collection from Mr. Backhouse would, therefore, be the one he took charge of. A number of blank pages follow the last entry. Then comes a long list (9¼ pages) of "Desiderata of Plants," in Alexander Macleay's writing. At a later date, some of the plants were obtained. The names of these are crossed out, and the dates of receipt, and sometimes the initials of the senders, are written in the margin. This is followed by a table of the "Subgenera of *Dendrobium*" in W. S. Macleay's writing. Then, after more blank pages, at the end, is a list of "Epiphytal Orchids," forty-two species, in W. S. Macleay's writing.

The entries in the Seed-book are by years, and numbered throughout. They are in the handwriting of a lady, presumably one of A. Macleay's daughters, or in his own, or in that of W. S. Macleay. For the years 1836-43 (both inclusive) the number of separate entries of seeds is 886, 347, 502, 498, 317, 101, 39, 186;

and for the years 1845, 1851 and 1853, the numbers are 184, 133, 93 (there are no records for 1844 and 1852); total, 3806. These include seeds for the orchard and kitchen-garden, as well as for the flower-garden. Some species are not named. The seeds were received from England, Madeira, Mauritius, India (Calcutta, Madras, Neilgherry Hills), China, Java, East Indies, Brazil, Bolivia, Chili, Valparaiso, Tahiti, Sandwich Islands, Society Islands, Cape of Good Hope, Australia (seeds of native plants from many localities), Van Dieman's Land, New Zealand, and Norfolk Island. W. S. Macleay brought with him seeds of 89 species from England; and of 107 species (including five species of *Erica*, five of *Leucadendron*, and six of *Protea*) from the Cape of Good Hope.

These records are of interest as contributions to the early horticultural annals of New South Wales. It is worth mentioning that the Botanic Gardens in Sydney were first opened to the public in 1831, and on Sundays in 1838.

Taking into account Alexander Macleay's efforts to foster horticulture in the early days, as represented by the foregoing records of his efforts to obtain plants and seeds, and also that the garden was in charge of an expert gardener, Mr. Henderson, it is not surprising that visitors were delighted with what they saw, when the garden was well established and at its best. Of some of these, of a later date than those already mentioned, there are records.

The first is a very brief notice of Allan Cunningham's third visit to Elizabeth Bay, in a letter to Heward, dated November 10th, 1838: "How fine *Grevillea robusta* (forty feet high) is at this time [in the Botanic Gardens], and at Mr. Macleay's at Elizabeth Bay, it is a mass of orange blossoms [Hooker's London Journ. Bot., Vol. i., p. 286].

H.M.SS. "Erebus" and "Terror," under the command of Captain James Clark Ross, visited Sydney in 1841, their stay lasting from July 7th to August 5th. Dr. Joseph Dalton Hooker was Assistant Surgeon and Botanist attached to the "Erebus." The following brief notice of this visit from "An account of the Voyage of the Erebus and Terror" by his father, based on his letters sent home during the voyage, which appeared in the London Journal of Botany" [Vol. ii., p. 272, 1843]—"A short time only was allowed here [Hobart, after the return from the Antarctic] for the needful refreshment and repairs, when the 'Erebus' and 'Terror' sailed for Sydney, where numerous excursions were made and plants collected, though few of these could have the charm of novelty; and after much kindness received from Messrs. M'Leay (father and son) they then pursued their course to the Bay of Islands, New Zealand."

The recent publication of the "Life and Letters of Sir Joseph Dalton Hooker, O.M., G.S.I., based on materials collected and arranged by Lady Hooker; by Leonard Huxley" (1918), is of very great value, not only from the intrinsic interest of the book, but because it supplements and completes the set of the three biographies which relate to the inauguration of modern ideas of evolution, namely "The Life and Letters of Charles Darwin. Edited by his son, Francis Darwin" (Second Edition, 1887), and the "Life and Letters of Thomas Henry Huxley. By his son, Leonard Huxley" (1st Edition, 1900). This gives fuller particulars about Hooker's visit to Sydney, though nothing is said about the numerous excursions and the collecting of plants nor are the Botanic Gardens mentioned. The following extract [Vol. i., p. 120] contains the earliest reference to Elizabeth Bay House known to me: "From Tasmania, a short visit was paid to Sydney in connection with the magnetic observatory, lasting from July 7th to August 5, 1841. Sydney in those days, only one year since the importation of convicts had ceased, could boast no shops finer than the Hobart Town ones; round the beautiful harbour stood a few fine houses, in particular the new Government House, still uninhabited, built in the Elizabethan style, the new Custom House, and Mr. M'Leay's house with its garden full of interesting plants." . . . . "A long visit to M'Leay's garden proved it to be a botanist's paradise. My surprise was unbounded at the natural beauties of the spot, the inimitable taste with which the grounds were laid out, and the number and rarity of the plants which were collected together. . . . The interior of the house, a striking specimen of Colonial architecture, the individual trees and creepers, flowers and shrubs, the revival of nature when the rain ceased, and a few insects came out, the Diamond birds flitted from tree to tree, and the large Sea Eagle or Osprey left his lovely lair and commenced wheeling over the calm waters of the bay, and beyond the bay 'a rocky precipice christened Sunium, on which it is the intention to build a temple'—all this is fully set forth in the Journal, with one very homely touch as to 'Mr. William's workshop': 'The smell of camphor and specimens, so well known to me at home, reminded me strongly of olden times, especially as I found everything in the inimitable mixture of confusion and order in which Mr. [R.] Brown's shop at the Museum and his rooms in Deane-street are wont to be.'" . . . . "The record of the visit ends with the entry for August 5th: 'at 11 a.m. sailing down Port Jackson along the cold-looking sandstone cliffs, leaving Sydney with few regrets but leaving Mr. McLeay's fine establishment where there was much to see.'"

A most interesting account of a visit to Elizabeth Bay by Mrs. Robert Lowe, towards the end of 1842 or early in 1843, is thus recorded in Patchett Martin's "Life and Letters of Viscount Sherbrooke, Vol. i., p. 162 (1893): "A few days ago I saw one of the most perfect places I ever saw in my life, belonging to Mr. Macleay. How I longed that Mrs. Sherbrooke could but see this splendid sight. The drive to the house is cut through rocks covered with the splendid wild shrubs and flowers of this country, and here and there an immense primeval tree: the house is built of white stone, and looks like a nobleman's place. Mr. Macleay took us through the grounds; they were along the side of the water. In this garden are the plants of every climate—flowers and trees from Rio, the West Indies, the East Indies, China, and even England. The bulbs from the Cape are splendid, and unless you could see them, you would not believe how beautiful the roses are here. The orange-trees, lemons, citrons, guavas are immense, and the pomegranate is now in full flower. Mr. Macleay has also an immense collection from New Zealand. I must not omit some drawbacks to this lovely garden: it is too dry, and the plants grow out of a white, sandy soil. I must admit a few English showers would improve it. As we went along the wild walks, cut through the woods, the native trees, covered with flowers, the views of rock, trees, and water were enchanting. The bays are innumerable, and resemble the Scotch salt-water lochs."

Sir George Macleay, then resident in England, inherited the property at Elizabeth Bay, after the death of his elder brother, W. S. Macleay, in January, 1865. The subsequent history of the old garden is briefly told by Robert Lowe's biographer in these words: "The beautifully situated home of the scholar and naturalist is now no more, and on the site of its grounds stand the villas and houses of a 'genteel' suburb. Sir George Macleay, when showing me a picture of the house and grounds said: My brother would never have consented to its demolition; but Sir Henry Parkes thought fit to tax the land exorbitantly, with the view of "bursting up" such estates near Sydney, and I at length was forced to subdivide it, and let it out on lease. But my brother,' he added, 'however much it might have added to his income, would never have allowed a tree or shrub to be removed.'" [Life and Letters of Viscount Sherbrooke, Vol. i., p. 163, footnote.]

This statement is one aspect of an old story—the inevitably increasing pressure, due to the expansion of a young and steadily growing city and its suburbs, on the open spaces within or contiguous to their boundaries, necessitating the subordination of private interests to general needs. The writer of the remarks quoted slightly misunderstood his informant. As a matter of fact, Elizabeth Bay House, surrounded by a much circumscribed garden, was left intact. But, by the formation of new streets, including Ithaca Road, Billyard Avenue, and Onslow Avenue, the outlying portion of the original garden was cut off from the remnant adjacent to the house, subdivided, and let on long leases in 1875, as the entail could not be cut off during the lifetime of any male member of the family. In the meantime, as soon as circumstances permitted, Sir William Macleay became the tenant on long lease, of the house and of some of the allotments bounded by Ithaca Road and Billyard Avenue, on two of which the Society's Hall now stands. His occupancy of the house lasted for the rest of his lifetime, until December 1891; and, thereafter, Lady Macleay's continued until her decease in August, 1903. With the exception of one year, when the house was sublet furnished during Lady Macleay's absence in England, after Sir William's death, the old house was continuously occupied by members of the family, from 1837 to 1903. The fate of the old garden has been similar to that of many others in Sydney and its neighbourhood. But under the circumstances of the case, its history and associations are worthy of record. The picture referred to may have been painted by Conrad Martens, for the view of the house and grounds from slightly different standpoints at Darling Point was a favourite one of this well-known artist. By the kindness of the Council of the Royal Society of Tasmania and Mr. Clive Lord I am able to exhibit a photograph of a pencil drawing of Elizabeth Bay House taken from Darling Point, by Conrad Martens.

But Alexander Macleay was not interested in horticulture only so far as the garden at Elizabeth Bay was concerned. In the letter from Mrs. Macleay to her son W. S. Macleay, from which I have already quoted, she says [about June, 1827]: "Your Father will soon become a large landed proprietor here; he has purchased 15,000 acres about 40 miles out of Sydney; and he has got a son of David Brodie's for an overseer there." The property here referred to comprised Brownlow Hill, near Camden, and Glendarewel farm attached to Brownlow Hill, as mentioned by Captain Sturt in the account of his second expedition "to follow the waters of the Morumbidgee" ["Two Expeditions," Vol. ii., pp. 9 and 11.]

Mr. A. Macleay's efforts to develop horticulture were not confined to Elizabeth Bay, but were extended to Brownlow Hill. Mr. J. Backhouse records, in his "Narrative," under date October 19th, 1836—"Departing from Jarvis Field [the residence of the Police-magistrate] we . . . . proceeded through open grassy-forest, to the Cow-pastures, where, at Brownlowe Hill, we were welcomed by George and James M'Leay, sons of our kind friend the Colonial Secretary. . . . . We visited the agricultural establishment of the M'Leays, on the Mount Hunter Creek, where they have a garden, producing Oranges, Apples, Loquats, Pears, Plums, Cherries, Figs, Mulberries, Medlars, Raspberries, Strawberries, and Gooseberries, and where Roses are in great profusion."

George Macleay subsequently became the owner of the Brownlow Hill property, and it was his home until his return to England in 1859. In a letter to his mother, written from Brownlow Hill on June 5th, 1857, the Governor, Sir William Denison, who had visited George Macleay there on two previous occasions, says—"The place where we are stopping is very prettily situated on a curious flat-topped knoll, rising out of a plain by the side of a brook; the soil is beautiful; I never saw such a growth either of flowers or fruit-trees as is shown in a garden which has just been made in the alluvial soil of the flat." [Varieties of Vice-Regal Life, Vol. i., p. 385, 1870.]

Additional testimony is afforded by a reprint of a lecture delivered at the Sydney School of Arts, in 1834, by Mr. Thomas Shepherd. This pioneer nurseryman and horticulturist arrived in Sydney on February 12th, 1826. He received a grant of land, at what is now Chippendale, from Governor Darling, to enable him to establish a public nursery and fruit-garden, long afterwards known as the Darling Nursery. In giving an account of his early experiences, Mr. Shepherd said: "About this time [January, 1827] I began to collect stock for budding and grafting fruit-trees upon; and also other plants of various kinds, to commence the nursery. Mr. William Macarthur, of Camden, furnished me with a choice collection of grafts and trees. Mr. Alexander Macleay, of Elizabeth Bay, was also a benefactor in supplying me with numerous species and varieties of fruit, ornamental trees, shrubs, and flower-roots; and it is to these two gentlemen that the early settlers were principally indebted for the numerous varieties of fruit and other trees raised in those days." ["In the 'Thirties': A Pioneer Gardener," by A.P.C. In "On the Land" column, *Sydney Morning Herald*, July 2nd, 1913.]

Elizabeth Bay House apparently was not occupied until after Mr. Macleay's retirement from the position of Colonial Secretary. In the Mitchell Library there is a copy of a "catalogue of an extensive and valuable library of nearly 4000 volumes, comprising the major part of the well-selected Library of Alexander McLeay, Esqr., M.C., who is removing to the country," to be sold by auction in 1-4 April [the year not given, probably 1837]. This may be taken to indicate that the removal from Bridge Street to Elizabeth Bay was carried out soon after. At this time Alexander Macleay was in his 70th year. The expenditure on the Elizabeth Bay property amounted to not less than £10,000; and the successful way in which the garden had been developed is said to have given a marked stimulus to ornamental gardening in Sydney.

William Sharp Macleay, M.A., F.L.S.

Eldest son of Alexander Macleay, born in London, July 21st, 1792—Educated at Westminster, and Trinity College, Cambridge—On leaving the University, appointed Attaché to the British Embassy in France: subsequently Secretary to the Board for liquidating British claims on the French Government, established at the peace of 1815—1825, Commissioner of Arbitration to the Mixed British and Spanish Court of Commission for the Abolition of the Slave Trade established at Havana, Cuba: 1830, Commissary Judge of the same Court: 1836, Judge of the Mixed British and Spanish Court of Justice established under the Treaty of 1835—1836, returned to England; 1837, retired from the Public Service, upon a pension—1838, left England for Australia with his cousins William and John, arriving in Sydney in March, 1839—1865, died in Sydney, on January 26th; buried in the family tomb in Camperdown Cemetery: cenotaph in St. James' Church.

Among the sources of our interest in W. S. Macleay, the following may be particularised. In due time he succeeded to the collection of his father, added considerably to it, and eventually passed on the joint collections to William Macleay. He had worked up the *Scarabaeidae* in his father's collection; also Captain P. P. King's collection of Australian Annulosa. The results of his work and of his influence are contributions to a not unimportant, Pre-Darwinian, English chapter in the history of Zoology. He was universally recognised as the leading representative of Zoology resident in Sydney from 1839 up to the time of his death in 1865. But a special source of interest is that he was the guide and mentor of William Macleay; and a most potent influence in starting his cousin on the first stage of his career, as a working entomologist, preparatory to becoming a member of the succession. And finally, we have a very interesting series of memorials of him.

The two original sources of biographical information concerning W. S. Macleay that we have are an obituary notice published in the *Sydney Morning Herald* of January 30th, 1865; and the memorial sketch communicated by the Senior Secretary, at the Anniversary Meeting of the Linnean Society of London, on May 24th, 1865 [Journ., Zool., ix., Proc., p.c.]. Later notices in Biographical Dictionaries are based on one or other of these. The first was utilised by the Rev. R. L. King in the preparation of his first Presidential Address to the Entomological Society of New South Wales, on January 30th, 1865 [Trans. Ent. Soc. N.S. Wales, Vol. i., p. xliii.]. Mr. King adds: "The following memoir I have taken principally from a notice which has lately appeared from the pen of an old friend." This would be, almost certainly, the Rev. W. B. Clarke, probably after a consultation with William Macleay. Mr. Clarke was one of the oldest and closest Australian scientific friends of W. S. Macleay. Their acquaintance probably began at the meeting of the British Association for the Advancement of Science at Liverpool, in 1837, when both were thinking of migrating to Australia.

The biographical sketch communicated to the Linnean Society, from internal evidence, was apparently drawn up by Mr. Busk, Senior Secretary, after consultation with George Macleay, possibly also with Professor Huxley. George Macleay, at this time, was a Member of the Council, and would have received full particulars of W. S. Macleay's decease from William Macleay.

W. S. Macleay graduated with honours at Trinity College, Cambridge, in 1814. His University career seems to have been without direct influence on his interest in Natural History, as might be expected from his own remarks on the backward state of Zoology in England in his day. Of this, he says: "Well may the foreigner who beholds our learned establishments so splendidly endowed, note, among the most remarkable circumstances attending them, that in none whatever should there be a zoological chair. It is not for me to enter into the causes of this, else it were desirable to know why plants should have been deemed worthy of attention, while animals have been utterly neglected. . . . It is true that there are professors of Natural History in three of our Northern Universities. . . . . But we must not conceal the fact that a professorship of Natural History is necessarily charged with duties that give ample employment in Paris to thirteen professors with their numerous assistants. I have ventured to give this humiliating picture of the state of zoological instruction in Great Britain, because there are persons who affect surprise, that in that science which relates to the animated works of God, France should take precedence over a nation incomparably more religious" [Hor. Ent. p. 457, footnote].

What awakened and developed W. S. Macleay's interest in Zoology seems primarily to have been his father's example, influence, and fine collection of insects; and, secondarily, his sojourn in Paris, where he had the opportunity of meeting Cuvier, Latreille, and other distinguished naturalists of that time, as well as of appreciating the importance of the magnificent establishment of the Jardin des Plantes.

It is quite possible to understand, from his own record, what W. S. Macleay's aims were; and, from the modern standpoint, to estimate fairly what was amiss in his method of trying to realise them, if Huxley's notable maxim be kept in mind, that "the ablest of us is a child of his time, profiting by one set of influences, limited by another."

W. S. Macleay had profited by his intercourse with the French naturalists in that, as a Zoologist, his status had improved, his horizon had enlarged, and his standpoint had advanced. Dr. Leach, Keeper of the Natural History of the British Museum, in succession to Dr. G. Shaw, from 1813-21, who was older than W. S. Macleay, is said to have been the British naturalist who "opened the eyes of English zoologists to the importance of those principles which had long guided the French naturalists." W. S. Macleay supported him in this respect. In the Horae Entomologicae, he recognised that, until the last few years, England stood still at the bottom of the steps where Linnaeus had left her, while her neighbours were advancing rapidly towards the entrance of the temple. He, therefore, endeavoured to pursue the example set by the new school of naturalists. He acknowledges his indebtedness to the labours of Cuvier, Lamarck, Latreille, and Savigny, and refers to Latreille as the father of entomology. He recognised, also, more clearly than his contemporaries did, that there was a profound difference between affinity and analogy.

But as a systematiser—the propounder of principles, and of a system, of classification—his limitations, apart from the imperfections of the knowledge of his time, and from the fact that he was a private individual, unattached to a teaching-institution or a museum, cultivating an interest in natural history in his leisure-hours, came in no small degree from his English traditions and nurture, from the earlier influence of the Time-Spirit of the land of his birth. For it was in England, in his day, that the views respecting the significance of the Natural System, which he advocated, chiefly prevailed.

In his paper "Remarks on the Comparative Anatomy of certain Birds of Cuba," read to the Linnean Society of London on November 21, 1826, W. S. Macleay says: "If it be well said by M. Cuvier, that the natural history of an ainmal is the knowledge of everything that regards that animal—then Natural History, as a science, is only studied in effect when we are engaged in the pursuit of the natural system" (p. 13). W. S. Macleay was a naturalist in the special sense that the primary and avowed object of his studies was the pursuit of the natural system. Descriptive zoology, therefore, to him, was but a means to that end; otherwise, it had little or no attraction for him; and, unless for special reasons, he did not attempt it. It was the philosophical side of the subject that appealed to him so strongly. But what is the natural system? He recurs again and again to the theme, either in stating his own case, or in criticising the views of others. For example, in the Preface to the Horae Ent., p. xiii., he says: "Thus it requires neither talent nor ingenuity to invent an artificial system, and there may be as many hundreds of such as there are heads to devise them; but of natural systems there is and can be only one. Finally, the former is the miserable resource of the feeble mind of man, unable to comprehend in one view the innumerable works of the creation; whereas the natural system is the plan of creation itself, the work of an all-wise, all-powerful Deity."

In his last paper "Annulosa of South Africa," before leaving England (1838), he says (p. 52): "It must not be supposed, however, that I offer this essay as perfect and complete, or that I absurdly pretend, as some have most unjustly laid to my charge, to have positively arrived at the *Natural System.* I merely publish this paper on *Cetoniidae* as another, and perhaps closer approximation to that Divine plan, which, every hour I have devoted to nature, whether in tropical forests or in the museums of Europe, has shown to be the branch of natural history most worthy of being studied by rational beings. But the truth is that this divine plan is not one particular branch of natural history, but the study of of every branch. It is the whole, of which it necessarily includes the knowledge every branch of natural history is but a part, and which I shall ever regard with gratitude, as having been the source of many moments of the purest pleasure while my residence was in an unhealthy climate."

Such views as these were entirely in keeping with the English Time-Spirit of the day. They were fostered by some of the current English literature of the time, notably a book entitled "The Wisdom of God manifested in the Works of the Creator," written by John Ray (1628-1705), the "father of modern zoology," a divine as well as a naturalist. It was a very popular book a century ago. W. S. Macleay quotes from it approvingly more than once in the Horae Entomologicae (pp. 468, 488). Another treatise breathing the same pious spirit was the "Reflections on the Study of Nature: translated from the Latin of the celebrated Linnaeus," by Dr. J. E. Smith, President of the Linnean Society, and issued together with his Inaugural Address to the Society, and some of his smaller botanical papers, in one volume, entitled "Tracts relating to Natural History," in 1798. In due time there followed the "Bridgewater Treatises on the Power, Wisdom, and Goodness of God as manifested in the Creation" (numerous volumes by various authors), and Paley's "Natural Theology."

The incentive to begin active work, with a view to publication, came quite simply. The first edition of Cuvier's "Règne Animal," in 4 vols., was published in 1817, while W. S. Macleay was officially resident in Paris. The entomological portion of this important work was contributed by Latreille, who therein "applied the name of *Lamellicornes* to an artificial division comprising all the insects which compose the genera *Lucanus* and *Scarabaeus*, as they were left by Linnaeus in his last edition of the Systema Naturae." W. S. Macleay, therefore, decided to revise the group, as his father's cabinet contained representatives of nearly 1800 species of the Linnean genus *Scarabaeus;* and, as an additional qualification for undertaking the work, he had had the good fortune to visit almost every collection of note in Europe, excepting those of Vienna and Berlin. The results of this investigation were published, as a separate work, in London, Part i. in 1819, and Part ii. in 1821, under the title of "Horae Entomologicae: or Essays on the Annulose Animals. Part i., containing general Observations on the Geography Manners, and Natural Affinities of the Insects which compose the Genus *Scarabaeus* of Linnaeus; to which are added a few incidental Remarks on the Genera *Lucanus* and *Hister* of the same author. With an Appendix and Plates." A second part was published two years after, in 1821, under the title "Part ii.: An attempt to ascertain the Rank and Situation which the celebrated Egyptian Insect, *Scarabaeus sacer*, holds among Organised Beings."

These two contributions to knowledge, in some respects perhaps his most important ones, were something more than merely entomological treatises, as the Title and Sub-titles might be taken to indicate. The arrangement of the Lamellicorn Insects in the first part was the result of rigid analysis, whereby the author arrived at some new principles of classification. These, in the second part, were applied to an arrangement of the entire animal kingdom, chiefly deduced from synthetical investigation, and confined, moreover, to the larger and more important groups, as pointed out by Jenyns. But in the course of his synthetical investigation, the author finds occasion to discuss the great problems of Philosophy, as they present themselves to the philosophical Theist.

W. S. Macleay's new principles of classification were incidentally treated of, but not formulated by him. This was afterwards done by the Rev. L. Jenyns, in a valuable "Report on the Recent Progress and Present State of Zoology," covering the period from the publication of the first edition of Cuvier's "Règne Animal" (1817) to date, drawn up at the request of the Section for Natural History of the British Association for the Advancement of Science, and included in the "Report of the Fourth Meeting held at Edinburgh in 1834" [pp. 143-251 especially pp. 152-155, *et seq.* (1835)]. The writer ably and fairly reviews W. S. Macleay's views on classification, gives references to the work of the new school of English zoologists [including, besides Macleay, Kirby, Vigors, Swainson, Horsfield, and J. E. Gray], and enables the reader to understand the zoological Time-Spirit of the period. He thus formally states Macleay's new principles:—"Mr. MacLeay [in the Hor. Ent.] announced some new principles connected with the classification of animals, which, from the circumstance of their having led to a peculiar school of zoologists in England it will be necessary to consider a little more in detail. The most important of these principles* [*Footnote*—* It may be observed that Mr. MacLeay has nowhere formally stated these principles as above. They are only gathered from what he has written on the subject.] are: (1st) That all natural groups, of whatever denomination, return into themselves, forming circles; (2ndly), That each of these circular groups is resolvable into exactly five others; (3rdly), That these five groups always admit of a binary arrangement, two of them being what he calls typical, the other three aberrant: (4thly) That while proximate groups in any circle are connected by relations of affinity, corresponding groups in two contiguous circles are connected by relations of analogy. Mr. Macleay has also observed [Hor. Ent. p. 518] that, in almost every group, one of the five minor groups into which it is resolvable, bears a resemblance to all the rest; or, more strictly speaking, consists of types which represent those of each of the four other groups, together with a type peculiar to itself." These views came to be known as the "Quinary System" or the "Circular and Quinary System."

Jenyns came to the conclusion that W. S. Macleay had pointed out more exactly than others the difference between affinity and analogy in natural history; and that he was also the first to establish by proof circular affinities. He then proceeds: "Whatever of error there may be in the rest of his views, whatever modifications already have been, or may yet further be made in them, by the help of the above principles he appears to have approached nearer than any before him to the true natural system, and (as has already been twice observed) [Kirby, Introd. to Entom., Vol. iv., p. 359; and Swainson, Fn. Bor.-Am., part 2. p. xlvi.] been enabled to reconcile facts which upon no other plan can be reconciled."

Ten years later, H. E. Strickland communicated a "Report on the Recent Progress and Present State of Ornithology" at the Fourteenth Meeting of the British Association held at York in 1844 [Fourteenth Report, pp. 170-221]. This also is a valuable report. It is of special interest, because it includes a critical review of the Quinary Theory, and of the work of Vigors and Swainson as exponents of it. At the same time, it illustrates the insuperable difficulty of finding a scientific meaning of affinity under the influence of the creation-hypothesis. Strickland rejects the Quinary System "as a theory which the most careful inductions and the most unprejudiced reasonings of subsequent naturalists have shown to have no claim to our adoption as a general law. . . . . The point at issue is this,—whether or not it formed a part of the plan of Creative Wisdom, when engaged in peopling the earth with living beings, that when arranged into abstract groups conformably with their characters, they should follow any regular geometrical or numerical law." After much interesting argument, too lengthy to quote, he concludes that irregularity and not symmetry may be expected to characterise the natural system; and that this view is more consistent with the benevolence of an all-wise Creator.

Strickland, reviewing Vigors' paper on "The Natural Affinities that connect the Orders and Families of Birds" [Trans. Linn. Soc., Vol. xiv.] says: "This treatise abounds with original observations and philosophical references, but unfortunately they are applied in support of a theory which the most careful inductions and the most unprejudiced reasonings of subsequent naturalists have shown to have no claim to our adoption as a general law. . . . . The application by Mr. Vigors of these novel and singular doctrines to the class of birds contributed in no small degree to the advancement of ornithological science; for, however erroneous a theory may be, yet the researches which are entered upon with a view to its support or refutation invariably advance the cause of truth. Alchemy was the parent of chemistry, astrology of astronomy, and quinarianism has at least been one of the foster-parents of philosophical zoology."

Reviewing Swainson's "Classification of Birds" forming part of Lardner's Cyclopaedia (1836-37). Strickland says of Swainson's method, that it is "only a modification of the quinary theory, originally propounded by Macleay and further developed by Vigors. In following Mr. Swainson into the details of his method, we miss the philosophical spirit and logical though not always well-founded reasoning of the last two authors. Firmly wedded to a theory, he is driven, in applying it to facts, to the most forced and fanciful conclusions. Compelled to show that the components of every group assume a *circular* figure, that they amount in the aggregate to a *definite number*, into which each of them is again subdivisible, and that there is a system of *analogical representation* between the corresponding members of every circle, which forms the sole test of its conformity to the natural arrangement, we need not wonder at the difficulties with which our author is beset; and we may certainly admire the ingenuity with which he has grappled with the Protean forms of nature, and forced them into an apparent coincidence with a predetermined system. I need not follow out the details of this Procrustean process, having already treated of it elsewhere" [p. 175. Reprinted in "Memoirs of Hugh Edwin Strickland." By Sir William Jardine (1848). This also includes a Selection from Strickland's scientific writings].

But Swainson did not confine his attention to the application of the Quinary System, as modified by himself to the classification of Birds. He narrates, in his autobiography, included in one of his books, how, under financial stress, he became a "professional author," and, as such, the contributor of about a dozen popular textbooks on Natural History, to Lardner's "Cabinet of Natural History," later "The Cabinet Cyclopaedia," during the years 1834-40. In some of these he applied his views to the classification of Quadrupeds, Reptiles and Fishes, Mollusca, and Insecta, as well as to the Principles of Classification and cognate matters. He became, in this way, the most voluminous expounder of the Quinary System. His books contain much useful information, but they are also open to Strickland's objection to the fanciful way in which he forced the Protean forms of nature into an apparent coincidence with a predetermined system.

These quotations are given because, without a knowledge of what they represent, it is difficult to understand the condensed statements about W. S. Macleay's work, as given in the Obituary Notices, to which reference has been made. Vigors, and especially Swainson, were the "injudicious friends" referred to by Mr. Busk.

Other Pre-Darwinian reviewers or critics of Macleay's system besides those mentioned, include Kirby and Spence [Introduction to Entomology. Fifth Edition (1828), Vol. iii., p. 12; Vol. iv., p. 477], E. Newman [Entomological Magazine, Vol. v., p. ix., 1838], J. O. Westwood [Arcana Entomologica, Vol. i., p. 188, 1845], W. Whewell [History of the Inductive Sciences, Vol. iii., p. 295, 1857], and Louis Agassiz [Essay on Classification, p. 234, 1859].

In his obituary notice of W. S. Macleay, Mr. Busk remarks: "It would be out of place here to enter into an analysis or criticism of this work [The Hor. Ent.], in which, however, it may be said are contained some of the most important speculations as to the affinities or relations of various groups of animals to each other ever offered to the world, and of which it is almost impossible to overrate the suggestive value. Speculative ideas, however, of such a general kind, even in the hands of their author, are apt to be carried too far in their application, and, when they fall into those of other speculators of less information and less capacity, can hardly fail to be grossly misused. This has been the case with Mr. MacLeay's ideas; and thus, as observed by the author of a notice in the 'Reader,' of his labours, the name of the 'circular system' and of 'quinarianism' became almost bywords, and the work of one of the most thoughtful and original of English biologists sank at one time into most unmerited neglect."

It is a reasonable, and very probably a correct surmise, that the notice of W. S. Macleay in the "Reader" referred to by Mr. Busk, was written by Huxley. Particulars of Huxley's association with the "Reader," as promoter and editor-in-chief, are given in the "Life and Letters" of Huxley [Vol. i., p. 305]. This weekly journal was established after the quarterly Natural History Review was given up, and lasted from 1863-66. It was the forerunner of the current "Nature," established in 1869. As far as one can judge, Huxley was the only one of those associated with the management of the "Reader" who had personally known W. S. Macleay. If so, his notice was his last tribute to the Sydney friend of 1847-50. Unfortunately no copy of the "Reader" is available in Sydney.

W. S. Macleay did reply to minor critics, like Bicheno and Fleming, on such subjects as Systems in the abstract, Natural, Artificial, or Dichotomous. But how was the finite mind of man to grapple successfully with such supernatural problems as symmetry in the natural system *versus* irregularity, as indicative of the benevolence of an all-wise Creator?

His only reply to Swainson is contained in his paper on the "Natural System of Fishes," dated Elizabeth Bay, near Sydney, September 12th, 1840, sent as a letter to Dr. J. McClelland, of Calcutta, published in the Calcutta Journal of Nat. Hist., July, 1841, and republished in the Ann. Mag. Nat. Hist., Vol. ix., p. 197 (1842). In this, he says: "I assure you that your excellent work on *Cyprinidae* has afforded me the greatest delight, and the more so, inasmuch as I am convinced natural arrangement is always best tested by accurate analysis, and also inasmuch as I am not by any means satisfied with Swainson's arrangement of Fishes. As from everything Swainson writes there is information to be derived, so I assure you, his little volume on Reptiles and Fishes has not been lost on me. . . . . I am often afraid of trusting myself to Mr. Swainson's method of drawing analogies between things in themselves wide apart. . . . . The nearer two groups are in general structure, the more striking their parallel analogies will be; and therefore I think, that by comparing fish with fish, we may obtain more striking analogies than by comparing them, as Swainson does, with Mammalia, birds, or insects; at all events, we shall have less reason to distrust the efforts of a fertile imagination. Still I am far from denying that such analogies as he delights in exist in nature. I only say that they are dangerous things to deal with, and that in his hands they often become far-fetched and even ludicrous" (pp. 203, 204).

Professor Ray Lankester, in his valuable Essay on "the History and Scope of Zoology," points out that the history of Zoology as a science is the history of the great biological doctrine of organic evolution as put forward, on a new basis, by Charles Darwin in his "Origin of Species," published in the year 1859. It is a long and involved story, and some of the details are still in question.

W. S. Macleay's published work covers the period 1819-47. Therefore, in time, as well as in character, in so far as it has to do with the significance of the natural system and with the principles of classification, it is pre-Darwinian.

What was needed then, no less than when Darwin offered it, in 1859, was what Huxley said: "That which we were looking for, and could not find, was a hypothesis respecting the origin of known organic forms, which assumed the operation of no causes but such as could be proved to be actually at work. We wanted not to pin our faith to that or any other speculation, but to get hold of clear and definite conceptions which could be brought face to face with facts and have their validity tested. The 'Origin' provided us with the working-hypothesis we sought. Moreover, it did the immense service of freeing us for ever from the dilemma—refuse to accept the creation-hypothesis, and what have you to propose that can be accepted by any cautious reasoner?" [Darwin's "Life," Vol. ii., p. 197].

In offering his working-hypothesis, Darwin first grouped his predecessors: "Naturalists try to arrange the species, genera, and families in each class, on what is called the Natural System. But what is meant by this system? Some authors look at it merely as a scheme for arranging together those living objects which are most alike, and for separating those which are most unlike; or as an artificial means for enumerating, as briefly as possible, general propositions. . . . But many naturalists think that something more is meant by the Natural System; they believe that it reveals the plan of the Creator; but unless it be specified whether in order, time or space, or what else is meant by the plan of the Creator, it seems to me that nothing is thus added to our knowledge. . . . I believe that something more is included; and that propinquity of descent—the only known cause of the similarity of organic beings—is the bond, hidden as it is by various degrees of modification, which is partially revealed to us by our classifications" [Origin of Species, p. 413, 1860].

The first group included the French school, led by Cuvier, and also other Continental zoologists. The second comprised the English zoologists who concerned themselves with the pursuit of the natural system in the first half of the last century, among whom W. S. Macleay was pre-eminent. It included also Louis Agassiz, a great teacher and an eminent naturalist, whose "Essay on Classification" was published in England as a separate work in 1859, the year in which Darwin's "Origin of Species" was issued.

After grouping his predecessors, Darwin presented his working-hypothesis in the following words:—"All the foregoing rules and aids and difficulties in classification are explained, if I do not greatly deceive myself, on the view that the natural system is founded on descent with modification; that the characters which naturalists consider as showing true affinity between any two or more species, are those which have been inherited from a common parent, and, in so far, all true classification is genealogical; that community of descent is the hidden bond which naturalists have been unconsciously seeking, and not some unknown plan of creation, or the enunciation of general propositions, and the putting together and separating objects more or less alike. . . . . On my view of characters being of real importance for classification, only in so far as they reveal descent, we can clearly understand why analogical or adaptive characters, although of the utmost importance to the welfare of the being, are almost valueless to the systematist. For animals, belonging to two most distinct lines of descent, may readily become adapted to similar conditions, and thus assume a close external resemblance; but such resemblances will not reveal—will rather tend to conceal their blood-relationship to their proper lines of descent" [Origin of Species, pp. 421, 426].

Viewed in the light of these illuminating propositions, it is obvious that the Circular and Quinary System did not fulfil the requirements of a working hypothesis, such as was needed. It was an artificial system, the fruit of philosophical speculation. Within its limitations, and from the particular standpoint from which it was attempted, the Horae Entomologicae was thoughtfully and ably written; and a stimulating contribution to the English scientific literature of the time. The defects of the principles and of the system were the inherent scientific weakness of the foundation on which they were based. They were the product of a studied attempt to develop the Natural System under the influence of the creation-hypothesis—in the belief that "the Natural System is the plan of creation itself, the work of an all-wise all-powerful Deity." This assumed the operation of causes outside the domain of science, involving the obscuration of both the need, and the possibility of finding a scientific meaning of natural affinity, and all that it connotes. The author's conceptions of circular affinities, of quinary groups, and of no true affinities unconnected with relations of analogy, were speculative ideas without a scientific basis; because, in the belief that devisers of systems were merely endeavouring to translate the thoughts of the Creator into human language, affinity and analogy could be interpreted only in terms of something supernatural and beyond the domain of science.

W. S. Macleay's views had apparently, not profoundly changed up to the time that Huxley said farewell to him in Sydney, in May, 1850. Huxley's second letter to Macleay, the only one which has come down to us, was written on November 9th, 1851, just a year after the "Rattlesnake" was paid off, after her return to England. In this, Huxley writes: "I am every day becoming more and more certain that you were on the right track thirty years ago in your views of the order and symmetry to be traced in the true natural system." These were not empty words merely intended to please. The reference to "thirty years ago," signifies 1821, the year in which the second part of the Horae Entomologicae was published. The extract quoted reveals the fact that Huxley had read the book, possibly on the homeward voyage, as he had an absorbing source of interest, apart from science, to claim his attention during his brief periodical visits to Sydney. Macleay had some spare copies of his book, and probably gave one to Huxley, perhaps as a parting gift. Moreover, in 1851, Huxley could write as he did, because, though he may have given up the "Pentateuchal cosmogony," he could still say, at this time: "But my mind was unbiassed in respect of any doctrine which presented itself, if it professed to be based on purely philosophical and scientific reasoning." When the letter was written, Huxley was still an Assistant-Surgeon in the Navy, on leave, in order to prepare his scientific work for publication. His future prospects were very uncertain; and, so early in his career, he had not as yet been brought into serious contact with the Species-question. "My last letter," he says, "is, I am afraid, nine or ten months old, but here in England, the fighting and scratching to keep your place in the crowd exclude almost all other thoughts. When I last wrote, I was but on the edge of the crush at the pit-door of this great fools' theatre—now I have worked my way into it and through it, and am, I hope, not far from the check-takers. . . . . In the meanwhile, I have not been idle, as I hope to show you by the various papers enclosed with this." It was after this, but before the publication of the "Origin," that, as his biographer says, he took up "a thoroughly agnostic attitude with regard to the species-question, for he could not accept the creational theory, yet sought in vain among the transmutationists for any cause adequate to produce transmutation." Or, in his own words, "I imagine that most of those of my contemporaries who thought seriously about the matter, were very much in my own state of mind—inclined to say to both Mosaists and Evolutionists, 'a plague on both your houses!' and disposed to turn aside from an interminable and apparently fruitless discussion, to labour in the fertile fields of ascertainable fact" [Life and Letters.]

It is a matter of history that Darwin's "Origin" made no favourable appeal for consideration as a working-hypothesis for the solution of scientific problems, either to Agassiz or to W. S. Macleay, not to speak of many others; and merely presented itself as a menace to their religious beliefs. But how few there were, who merely from a perusal of the book, without, or even with, verbal or epistolary explanations from the author, were ready to accept it at its face-value?

It is not surprising, therefore, that the receipt of a copy of Darwin's "Origin" sent by Mrs. Lowe, with a request for an expression of his opinion about it, should furnish W. S. Macleay with an opportunity only for a theological discussion. In his reply to Robert Lowe, he says [May, 1860]: "It is lucky for me therefore, that both you and Mrs. Lowe have given me the subject of this letter in asking me for my opinion of Darwin's book. To me, now on the verge of the tomb, I must confess the subject of it is more interesting than either the extension of British commerce or even the extension of national education. This question is no less than 'What am I?' 'What is man?', a created being under the direct government of his Creator, or only an accidental sprout of some primordial type that was the common progenitor of both animals and vegetables. The theologian has no doubt answered those questions, but leaving the Mosaic account of the Creation to Doctors of Divinity, the naturalist finds himself on the horns of a dilemma. For, either from the facts he observes, he must believe in a special creation of organised species, which creation has been progressive and is now in full operation, or he must adopt some such view as that of Darwin, viz., that the primordial cell of life has been constantly sprouting forth of itself by 'natural selection' into all the various forms of animals and vegetables. . . . . I am myself so far a Pantheist that I see God in everything: but then I believe in His special Providence, and that he is the constant and active sole Creator and all-wise Administrator of the Universe" [Life and letters of the Right Hon. Robert Lowe, Viscount Sherbrooke, Vol. ii., p. 204 (1893)].

It is to be remembered, of course, that the letter was a private one, not intended for publication.

From the foregoing, it is evident that the words which Sachs applies to the contemporary botanists, are also applicable to the zoologists:—"It is easy to understand why the first feeble attempts at a theory of descent encountered such obstinate, nay fanatical opposition from professed systematists, who looked upon the system as something above nature, a component part of their religion" [History of Botany, p. 111].

It is not necessary to enter into details respecting W. S. Macleay's published papers. Work done from upwards of seventy years to more than a century ago, whether relating to the significance of the natural system, to the morphology of insects, or to descriptive zoology, is now chiefly of historic interest, because, since then, all branches of knowledge have progressed. Twenty-six papers—not including the Horae Entomologicae, Annulosa Javanica, Annulosa of New Holland, collected by Captain P. P. King, and the Annulosa of South Africa, which were not published by Societies—are listed in the Royal Society's Catalogue of Scientific Papers, Vol. iv. The entire series can be consulted in the Society's library.

W. S. Macleay left England for Cuba in October, 1825, to take up his duties in connection with the Mixed British and Spanish Court of Commission for the Abolition of the Slave Trade established at the Havana. His residence in Cuba lasted from December, 1825 to early in the year 1836.

At a Meeting of the Zoological Club on February 14th, 1826, "Mr. Vigors read some extracts from a letter which he had received from W. S. Macleay, Esqr., F.L.S., from the Havannah, December 27th, 1825. The extracts consisted of Ornithological observations made by that gentleman, during his voyage from England to the Island of Cuba, in the months of October, November, and December, 1825; including remarks on the Ornithology of the Islands of Madeira, Teneriffe and St. Jago; as also a few cursory observations made at Barbadoes, Martinique, and off the coast of St. Domingo, on the same subject" [Zoological Journal, Vol. ii., p. 553, 1826].

With the exception of one interesting letter to his friend Kirby, dated January 3rd, 1827, about a year after his arrival, few particulars of this period of his life are available, except what can be gleaned from casual remarks in some of his papers. To Kirby, he wrote: "I fear that you will imagine that, by crossing the

Atlantic, I have forgotten my old friends; but the fact is that I was unwilling to write to you until I had carefully studied the 'Introduction' [Kirby and Spence's Introduction to Entomology] and had enabled myself to give you some opinion upon this very useful and laborious work, for which I beg leave to return you best thanks. It contains, indeed much information quite new to me; and although we differ in some important points, time, I have no doubt, will set all things right.

"The climate has, I thank God, hitherto agreed with me much better than that of England: but there is a languor attendant upon every kind of exertion, which makes reading or study here a very different thing from what it is in England.

"This is a good place for Wading Birds, Lizards, Butterflies, and Sphinges, but apparently nothing else.

"I live in the country, where I have a large house and garden; this is my principal amusement, as I take great pleasure in cultivating Orchideae, particularly those which are parasitical on trees. The disagreeables are ants, scorpions, mygales, and musquetoes. The latter were quite a pest on my first arrival within the tropics; but now I mind them about as much as I did gnats in England." Then follow some particulars of his having been stung by an immense scorpion and a large wasp [Freeman's Life of Kirby, p. 422].

This letter is of special interest, because of the reference to his interest in horticulture. The garden would be at Guanabanacoa. For in his description of a curious spider with two eyes, *Nops Guanabanacoae*, g.et sp.n., in the Annals of Nat. History [Vol. ii., No. 7, p. 1, 1839] published after his return to England, he says—"the trivial name of this remarkable spider will serve to commemorate Guanabanacoa, the place where first I found it, a place in which I long resided, devoting many delightful hours to the science of natural history."

Natural history soon began to claim his attention in his leisure, but in the absence of any other records, the particulars have to be gleaned from his own papers, or from those who recorded or described the collections or specimens he sent to England.

Specimens of lizards, bats, and of forty-five species of birds were sent to England, exhibited at meetings of the Zoological Club of the Linnean Society, and recorded by Bell, Horsfield, and Vigors in the Zoological Journal [Vol. iii., pp. 235, 236, and 434 (1828)]. J. E. Gray, at a later date, described a collection of Cuban bats sent by W. S. Macleay; and he mentions also a foetal specimen of a dolphin [Ann. Nat. Hist., Vol. iv., Sept., 1839, p. 16].

The curious rodent, *Capromys*, birds, and Annulosa, especially interested W. S. Macleay. His acquisition of a copy of Oviedo's book "Historia general de las 'Indias,'" the oldest and one of the rarest and best books on the Natural History of the West Indies, published in 1547, led him to take an interest in the remarkable rodents referable to the genus *Capromys*. In the first of two notes about them, published in the Zoological Journal [Vols. iv., 269; v., 179, 1829-30] he says: "Having now three species of *Capromys* alive in my garden, and ready to be sent by the first opportunity to the Zoological Society, I shall avail myself of the information to be found in Oviedo, to correct some of the absurd errors which have been lately propagated on the subject of this genus." He records also his own observations on the animals in their native haunts. It appears, from the second note, that he sent five living specimens by the "Aurora Frigate," but that they did not survive the voyage.

One of the papers sent home during his residence in Cuba was entitled "Remarks on the Comparative Anatomy of certain Birds of Cuba, with a view to their respective places in the System of Nature." [Trans. Linn. Soc., Vol. xvi., Part i., p. 149]. But, as remarked in a lengthy review of the paper in the Zoological Journal [Vol. iv., p. 483], "of comparative anatomy they contain but little, and appear rather to be designed as prefatory observations introductory to anatomical notices which are intended hereafter to be given." It was the author's intention to examine anatomically particular genera, which were not within the reach of naturalists at home; but the supplementary details were never published.

No papers dealing especially with Cuban insects were published by W. S. Macleay. But among our memorials of him there are thirty-nine water-colour drawings of lepidopterous larvae, from which he may have bred the perfect insects. Besides these, there are a number of pencil or pen and ink sketches of lepidoptera, scorpions, ticks, and mites.

After his return to England, he contributed a short paper "On some new Forms of Arachnida," to the Annals of Natural History [Vol. ii., No. 7, Sept., 1838] in which he described and figured the types of four new genera, and the type of a new subgenus of Dufour's genus *Selenops*. Four of the species were Cuban, and one Indian. These particular species were selected for their singularity "out of a great variety of new forms in my cabinet," "in order to prove how little is as yet known of even that part of the class *Arachnida* which has been the most studied, namely Spiders"; and thus to enable him to re-define the Order *Araneidea*.

Poulton [Essays on Evolution, Chap. viii., p. 220, 1908] has pointed out that "W. S. Macleay, in his Hor. Ent. alluded to certain cases which are now included under Mimicry, viz., the likeness of some Diptera to Hymenoptera, and interpreted them, together with many other resemblances of structure and life-history, by the principle of Analogy, as distinct from Affinity in Nature [Pt. ii., p. 365]." In the paper above referred to, W. S. Macleay described an Indian spider, in appearance resembling an ant, as the type of the new genus *Myrmarachne*, of which he says: "Nothing is certainly known with respect to the manners of these curious spiders, but I suppose from analogy, that they may eventually be found to feed on ants. It has long been known that the *Voluceltae* in their larva state live in the nests of the *Bombi* they so much resemble; and I have discovered that the larvae of those tropical *Bombylii* which have such a bee-like form live on the larvae of the bees they so strikingly represent. Perhaps, in like manner, the object of nature in giving such a striking form to this spider is to deceive the ants on which they prey" (p. 12).

Only the most meagre record of W. S. Macleay's experiences as a collector, before he went to Cuba, has come down to us. One cannot believe that the attractions of Combe Wood, "classical ground to entomologists" (Lyell), Wimbledon Common, Battersea Fields, and other favourite localities for the entomological collector resident in London a century ago, were unappreciated either by him or his father. Probably, too, during his undergraduate days, he may have had experiences like those of Charles Darwin about seventeen years later, in collecting insects in the neighbourhood of Cambridge, and in having fellow-students who shared his interest.

Nevertheless the solitary record of a collecting excursion before he left England in 1825, known to me, is a casual remark in the Horae Entomologicae (Part i., p. 62)—"Mr. Kirby mentions in the Introduction to Entomology, his having found these insects [Troges] on a ram's horn. I was myself present in the forest of Fontainebleau, with the last-mentioned entomologist, when he took a specimen of *Trox* from off a horse's scull" This was in June, 1817. Kirby, in a letter to his friend Sutton, has given an account of his first visit to Paris, of his introduction to Latreille, and of W. S. Macleay's kindness and helpfulness to him.

It is evident that W. S. Macleay had the opportunity of making a good collection of the Cuban groups in which he was interested, sufficient not only for his own requirements, but for purposes of exchange with his scientific friends; as well as of supplementing it, to some extent, at the places which he visited on the voyages outwards and homewards

He does not appear to have had a separate collection of his own prior to his departure for Cuba in 1825. Any specimens which came into his possession, whether as the results of his own collecting, or as gifts or exchanges, were added to the paternal collection. But just before the time of parting came, his father allowed him to take over such specimens as he was particularly interested in, as an aid to work he may have had in hand, or in prospect. These formed the nucleus of the collection he eventually brought out to Australia in 1838. Some of the items, as well as some of his records of observational zoology, are mentioned in his paper "On the Annulosa of South Africa." On p. 22, he says—"I have found *Diplognatha Gagates* common at Porto Praya in the Cape de Verds; but I cannot say that it is a flower-frequenting insect, as I never met with it except in the cocoa-nut groves below the town, and always on the foliage of the underwood which grows beneath the Palms." On p. 54 he refers to "the Decapods of my own collection." On p. 63, he remarks—"It becomes necessary to point out the families of a stirps [*Grapsina*] which is very common in warm climates, and the study of whose manners afforded me much amusement whilst I resided in the West Indies." On p. 65, of a crab, he adds—"I have found in Cuba the species of *Sesarma* to live generally under stones on the banks of the muddy mouths of rivers." And on p. 66, of another crab, he says—"The type of this genus is the *Grapsus ruricola* of Degeer, a crab whose manners are detailed by me in the first volume of the Transactions of the Zoological Society. Also on p. 67—"I have taken abundance [of *Neutilograpsus minutus* Fabr.] in the Atlantic Ocean, adhering to the gulf-weed."

After his return to England, W. S. Macleay undertook the description of the Annulosa, chiefly collected during an Expedition into the Interior of South Africa, under the direction of Dr. Andrew Smith, in the years 1834, 1835, and 1836; fitted out by the Cape of Good Hope Association for exploring Central Africa. The first portion only of his intended contribution was published, in 1838, shortly before his departure for Australia. In the preface (p. 1) he says—"It may be well that I should mention here my having lately acquired, by purchase, the very extensive collection of *Annulosa* made by M. Verreaux during his long residence at the Cape, and also his manuscript notes on the species collected. Perhaps therefore no naturalist is better provided than I am with those materials which are necessary to enable us to form accurate notions of South African entomology. Upon this subject also, my personal acquaintance with the habits of many exotic genera, may to a certain degree be brought to bear."

Early in the year 1836, after completing more than ten years' service, W. S. Macleay set out on his return to England. On the way, he visited the United

States. This gave him the opportunity of getting into touch with American entomologists, of doing some collecting, and the chance of entering into exchanges; and led up to his election as a Corresponding Member of the Academy of Natural Sciences of Philadelphia. His own brief record of this visit is given in the "Annulosa of South Africa" (p. 17) in the following words:—"The species of *Cremastocheilus* are not common. In company with Dr. Pickering, and Mr. Titian Peale, I found *C. castaneae* of Koch, in June, 1836, on the banks of the Delaware, on the New Jersey side, opposite Philadelphia. These singular beetles are never found except flying, like Cicindelae, over the sand which there lines the bank of that noble river."

Soon after his arrival in England in the autumn of 1836, W. S. Macleay was presented at Court, as a mark of approbation of the way in which he had carried out his responsible official duties in Cuba.

He soon received a welcome back into scientific circles in London. In 1837, he was elected to the Council of the Linnean Society. The Lord Bishop of Norwich, Dr. Stanley, father of Dean Stanley, and of Captain Owen Stanley, was President. Among the Members of Council were J. J. Bennett of the British Museum, George Bentham, Robert Brown, the Earl of Derby, President of the Zoological Society, Dr. Horsfield, and Richard Owen.

In the same year, he was elected to the Council of the Zoological Society. Thomas Bell and Richard Owen were Members of the Council at this time. We have some interesting relics of W. S. Macleay's connection with the Society, in the shape of notices to attend Council or other meetings, signed by W. H Yarrell as secretary; and proofs of two papers submitted to him as a member of the Publication Committee.

About the same time, too, W. S. Macleay was elected to the Council of the British Association for the Advancement of Science, and President of Section D at the meeting of the Association held at Liverpool in September, 1837. The Earl of Burlington was President, but the Address was delivered by Professor Traill. The Presidents of Sections were: Sec. A, Sir David Brewster; Sec. B, Dr. Faraday; Sec. C, Professor A. Sedgwick; Sec. D (Botany and Zoology), W. Sharp Macleay; and Sec. E, Professor Clark. The Vice-Presidents of Sec. D, were Dr. Richardson, Professor Graham, and Professor Lindley; and the Secretaries, Professor Babington, W. Swainson, and the Rev. L. Jenyns. No papers of particular interest to us were communicated to Section D. But John Gould exhibited coloured drawings of Australian and New Zealand birds; and W. S. Macleay and the Rev. F. W. Hope described some insects from the fine collection of Mr. Melly, then resident in Liverpool. It was a very successful and interesting meeting, as described by R. Murchison, General Secretary, in a letter to his wife ["Life of Sir Roderick Murchison," Vol. i., p. 238]. The Rev. W. B. Clarke attended; and he, John Gould, who left England for Tasmania in 1838, and W. S. Macleay had the opportunity of meeting again in Sydney in 1839.

After the "Beagle" had completed her voyage, and W. S. Macleay had returned to England from Cuba, Charles Darwin and he seem to have met, in 1836 or early in 1837. For, in a letter dated April 10th, 1837, written by Darwin to the Rev. L. Jenyns, he says—"During the last week several of the zoologists of this place [London] have been urging me to consider the possibility of publishing the 'Zoology of the *Beagle's* Voyage' on some uniform plan. Mr. [W. S.] Macleay has taken a great deal of interest in the subject, and maintains that such a publication is very desirable because it keeps together a series of observations made respecting animals inhabiting the same part of the world, and allows any future traveller taking them with him" ["Life," Vol. i., p. 281].

The concluding sentence of the "Annulosa of South Africa" contains the first announcement of W. S. Macleay's intended visit to Australia—"I hope, however, as I am about to visit Australia, soon to be able to make myself master of the economy of these insects [Australian *Paussi*], and also to publish a correct representation of the parts of the mouth" (p. 75).

A more definite statement about his contemplated departure, and a request for exchanges of specimens, is to be found in a letter from W. S. Macleay to his friend John McClelland, Assistant Surgeon, Bengal Medical Service, at Calcutta. The latter, wishing to make known Macleay's wishes for exchanges, appended the following extract from the letter to his own paper on "Indian Cyprinidae," which was communicated to the Asiatic Society of Bengal, on 5th September, 1838, subsequently printed in Vol. xix., Part ii., of the Asiatic Researches, and reprinted in the Annals and Magazine of Natural History [Vol. viii., 1842, p. 199]—"Mr. MacLeay writes from London, 12th August, 1838: 'I am now on the eve of embarking for Sydney, where I intend to remain for the next three or four years; and what I would ask of you is, to exchange invertebrated animals, collected in India, as the Annelida, Annulosa, Cirripedes, Radiata, and Acrita, for other objects collected in New Holland; insects, spiders, and crustacea of India I at present desire above all, and shall feel obliged by any notes on their metamorphoses or oeconomy. With regard to such notes, I need not say I shall bear in mind the axiom "*Suum cuique.*" If you will point out your particular *desiderata* in natural history, I will endeavour to add to your collections.'" By way of commending the request, Dr. McClelland adds—"Considering the intimate intercourse now established between Calcutta and Sydney, it is to be hoped that an appeal to India from such a quarter will not be made in vain, and that all who are interested in the advancement of natural history will collect and forward whatever objects their particular localities may afford, with a view to facilitate the researches of the illustrious author of 'Horae Entomologicae.'"

Some interesting details relating to this period are furnished by two letters among the W. S. Macleay relics, from Edward Macarthur, eldest son of John Macarthur of Camden, and afterwards Major-General Sir Edward Macarthur. One of these, dated, "Thursday, 4 Jany." [? 1838] is an intimation that his brother, possibly James, and his cousin, Captain Macarthur, were intending to call on W. S. Macleay; that the latter, who had been appointed to conduct the new settlement on the north shore of New Holland [Port Essington], was desirous of taking out a good selection of plants, especially such as were of commercial value, suitable for cultivation in the tropics; and asking W. S. Macleay if he would supply a list of desirable plants. The interview, doubtless, took place, and we may be sure that W. S. Macleay did his best to supply a list of plants, based mainly on his experiences in Cuba.

The second, unfortunately not dated, but probably written in July, 1838, is as follows—"I believe that I have found, at length, the sort of ship we want. If you could call on me to-morrow, about eleven, we might talk it over. It is very necessary that your friends should inform you, whether they will accompany you; for, on the 1st of August, the owner of the ship is to have a positive answer from me. . . . . Believe me, very truly yours, Edw. Macarthur."

What is here meant seems to be, either that Macarthur, or perhaps his brother James, was arranging to return to Australia as soon as he could hear of a suitable ship, and that W. S. Macleay was hoping to accompany him as a fellow-passenger. Or it may, perhaps, have meant that he had merely undertaken, on W. S. Macleay's behalf, to make inquiries for a suitable ship for the latter and his friends, his cousins, William and John. W. S. Macleay was prepared to depart in August, as appears from his letter to Dr. McClelland, written on August 12th, 1838, "I am now on the eve of embarking for Sydney," meaning approximately, and not on the following day. But the cousins were not ready to sail so soon, possibly on account of the last illness of their mother, or of John's delicate health. The Plant-book gives the date of receipt of the plants brought by W. S. Macleay, per Royal George, as March, 1839. Allowing four months for the voyage, the embarkation of the party must have been postponed from August to November or early in December, 1838.

W. S. Macleay's motives for visiting Australia, besides a desire to rejoin his relatives, from whom he had been separated for more than twelve years, may very well have been to give the climate a trial, as that of England did not suit his health after ten years' residence in the tropics; and to see something of the wonderful fauna and flora, under very favourable conditions. After some experience, the attractiveness of the mild and sunny climate, of congenial friends, of the beautiful garden, and of the harbour and the bush close at hand, irresistibly appealed to him; the idea of remaining for three or four years only was given up, and Sydney became his permanent home for the rest of his life. Indeed, he never seems to have left it, except to visit Brownlow Hill, and possibly Illawarra. He would certainly never have left Australia while Robert Lowe was a resident of Sydney (1842-50).

W. S. Macleay and his two cousins arrived in Sydney in March, 1839. Other notable arrivals in the same year were the Rev. W. B. Clarke, Mr. John Rae, and Mr., afterwards Sir Alfred Stephen (from Tasmania), all three of whom spent the rest of their days in Sydney; and John Gould, and Mr. and Mrs. Charles Meredith, who came as visitors.

After his arrival in Sydney, W. S. Macleay seems to have been most attracted by the marine fauna. This is not surprising, as he had never before been so favourably situated for marine collecting and study. Tow-netting, dredging, and shore-collecting could be carried out under most favourable conditions. The fishermen used to draw their nets on the sandy beach at the bottom of the garden; and it was easy to get into touch with them, for the supply of remarkable or other specimens desired, that they might capture. It was from this source, evidently, that the sea-snake, offered to Dr. Cantor, was obtained.

The first contribution to Science after his arrival was a paper on the "Natural arrangement of Fishes," sent as a letter to his friend Dr. McClelland, in Calcutta, dated 12th September, 1840. This was published in the Calcutta Journal of Natural History for July, 1841; and reprinted in the Ann. Mag. Nat. Hist., Vol ix., p. 197 (1842). It was written partly to express W. S. Macleay's appreciation of McClelland's paper on Indian *Cyprinidae*, to which family the author had applied Macleay's principles of classification; partly to apply his principles to the classification of Fishes in general; and partly because he was not satisfied with Swainson's arrangement. His objections to Swainson's methods have been quoted above. A number of outline sketches of Sydney fishes among the W. S Macleay relics were probably made in the preparation of the paper.

In concluding his letter, W. S. Macleay says of himself—"I am sorry that I have not been able as yet to get any *Cyprinidae* from our New Holland rivers; but I attribute it to my own residence so far from any river, not to the absence of them. I am promised by friends, who have better opportunities, the result of their researches; but *I receive nothing*, as they know not how to catch the minute fish of the river. However, I intend to try the Nepean River myself when I go down there, which I soon propose to do [this would be near Brownlow Hill]. In the meantime my residence on the sea-side enables me to increase my collection of marine genera, and if there be any you wish for, I shall be most happy to send them. A thousand thanks for your kind method of *beating up* for insects to be sent me from India. I shall be happy to pay any fair price for the collector's time and trouble. Tell Dr. Cantor that I depend on *him* to increase my collection of Annulose animals, and that I hope he will soon write to me. Tell him also that I have got a marine serpent of the genus *Pelamys*, caught in the mouth of Port Jackson harbour, the only one our fishermen have ever seen. If he wishes for it, it is at his service; for he knows infinitely more of Serpents than I do, and my grand desire is, to increase my collection of Annulose animals. . . . I shall write you on *Echinidae* in my next, and send you some the very first opportunity." It was not known at this time that the family *Cyprinidae* is not represented in the Australian fauna. But several species have been introduced.

I do not know what collections W. S. Macleay may have received from India as the result of his offer to Dr. McClelland. But among the memorials of W. S. Macleay are four beautiful coloured drawings of Indian spiders, two of the sexes of a remarkable antlike spider *Myrmecarachne macleayi* Cantor; and three of remarkable Membracid insects, with remarks on the back of the drawings signed Theo Cantor, Calcutta, May-June, 1841. These were evidently sent to him by Dr Cantor; but I have not been able to find out in what Journal the original descriptions of these were published. We have also several reprints of Dr. Cantor's papers, but no letters from him, or from Dr. McClelland.

Another interesting scrap of information is the following notice of a letter to the editor of the Annals and Magazine of Natural History [Vol. viii., No. 48, September 1841, p. 153].—"Mr. W. S. Macleay writes from Sydney, April 28, 1841, that he is much occupied with Natural History, and making large additions to his collection. He gratifies us with good accounts of the health of his excellent father, who is always most affectionately remembered here. R.T."[aylor].

John Gould, accompanied by Mrs. Gould, left England for Tasmania in May, 1838, in order to study the birds of Australia; and returned to England in August, 1840. After spending some months in Tasmania, he visited New South Wales in 1839-40, and South Australia. In the Preface to the "Birds of Australia," he records his best thanks for kindness and help during his stay in New South Wales, among others, to Alexander and W. S. MacLeay, Esqs. Gould probably visited Sydney at least twice, before setting out to collect, with Gilbert, in the interior, and after returning. The letter which he conveyed to Shuckard was dated April, 1840. During one of the visits, W. S. Macleay furnished Gould with the description, and possibly showed him specimens, of a nest-building rat, which he named *Hapalotis arboricola*, in the belief that it was indigenous, as it was not uncommon in the garden. The description was afterwards published in the Introduction to Gould's "Mammals of Australia," p. xxxv., 1863. Mr. E. R. Waite subsequently gave full particulars of the remarkable habits of this rat [Proc. Zool. Soc., 1897, p. 857]. By Mr. O. Thomas, this rat is regarded as a variety of the Black Rat, *Mus rattus* [*see*, an appendix to Waite's paper].

I have already referred to the visit of H.M.SS. "Erebus" and "Terror" to Sydney, from 7th July to 5th August, 1841. Dr. J. D. Hooker, Assistant-Surgeon and Botanist, in a letter to his father, says of W. S. Macleay that, "Twice the naturalist came on board the 'Erebus' and spent all day looking over the Southern collections. He is delighted with my drawings of sea-animals, of which many are entirely new; I must, however, redouble my efforts on that head, little as I care about them, as I hear that the Americans [U.S. Exploring Expedition, 1838-42, in command of Commodore Wilkes] have done much during their voyage to them, and that, McLeay says, is the only thing they have done." Captain P. P. King also visited the ship to see the collections. Some of the shells he "recognised as South American, especially the small yellow bivalves from the Macrocystis" ["Life", Vol. i., pp. 121-122].

Within two years after W. S. Macleay's arrival in Sydney, he made the acquaintance of Dr. James Stuart. Their friendship had a sequel, in which the Society is directly interested. I have not been able to learn anything more about this worthy man than is given by W. S. Macleay himself, in the following extracts [date not given]—"J. Stuart, Esq., is a surgeon in the army, who has been frequently employed by the Colonial Government in superintending the quarantine to which vessels arriving unhealthily in Port Jackson are subjected. . . . Here [at Spring Cove] they remain under the care of a surgeon for the necessary period; and Mr. Stuart, who has often undertaken this painful charge, has, by means of his admirable skill in drawing objects of natural history, and his powers of accurate observation, been enabled to employ to the advantage of every department of science those spare hours which otherwise, in the midst of contagion and disease, would have proved so dreary."

"From among several great novelties which I have found in his collection of drawings, I have selected the representation (nat. size) here given, Pl. vii., of a quadruped which I shall call *Antechinus Stuartii*, and of which Mr. Stuart killed one male specimen at Spring Cove in August, 1837. As this specimen has been unfortunately lost, and I have never seen it, I am obliged to describe it from his notes, hoping that the attention of naturalists will be drawn to the animal, and that some further knowledge may soon be acquired with respect to the habits and structure of the species." Then follows a description based on Dr. Stuart's notes [Ann. Mag., viii., p. 242, 1842].

Shortly afterwards, under date 9th August, 1841, W. S. Macleay sent a note to the same Journal [viii., p. 337] giving "Additional particulars respecting *Antechinus Stuartii*, a new Marsupial Quadruped." In this he says—"Since I wrote to you concerning what I had reason at that time to think might possibly prove to be a new quadruped belonging to the group of *Insectivora*, I have had an opportunity of examining a skeleton, now in the possession of Major Christie, and which Mr. Stuart himself had prepared at the time the animal was killed. This skeleton, by the presence of the marsupial bones, distinctly shows that the quadruped in question belongs to the group *Marsupialia*. It also demonstrates that there was an important error in the dental formula as given me in the manuscript of Mr. Stuart,—the very error, indeed, that led me to think that the animal might eventually be found to belong to the Insectivora." The dental formula was corrected, and recognised as that of *Phascogale* [*Phascologale*] "from which genus our animal differs in the three lateral incisors of the upper jaw being of equal size, and also in the pseudomolars being all of equal size." But there is no record of W. S. Macleay's "hopes of soon possessing a specimen from Spring Cove, when I shall be liable to determine how far this animal differs from the genus *Phascogale*, or whether it may not be safely assigned to it." Thomas, in the British Museum Catalogue of Marsupials, reduces *Antechinus Stuartii* Macleay to a synonym of *Phascologale flavipes* Waterhouse. Nevertheless, Krefft (1871) still retained both Macleay's genus and the species.

Under date 5th July, 1847, W. S. Macleay sent a letter to the *Sydney Morning Herald*, entitled "On the skull now exhibited at the Colonial Museum of Sydney, as that of the 'Bunyip'." The skull had been sent to him for report by the Speaker of the Legislative Council [Dr., afterwards Sir Charles Nicholson] to whom it had been forwarded by Mr. Edward Curr of Port Phillip, as that of the so-called *Bunyip* or *Kine Pratie*. He was induced to send the description of it for publication, "as another and still more extraordinary skull in my possession offers very considerable means for throwing light on the subject." After describing the skull sent by Dr. Nicholson, he proceeds—"I have, however, I repeat, in my possession the skull of a foetus of a mare, which was found floating on the River Hawkesbury, in the year 1841. This skull was prepared by the lamented late Dr. Stewart [Dr. Stuart], and he has made drawings and notes of it, which I intend before long to publish, with his other observations on various branches of natural history." The letter concludes with the statement—"In my judgment, however, the animal is not new, and this skull, when compared with the one from the Hawkesbury only serves to show the extreme limits between which all monstrous variation of the place of the eyes in the horse can possibly occur."

From this letter, it appears that Dr. Stuart died before July, 1847, but I have not been able to ascertain exactly when. Also that his drawings and notes were then in the possession of W. S. Macleay; for they were a bequest from the artist.

While the drawings were in the possession of W. S. Macleay, they were shown to the Governor, Sir William Denison, under the circumstances narrated in a letter to his son, dated 6th February, 1859—"I told you in my last letter, that Sir Daniel Cooper and I were about to send a schooner down the coast to trawl for fish and dredge for shells. . . . Great excitement has been caused in the Legislative Assembly by the production of a tortoise, which was said to have been found alive in a cavity in the rock 13 feet under ground, and 4 feet from the surface of the rock, by the men employed upon the railway cutting. The Speaker sent it to me, and I took it to Mr. W. [S.] Macleay, who pronounced it to be a young specimen of the 'Emys longicollis,' or long-necked tortoise, which is common in this country. There must have been a crevice in the stone, through which the animal had penetrated into its receptacle. . . . . When I went to Mr. Macleay to ask him about the tortoise, he showed us a set of drawings of Australian fish, many of which, he said, were to be caught in Middle Harbor, so we had decided to go down and try for them both with hook and line and the seine; but a southerly wind set in, which made it impracticable to get into Middle Harbour with any comfort, and as the fish never bite in a southerly wind, we gave up our expedition" [Varieties of Vice-Regal Life, Vol. ii., p. 458].

The Stuart Drawings were inherited by George Macleay from his brother, and by him were taken to England on the termination of his visit to Australia, after W. S. Macleay's death. George Macleay eventually presented them to William Macleay in the year 1887. I was present when the box containing them was opened by Mr. Masters. After going over the contents carefully, Sir William handed them over to me for the Society; and until Dr. Walkom relieved me, I had had charge of them ever since. There are 161 drawings, all watercolour sketches, with the exception of five pencil or crayon drawings—Mammals, 13; Birds, 35; Reptiles, 6; Amphibia, 1; Fishes, 82; Crustacea, 8; Mollusca, 13; Echinoderms, 2; Insects, 1.

Now that I know the complete history of them, I hope to contribute a paper giving a complete list of them, as soon as I can enlist the help of an ichthyologist to name the fishes for me. With the Stuart drawings also came the rare coloured portrait of Linnaeus in his Lapland dress, published by Dr. Thornton in June, 1805, reproduced from a painting by Hoffmann, now framed and hung in the Hall; and a good watercolour drawing of the rare Marsupial, *Chaeropus ecaudatus*, by Gerard Krefft. The entire collection was insured by George Macleay for the sum of £200, when it was sent out.

Another short paper, entitled "On doubts respecting the existence of Bird-Catching Spiders," dated Elizabeth Bay, July 8th, 1841, also appeared in the eighth volume of the Ann. Mag. Nat. Hist., p. 324. This was written in correction of a mis-statement in the "History and Natural Arrangement of Insects" (1840), by Swainson, in collaboration with W. E. Shuckard, a copy of which W. S. Macleay had recently received. Speaking of the large and powerful ground-spiders of the genus *Mygale*, Shuckard says—"The fact has been doubted, of these catching birds in their nets, and feeding upon them; but the probability of this has been substantiated and confirmed by a communication we have recently received from W. S. Macleay, Esq., who informs us, that in the vicinity of Sydney, N.S.W., he has met with a true bird-catching spider,—having himself found one of the *Epeiridae* actually devouring the young of a *Gasterops*, that had, no doubt, lately flown from the nest; and which is not a solitary instance, as his father, A. MacLeay, Esq., had previously observed a similar fact. He therefore retracts his observations upon *Mygale* in the *Zoological Transactions;* for here, evidently, is a spider which feeds upon the juices of a warm-blooded animal." He adds in a footnote—"From a letter to me dated 7th April, 1840, brought by Mr. Gould from Sydney."

In reply to this, W. S. Macleay pointed out in his paper, that the correct name of the bird was *Zosterops dorsalis;* that the spider was a species of the *Epeiridae*, and not of *Mygale;* and that the reason for mentioning the circumstance, when writing to Shuckard on another subject, was, that he was "anxious, from the love of truth, to retract a remark which I had made in a paper of mine printed in the Transactions of the Zoological Society, some years before, namely that 'I disbelieved the existence of any bird-catching spider.'" But he still held to the belief that no *Mygale* can catch birds in its net. The observations of Bates, however, without being conclusive, cast some doubt on this opinion [Naturalist on the River Amazon, p. 83, 1879].

The four papers contained in the Ann. Mag. Nat. Hist., Vols. viii. and ix. (1842), from which I have quoted, are W. S. Macleay's only contributions to science published in England after his removal to Australia. Two others were communicated as letters to the *Sydney Morning Herald*, of July 5th, and December 2nd, 1847. One, descriptive of the skull of the so-called Bunyip, has already been mentioned in speaking of Dr. J. Stuart. It was reprinted in the Tasmanian Journal of Science, Vol. iii., p. 275, 1849. The second, descriptive of some bones of the Diprotodon, was written in response to a request from the Rev. W. B. Clarke; and is referred to later on These six communications, unfortunately, represent all the author's own printed records of his scientific work during his residence in Sydney, that we have. Particulars of what he actually succeeded in adding to the Macleay Collection are even more incomplete.

Information relating to his correspondence with scientific friends in England is very meagre. He certainly sent specimens to the Rev. F. W. Hope, but all that is known to me about them is, that when describing *Scarites* (*Scaraphites*) *MacLeaii*, J. O. Westwood adds—"Mr. Hope informs me that Mr. [W. S.] MacLeay has named this section in his manuscripts Scaraphites, and that he has discovered a new species on the east coast of New South Wales, at Elizabeth Bay, where it was found many feet deep in the earth, whilst trenching in sandy soil to form a Pinetum. I would suggest that it should be named in honour of its discoverer. . . . Mr. MacLeay has recently forwarded to Mr. Hope a Carenum, under the name of C. 4-punctatum. . . . . It is a native of New South Wales, and was found under stones at Illawarre" (*sic*) [Arcana Entomologica, Vol. i., pp. 157, 158].

He also corresponded with John Blackwall, the British authority on Spiders, in his day. A most friendly letter from the latter, dated November 18th, 1856, in reply to one from W. S. Macleay of date July 2nd., asking for specimens of certain British species of spiders, and for a good method of preserving Arachnida so as to retain their colours, is the only record available. The requests were complied with as far as possible, with an offer of future help in supplying additional material, if desired. A list of specimens of thirty species sent by post, by the same mail as his letter, is given. And a copy of his "List of Species of Araneida at present known to inhabit Great Britain," was enclosed.

With the exception of W. E. Shuckard, mentioned above, there are no other available records of correspondence with English scientific friends among the relics of W. S. Macleay. But this is hardly a matter of surprise, as I shall point out later on, in speaking of George and of William Macleay.

For any other particulars of W. S. Macleay's life in Australia, we are almost entirely dependent on the records of his friendship with Robert Lowe, who was a barrister and a politician, but not a man of science, as given in Patchett Martin's "Life and Letters of the Right Honourable Robert Lowe, Viscount Sherbrooke" (2 vols., 1893), who lived in Sydney from 1842-50; the published or unpublished records of casual or periodical visitors to Sydney, who were interested in science, including Huxley, or of resident friends, scientific or otherwise; and on the official or other records of his association with the Australian Museum, as a Trustee.

Apart from purely scientific matters, Robert Lowe's biography is the most important self-contained source of information about W. S. Macleay as a private individual, a man of ability and a scholar, a brilliant conversationalist, an inspirer of friendship to those who knew him intimately, and shared his interests; and, though keeping aloof from direct participation in politics, a colonist interested in the progress of Australia, and a believer in her future possibilities. This well-written book, therefore, is a most important supplement to the published Obituary Notices of W. S. Macleay.

Robert Lowe (1811-1892) arrived in Sydney in October, 1842, when he was in his 31st year. He had graduated, with first-class honours, at Oxford in 1833; was a private tutor thereafter until he began to study for the Bar, Fellow of Magdalen in 1835; and was called to the Bar in 1842, and shortly after sailed for Australia, with his wife, to whom he was married in 1836. Robert Lowe was an albino, and his eyes were unprotected by a pigmentum nigrum. Three medical men, whom he had consulted, informed him that he would become blind in seven years, and recommended him to follow some out-of-door employment in Australia or New Zealand. Hence his migration to New South Wales. Shortly after his arrival, as he found that his eyes were prejudicially affected by the glare of the Australian summer, he consulted a doctor, who cupped him, and advised him that it was absolutely necessary to discontinue his practice of the law. To add to his depression, he was forbidden to read. He says, in his unfinished autobiographical sketch, in reference to these trials—"However, in this the lowest ebb of my fortunes, I found several alleviations. The principal was the extraordinary good fortune which gave me the acquaintance, and I am proud to say, the friendship, of Mr. William [S.] Macleay. He had been secretary at Paris for claims of English subjects, and afterwards had been a commissioner for the extinction of the slave trade at Cuba. He was an excellent classical scholar, he knew more of modern history and biography than anyone with whom I was ever acquainted, and in addition to all this he was a profoundly scientific man, thoroughly conversant with Zoology and entomology. An excellent companion, with a store of caustic wit, he reminded me continually of the best part of Scott's Antiquary. It fell to my lot to do him some service from which he never knew how to be sufficiently grateful. It would have been a good find to meet with such a person anywhere, but in a remote colony it was a good fortune for which one could not be sufficiently grateful. I have not seen and shall not see his like again" ["Life," i., p. 41].

Of this, Lowe's biographer says—"Such is Lord Sherbrooke's tribute to William Sharpe (*sic*) Macleay, his most cherished Australian friend, who fully returned his affection, and whose admiration for his great abilities, indomitable courage, and personal worth was unbounded. . . . . It is not difficult to imagine what a solace the conversation of so cultivated a man must have been to one who felt that, despite his own great powers and grasp of mind, his career, from impending blindness, was about to close before it had well begun" [Vol. i., p. 183].

The following extracts are of great interest:—"It must be frankly admitted that Mrs. Lowe's letters of this period [1845] are not very complimentary to the society of Sydney. But she thoroughly appreciated the high qualities of the one or two intimate friends whom they saw frequently at Nelson Bay. Of these she specially mentions three: Sir Thomas Mitchell, W. S. Macleay, and Sir Alfred Stephen. . . . .

"Sir Thomas Mitchell, Sir Alfred Stephen, William Sharpe Macleay, and the future Lord Sherbrooke, sitting together, as they frequently did at Nelson Bay, all in the full vigour of their rare conversational powers, would have been considered a distinguished group in any city in the world. Lord Sherbrooke always declared, though in after years he was intimate with the cleverest and most cultured men in England, that he had met no one whose conversation was more varied and charming than William Macleay's. With such companions, one could not be said to be out of the only world worth living in—the world of ideas—and the leisure hours which Robert Lowe enjoyed with these old colonial friends, within sight and sound of the 'wide Pacific,' were amongst the happiest of his life" (p. 286-287).

"Also in these first years [after the return to England] he [Robert Lowe] received much Australian intelligence from the pen of his trusted and intimate friend in Sydney, the late William [S.] Macleay. At parting they made a kind of loose compact that they would regularly exchange the experiences and impressions of their widely-sundered lives; and this was done as far as possible until Macleay's death in 1865. Of this correspondence but a very small portion has been preserved, and of that, only a mere fraction in any way concerns this narrative."

"Like all men of that highly refined and cultured type, Macleay was of a reserved nature, as well as of very studious habits, and admitted few to the inner sanctuary of his feelings. But he had an affection, surpassing that of a brother, for Robert Lowe, and he felt also a great liking and admiration for the courage and wifely devotion of Mrs. Lowe. His beloved Elizabeth Bay was never to him altogether the same after the departure of the young English barrister and his wife who had so strangely dropped into the orbit of his retired existence" [Vol. ii., p. 92].

Extracts from, or summaries of, some of W. S. Macleay's letters, relating to political or social matters, are given, as well as a few letters of special interest to us. Mrs. Lowe's description of Elizabeth Bay House and the garden, as well as a portion of W. S. Macleay's letter about Darwin's "Origin of Species," have been quoted above. His last letter, written about three months before his death, is given in its chronological place, in concluding my remarks.

An interesting memento of Robert Lowe's friendship with W. S. Macleay, among the relics of the latter is a copy of the famous macaronic poem which Lowe composed on the visit of Queen Victoria—then the Princess Victoria—and her mother, the Duchess of Kent, to Oxford, in 1833. The author was then an undergraduate. The poem is reprinted in Lowe's "Life," with interesting comments [Vol i., p. 86]. Copies are now extremely rare, and the biographer had some difficulty in borrowing one, for, he says, "Lord Sherbrooke had indeed lost his own copy." I think it is extremely probable, that Lord Sherbrooke forgot that he had given his own copy to W. S. Macleay. The poem was published anonymously, but on the title-page of our copy is inscribed "a Roberto Lowe, A.M." in the author's handwriting, as I think.

Among other most pleasant interludes in W. S. Macleay's life in Australia, special mention may be made of his friendly intercourse with Lieutenant J. B. Emery, of H.M.S. "Beagle," in command of Captain Lort Stokes; Assistant-Surgeon Huxley, of H.M.S. "Rattlesnake"; and Surgeon F. Rayner, and Assistant Surgeon J. Denis Macdonald, of H.M.S. "Herald," in command of Captain Denham. These were all periodical visitors to Sydney during the time their vessels were on the Australian Station.

Lieutenant J. B. Emery, of H.M.S. "Beagle," in command of Captain Stokes, was interested in Zoology, as well as the Surgeon, Dr. Bynoe, who collected birds and mammals more particularly. While the "Beagle" was at Port Darwin in September (12th), 1839, Captain Stokes records that—"On this beach, several unsuccessful hauls were made with the seine, though a few rare and curious fish were taken, which Lieutenant Emery added to his collection of coloured drawings of Australian fish; some of them will be found in the appendix to this volume." Also during the visit to Western Port, in Victoria (January 10-19th, 1839)—"A few rare insects were collected by Mr. Emery" [Stokes' "Discoveries in Australia," 2 vols., 1846]. One letter, undated, from Lieutenant Emery to W. S. Macleay, is included among the relics of W. S. Macleay. This returns thanks, in the name of the mess, for two baskets of delicious fruit. The writer also accepts an invitation to dinner on the following Wednesday. The letter concludes with—"Please to make my respects to your Brother."

Thomas Henry Huxley (1825-95), Assistant-Surgeon of H.M S. "Rattlesnake," in command of Captain Owen Stanley, arrived in Port Jackson on July 16, 1847. His biographer says of him—"He had not had, so far, much opportunity of entering the social world; but his visit to Sydney gave him an opportunity of entering a good society to which his commission in the navy was a sufficient introduction. He was eager to find friendships if he could, for his reserve was anything but misanthropic. It was not long before he made the acquaintance of William [S.] Macleay, a naturalist of wide research and great speculative ability; and struck up a close friendship with William Fanning, one of the leading merchants of the town" ["Life and Letters," (3 vols). Vol. i., p. 52].

In a letter to his sister, March 21, 1848, Huxley wrote—"I found it exceedingly disagreeable to come to a great place like Sydney and think that there was not a soul who cared whether I was alive or dead, so I determined to go into what society was to be had and see if I could not pick up a friend or two among the multitude of the empty and frivolous. I am happy to say that I have had more success than I hoped for or deserved, and there are now two or three houses where I can go and feel myself at home at all times. . . . . I am getting on capitally at present. Habit, inclination, and now a sense of duty keep me at work, and the nature of our cruise affords me opportunities such as none but a blind man would fail to make use of. I have sent two or three papers home already to be published, which I have great hopes will throw light upon some hitherto obscure branches of natural history, and I have just finished a more important one, which I intend to get read at the Royal Society. The other day I submitted it to William [S.] Macleay (the celebrated propounder of the Quinary system), who has a beautiful place near Sydney, and I hear, 'werry much approves what I have done' " [Life, Vol. i., p. 54].

In a letter to his mother, from Sydney, Feb. 1, 1849, Huxley wrote—"If my various papers meet with any success, I may perhaps be able to leave the service [after his return to England]. At present, however, I have not heard a word of anything I have sent. Professor Forbes has, I believe, published some of Macgillivray's letters to him, but he has apparently forgotten to write to Macgillivray himself or to me. So I shall certainly send him nothing more, especially as Mr. [W. S.] Macleay (of this place, and a great man in the naturalist world) has offered to get anything of mine sent to the Zoological Society" ["Life," Vol. i., p. 57].

The publication of Huxley's important paper on the "Oceanic Hydrozoa" was unfortunately delayed through lack of official support, and was ultimately issued by the Ray Society in 1859. The author, in the preface (p. viii.) says—"I made a good many observations during our cruise, and sent home several papers to the Linnean and Royal Societies; but of these doves, or rather ravens, which left my ark, I had heard absolutely nothing up to the time of my return; and, save for the always kind and hearty encouragement of the celebrated William [S.] MacLeay, whenever our return to Sydney took me within reach of his hospitality, I know not whether I should have had the courage to continue labours which might, so far as I knew, be valueless."

The "Rattlesnake" was absent from England almost four years, and her stay in Australian waters lasted nearly three, about eleven months of this period being spent in Port Jackson. After his return to England, Huxley redeemed his promise to write to W. S. Macleay. His first letter is merely mentioned in the "Life." But the second, dated November 9th, 1851, a long and very interesting letter, amounting to nearly six printed pages, is given almost in full. In this, he gives a detailed account of the scientific news of the day, and of his own work. Of himself he says—"Had the Sydney University been carried out as originally proposed, I should certainly have become a candidate for the Natural History Chair. I know no finer field for exertion for any naturalist than Sydney Harbour itself. Should such a Professorship be hereafter established, I trust you will jog the memory of my Australian friends in my behalf. . . . . Believe me, I have not forgotten, nor ever shall forget, your kindness to me at a time when a little appreciation and encouragement were more grateful to me and of more service than they will perhaps ever be again. I have done my best to justify you. . . . . I send copies of all the papers I have published, with one exception, of which I have none separate. Of the Royal Society papers, I sent a double set. Will you be good enough to give one, with my kind regards and remembrances to Dr. Nicholson? . . . . I shall be very glad if you can find time to write" ["Life," Vol. i., p. 132].

All that Huxley has to say about, or in his letter to, W. S. Macleay goes to show that he was very favourably impressed by his friendly intercourse with the Sydney naturalist; and very appreciative of the advice and help that the latter was always ready to give. For it may be mentioned, that there was no scientific library for the naturalist on board the ship, though Captain Stanley had asked, but in vain, for some money to provide one.

I regret that the obituary notice of W. S. Macleay in the "Reader," which, I think, was Huxley's last tribute to his old friend, cannot be consulted in any of our libraries.

An interesting memento of Huxley's intercourse with W. S. Macleay, among the relics of the latter, is a pencil-sketch of a pelagic Tunicate (*Appendicularia*), by W. S. Macleay, with the legend—"This animal, forming a link between Ascidia and Salpa, was found in Torres Straits by Mr. Huxley, who caught it in his towing-net, swimming with the long, transparent tail." Apparently the sketch was made from a specimen given to him by its captor.

No complete narrative of the voyages of H.M.S. "Herald," employed on Surveying Service in the South-Western Pacific, was published, and it is difficult to follow the itinerary. But the "Herald" visited Sydney in 1858, and several times before and after this year. Surgeon Rayner was interested in, and collected insects and other land-animals, but he did not publish any papers. After his return to England, Mr. Adam White exhibited portion of Dr. Rayner's collection at a meeting of the Entomological Society of London, on November 4th, 1861. This exhibit included specimens from Aneiteum, New Hebrides, and

Lord Howe Island. On his visits to Elizabeth Bay, Dr. Rayner would have much to show to, and to discuss with W. S. Macleay. Dr. Rayner was also a friend of William Macleay, and used to accompany him on collecting excursions, as narrated later on.

Dr. J. Denis Macdonald was interested in marine organisms, and the author of thirty-five papers listed in the Royal Society's Catalogue, and covering the period 1853-63. Some of these were sent home for publication while he was on the Australian Station. In one of them, "On the Anatomy of *Eurybia Gaudichaudi*," he gives a synopsis of the Pteropoda, of which he says—"This table is advanced with a little more confidence, as it has benefited by the revising hand of Mr. W. S. Macleay" [Trans. Linn. Soc., xxii., p. 248, read Feb. 18th, 1858]. The relics of W. S. Macleay include a water-colour sketch of the remarkable, pelagic, footless slug, *Phyllirhoe Peronii*, described by Dr. Macdonald. This is signed and dated September, 1854. He, too, would have much to show, and to talk about, whenever the return of the ship to Sydney enabled him to visit Elizabeth Bay.

Captain Denham, Dr. Rayner, and Dr. Macdonald were elected Honorary Correspondents of the Australian Museum in July, 1857, as noted in Etheridge's History, wherein it is stated that—"All these gentlemen had performed excellent investigations in marine life, and the Museum gained much benefit thereby" (p. 385).

Dr. W. Stimpson, Naturalist on the U.S.N. "Vincennes," under the command of Captain John Rogers, visited Sydney, December 26th, 1853, to January 8th, 1854, and recorded his experiences, unpublished during his lifetime, but since published by Mr. C. Hedley, F.L.S. ["The Australian Journal of Dr. W. Stimpson, Zoologist." With an Introduction by C. Hedley, F.L.S. Journ. Proc. R. Soc. N.S. Wales, Vol. xlviii., p. 140, 1914]. After visiting the Australian Museum, when Mr. Wall was Curator, on December 31st, 1853, Dr. Stimpson records that "we went to see Mr. [W. S.] Macleay, who lives in a large house, having extensive grounds, situated beyond the town of Woolloomooloo He treated us with kindness and showed us his fine collection of insects, and the plants of his fine garden. He appeared to care little for marine invertebrata, and on the whole I was not much interested by my visit. He is a man of immense general information, having a remarkable memory, and is equally versed in zoology and botany. He is now about 80 [? 60] years of age, and his working days are over."

William Swainson seems to have visited Sydney about 1851 or 1853. But no particulars of his visit are available. He finally settled permanently in New Zealand.

Dr. W. H. Harvey, the Algologist, on his world-wide quest for seaweeds, spent some time in Sydney, in May, 1855. On May 12th, he records—"Visited Mr. [W. S.] McLeay, the celebrated entomologist, and author of what is called "the circular system," of which (once upon a time) I was an admirer. He has a fine house in a beautiful park of sixty acres, all within the city of Sydney. He cultivates many rare trees, shrubs, and plants, and from his grounds there are charming prospects" [Memoir of W. H. Harvey, M.D., F.R.S., p. 291, 1869.]

The Austrian Frigate, "Novara," on a circumnavigating cruise, visited Sydney in 1858, remaining from November 5th to December 7th. The historian of the expedition, Dr. Karl Scherzer, says—[p. 14] . . . . . "Among the excursions in the immediate neighbourhood of Sydney, we at once selected a visit to the well-known naturalist, Mr. [W. S.] Macleay, who resides at a beautiful estate near Elizabeth Bay. In his beautiful garden, one sees the most interesting plants of Australia side by side with splendid specimens from all other parts of the world. A stroll through the extensive grounds derives a double interest when in company with its highly-cultivated proprietor, and we are the more grateful for this good fortune, as the venerable old gentleman [æt. 66] lives in strict seclusion" [Narrative of the Circumnavigation of the Globe by the Austrian Frigate "Novara." By Dr. Karl Scherzer, English Edition. Vol. iii., p. 16, 1863].

Scientific or other friends of W. S. Macleay, who resided for some time or permanently in Australia, and of whom there are records or mementos of some kind, most of these forming part of the memorials of him, may next be mentioned. These include, besides Dr. James Stuart, to whom reference has already been made—Mrs. J. S. Calvert (*née* Louisa Atkinson), Dr. George Bennett, Rev. W. B. Clarke, Sir William Denison, Rear-Admiral P. P. King, Dr. L. Leichhardt, Sir William Macarthur, Baron von Mueller, Sir Charles Nicholson, Mr. A. W. Scott and his accomplished daughters, Harriet (Mrs. C. W. Morgan), and Helena (Mrs. Edward Forde) of Ash Island, Mr. Justice Therry, Dr. John Vaughan Thompson, and the Rev. Dr. Woolls. Sir Thomas Mitchell and Sir Alfred Stephen are referred to in the extracts given from Robert Lowe's biography.

Miss Louisa Atkinson (Mrs. J. S. Calvert) [1834-72] lived at "Fernhurst," Kurrajong Heights, before her marriage, in 1870. She collected plants for Dr. Woolls and Baron von Mueller, and many of them are recorded in the Baron's "Fragmenta," or in the "Flora Australiensis." Mr. Maiden has given a biographical notice and a portrait of this accomplished woman in his paper "Records of Australian Botanists—(*a*) General, (*b*) New South Wales" [Journ. Proc. R. Soc. N.S. Wales, Vol. xlii., 1908, p. 83]. Miss Atkinson was also interested in "Vegetable Caterpillars," and corresponded with W. S. Macleay on the subject. In a letter to Miss Scott of Ash Island, dated July 23rd, 1861, referred to again later on, W. S. Macleay wrote—"I know two species of *Sphaeria* that grow from the *Charagiae* of this Colony, and a Lady-friend of mine, who is a capital botanist, though no entomologist, is now preparing a work on the New Holland species of *Sphaeria*, which she is studying in the country." The Lady-friend referred to was Miss Louisa Atkinson. Her visiting-card, and some "Notes on the Sphaeria and Grub," written after a visit to Mount Tomah, in search of specimens, on April 22nd [year not given] are included among the relics of W. S. Macleay. Miss Atkinson says in her Notes, that she and her companion dug up about eighteen vegetable caterpillars, but they were old ones, not in good condition, as no fresh ones seemed to have developed since her last researches.

Most of W. S. Macleay's scientific friends in Sydney were members of the governing body of the Australian Museum. In those early days, when there was no scientific Society specially concerned with biology, the Colonial Museum, later the Australian Museum, was the rallying-ground for naturalists, especially those interested in zoology; and the Meetings of the Committee or of the Board brought them together and kept them in touch.

Dr. George Bennett (1804-93) paid two visits to Sydney as medical officer of passenger-ships in 1829-32. Finally he settled in Sydney in 1836, and began to practise medicine. Very soon after he became officially connected with the Colonial Museum, later the Australian Museum. His official record is: Director, Superintendent, Zoologist, Curator, previous to 1841, Hon. Secretary (1836?), July 1838-41, Committeeman (1836?) 1838-53, Elective Trustee, 1853-74 (Etheridge). W. S. Macleay was a Committeeman from 1841-53, and an Elective Trustee from 1853 until his resignation in 1862, on account of ill-health. Both Dr Bennett and W. S. Macleay had known Professor Owen in London.

There is a reference to Dr. Bennett in W. S. Macleay's letter to Miss Scott, quoted later on. There is no memento of him among the memorials of W. S. Macleay.

But the Society has some very interesting memorials of him, in the shape of valuable books, all with book-plates, purchased by the Council, at the sale of his fine library, after his decease. One of these is J. D. Hooker's "Flora Novae Zealandiae" being the second section of "The Botany of the Antarctic Voyage of H.M. Discovery Ships "Erebus" and "Terror," 1839-43, &c." This would be the copy to which J. C. Bidwill refers in a letter to Captain P. P. King, dated February 8th, 1846—"I was much delighted at looking over the Flora Antarctica at Dr. Bennett's, not the less so as I see that in it I have credit done me for my early discoveries in New Zealand" [Maiden, "Records of Australian Botanists," p. 89]. Another scarce and valuable purchase was a set, complete except for one volume, of the Botanical Journals, in four successive series, published by Sir William J. Hooker, 1830-57 (23 vols.). Four of the volumes of the last series, Hooker's London Journal of Botany, have original letters, from Sir W. J. Hooker to Dr. Bennett, pasted in at the front or back, one in each volume. The first, not dated, relates to Vegetable Ivory; the second, November 29th, 1852, is about the Rice-paper Plant; the third, November 27th, 1857, returns thanks for Macrozamia-seeds sent in salt-water, and reports that Dr. Harvey is working at Kew; and the fourth, June 1st, 1859, is an invitation to Kew Gardens, when Dr. Bennett was visiting England.

The Rev. W. B. Clarke (1798-1878), M.A., F.R.S., F.G.S., the "Father of Australian Geology," and W. S. Macleay attended the meeting of the British Association for the Advancement of Science at Liverpool, in 1837; and both arrived in Sydney in the same year, 1839. On his arrival, Mr. Clarke was appointed to take charge of the King's School, Parramatta; he was afterwards Rector of Willoughby, 1846-70. He very soon became interested in the Australian Museum, the record of his official connection therewith being—Secretary 1839-41; Secretary and Curator, 1841-42; Committeeman, 1839-53; Elective Trustee, 1853-74 (Etheridge). The long association of Mr. Clarke and W. S. Macleay with the governing body of the Australian Museum provided them with abundant opportunities of meeting.

There is but one letter to W. S. Macleay, dated from St. Leonards, 29th November, 1847, among his memorials, which begins—"Had not this blessed rain kept me at home, to recruit after the fatigue of living till it came, I intended to call on you to talk over Turner's Diprotodon. He has requested me to draw up a notice, to help him. I have done so, but with much misgiving; and I have put to it my initials, that no one else may be blamed if I am wrong. I have taken the liberty of calling on you to give the public a benefit—I hope you will 'honour the bill.'" W. S. Macleay complied with the request by sending a long letter, "On the Bones brought to Sydney by Mr. Turner," dated December 2nd, 1847, to the Sydney Morning Herald. This, together with Mr. Clarke's letter, and one by Dr. L. Leichhardt on the same subject, were afterwards republished by Mr. Clarke as an appendix to his Report, No. x. [Further Papers relative to the Discovery of Gold in Australia, p. 38, 1855].

Owen's original description of the genus *Diprotodon* was based on a very incomplete series of specimens, including a molar tooth, and portions of broken bones of various parts of the skeleton. Turner's specimens were more complete, and included a shattered skull, which Mr. Wall of the Museum, with the co-operation of Mr. Clarke and Dr. Leichhardt, succeeded in putting together; this measured four feet in length from the frontal bone to the occiput. The pelvis was incomplete, and the marsupial bones were missing. W. S. Macleay, in his lengthy account, gave the dental formula, compared it with that of other marsupials, and discussed the relationship of *Diprotodon*. His conclusion was—"But this collection is above all interesting, as proving the truth of Professor Owen's suggestion, that there formerly existed in the Australian wilds a marsupial Pachyderm, thus serving to complete that series of analogies which quadrupeds with marsupial bones bear to the several classes of placental mammalia."

Turner's collection of bones was afterwards sold, sent to London, and subsequently described and figured by Professor Owen.

Mr. Clarke conducted the burial service at the funeral of W. S. Macleay, on January 28th, 1865. An obituary notice appeared in the Sydney Morning Herald of January 30th. The Rev. R. L. King, in his Presidential Address to the Entomological Society of New South Wales, refers to this as from the pen of an old friend. It is, I think, almost certain that it was written by Mr. Clarke, perhaps after consultation with William Macleay. It is much to be regretted that no "Life and Letters" of this eminent Australian pioneer in geology has been published.

Sir William Denison, the Governor General, has recorded two visits to W. S. Macleay, in his "Varieties of Vice-Regal Life." Mr. Deas Thomson's position as Colonial Secretary was about to lapse, on the eve of the inauguration of Responsible Government; and the question for his Excellency to settle was, who should be asked to be Premier. Sir William, in a letter to Mr. Deas Thomson, dated January 15th, 1856, said [Vol. i., p. 332]—"I paid a visit to Mr. [W. S.] Macleay yesterday, and had a long conversation with him on political matters, of which I give you the substance, as it will serve to show you the views entertained by a man like him, not actually engaged in the strife of party. . . . . In the first place, great anxiety was expressed that you should take the lead, and constitute the Government; it was said that all expected you to do so; that the Government would be placed in great difficulty without your knowledge and experience to keep things steady. . . . . The conclusion of the whole matter is, that I very much wish you to form a Government, and assist me in working out the experiment which is about to be made." Mr. Deas Thomson, however, could not see his way to accept the Governor's offer. Mr. Stuart Donaldson was sent for, and subsequently formed the first Ministry, Mr. Deas Thomson being appointed President of the Legislative Council.

On his second visit on February 6th, 1859, [Vol. i., p. 458] to show Mr. W. S. Macleay a tortoise sent to him by the Speaker of the Legislative Assembly, Sir William saw the Stuart Drawings, as noted above.

Captain, afterwards Rear-Admiral Phillip Parker King (1793-1856) was an old friend of W. S. Macleay. They had met in London before 1826. At Captain King's request, W. S. Macleay described the collection of Annulosa accumulated by the former, during his survey of the Inter-tropical and Western Coasts of Australia between the years 1818 and 1822 [King's "Narrative," Vol. ii., Appendix, p. 438, 1827]. Captain King was a Committeeman or a Trustee of the Colonial or Australian Museum for many years, from 1836 onwards.

Rear-Admiral King is another distinguished Australian, born in Norfolk Island, of whom, unfortunately, no "Life and Letters" has been published. A very interesting biographical notice of this eminent man, by the late Mr. H. C. Russell, will be found in the First Report of the Australasian Association for the Advancement of Science (p. 48). In addition to what is therein stated, it may be pointed out that Captain King became very interested in zoology during his survey of the Southern Coasts of South America, 1826-30. The results of some of his observations, dated July 8th, 1827, were sent to Mr. Vigors, who published them, under the title of "Extracts from a letter addressed by Captain Phillip Parker King, R.N., F.R.S. and L.S., to N. A. Vigors, Esq., on the Animals of the Straits of Magellan," in the Zoological Journal, [Vol. iii., pp. 422-432; Vol. iv., pp. 91-105]. He was also the joint author of another paper, "Description of the Cirrhipeda, Conchifera and Mollusca, in a collection formed by the Officers of H.M.S. Adventure and Beagle employed between the years 1826 and 1830 in surveying the Southern Coasts of South America, including the Straits of Magalhaens and the Coast of Tierra del Fuego. By Captain Phillip P. King, R.N., F.R.S., &c., assisted by W. J. Broderip, Esq., F.R.S., &c." This paper likewise was published in the Zoological Journal, Vol. v., p. 332, 1835.

The existence of these papers helps to explain why, like W. S. Macleay, Captain King visited the "Erebus" in Port Jackson, to see Dr. J. D. Hooker's Southern collections, and his drawings of sea-animals, as already mentioned. He also contributed an article on "The Antarctic Expedition of Discovery" to the Sydney Herald of August 19th, 1841, a fortnight after the "Erebus" and "Terror" sailed from Port Jackson for New Zealand. This gives an account of the doings of the Expedition up to the time of its arrival in Port Jackson. A reprint of this article, no doubt presented to W. S. Macleay by the writer, is included among the memorials of the former.

Another interesting relic is portion of a letter from Captain King to W. S. Macleay, dated June 4th, 1842. The address is not mentioned, but it would be Tahlee, Port Stephens, where Captain King resided from 1839-48, and then removed to Sydney. The writer says—"I have found here to-day a sp. of Latr. genus *Mictyris* running on the sand at low tide. The above [a pencil-sketch of a crab] is, no doubt, a bad resemblance, but it will serve to show nearly what it is, and whether it is of use to your collection. The carapace is a dull blue, and the sides a yellow fawn colour. I believe I am right in assigning it to Latreille's genus *Mictyris*. I have him in spirits, at your disposal, if wanted."

Other interesting relics are three rare pamphlets, being the first, second, and fourth of the series mentioned by Mr. Russell as printed at Captain King's own private printing-press, when he resided at Tahlee. These relate to the specific gravity of sea-water, and to meteorological or astronomical observations. W. S. Macleay's three copies have inscriptions by the author.

A very interesting memento of Captain King, in the Society's library, is the copy of J. D. Hooker's "Flora Antarctica" being Section i. of "The Botany of the Antarctic Voyage," inscribed and presented to him by the author. This was subsequently handed over to his eldest son, Phillip Gidley King, who generously gave it to the Society in 1882, when the Council was trying to replace the original library destroyed in the Garden Palace Fire.

The Honourable Phillip Gidley King, M.L.C., (1817-1904) was an Original Member of the Society, and, for six years, a Member of the Council. An obituary notice of him, which includes his own account of his experiences as cabin-mate of Charles Darwin on the voyage of the "Beagle," and as his companion on some of Darwin's land-excursions, will be found in the Society's Proceedings, 1905, p. 5. Darwin paid a visit to Captain King, at "Dunheved," St. Mary's, on his return-journey from Bathurst, in January, 1836.

The Rev. Robert Lethbridge King, second son of Rear-Admiral King, was a valued friend and correspondent of both W. S. Macleay, and William Macleay; and a keen entomologist. The memorials of W. S. Macleay include an excellent pencil-sketch by Mr. King, of a remarkable Pselaphid beetle, initialled, and dated, Parramatta, April 4, 1858; and a very interesting letter dated July 28th, 1859, in which Mr. King says—"I send you a sketch in pen-and-ink [on p. 3 of the letter] of two ferns in my friend, Mr. Woolls' herbarium: Do you recognise them as South Sea Islanders? I should be very glad to introduce Mr. W. to you, that he might have a look over your garden. He is taking a very great interest in the science, and has a good knowledge of our Parramatta ferns. I think a trip to Elizabeth Bay would encourage him—if you will allow me to introduce him. I have had the *Eucalyptus globulus* (I think) in flower in my garden. Gen. Macarthur gave me a small plant 2 years ago. It is now 12ft. I think I wrote you before of the change of leaf—from sessile and amplexicaul, and opposite, to peduncled (?) and alternate." Dr. Woolls was duly introduced, and became W. S. Macleay's friend and correspondent.

In Mr. King's paper on Pselaphidae, in the Trans. Ent. Soc. N.S. Wales (Vol. i., p. 54), he described several species from specimens found by W. S. Macleay in his garden at Elizabeth Bay, and acknowledges his indebtedness for them. He mentions also that he had found a single specimen of one of them on the sea-beach in the same locality.

Dr. Leichhardt presented some insects to W. S. Macleay, as mentioned in one of William Macleay's papers. But this is all the available information about their intercourse.

Sir William Macarthur (1800-82) of Camden was a friend of all the Macleays. He exchanged plants with Alexander Macleay, and afterwards with W. S. Macleay. He was a neighbour of George Macleay at Brownlow Hill, for more than thirty-one years. Both of them, as well as James Macarthur, and others, were Magistrates in the district of Camden and Narellan. He was also a friend of William Macleay. Details of their friendship are given later. Sir William Macarthur was an Original Member and the first Vice-President of our Society. Captain Arthur Onslow, R.N., grandson, on his mother's side, of Alexander Macleay, married the daughter of James Macarthur, of Camden, in 1867.

W. S. Macleay corresponded with Baron von Mueller, but no letters are available. The Baron, in the Eucalyptographia, under *E. Foelschiana*, refers to some remarks by W. S. Macleay, on the possible hybridisation of Eucalypts by birds. These must have been communicated by letter to the Baron; as I cannot find any reference to the subject by W. S. Macleay in print. The remarks are quoted, with comments, by Dr. Woolls, in his "Contribution to the Flora of Australia" (p. 219), and in his "Lectures on the Vegetable Kingdom," (p. 95). And also by Mr. Maiden in his paper "On Hybridisation in the Genus Eucalyptus" [Report of the Dunedin Meeting Aust. Assoc. Adv. Science, January, 1904, p. 298]. Presentation-copies of some of the early numbers of the "Fragmenta," and of the "Plants of Victoria," duly inscribed, are included in our series of memorials of W. S. Macleay.

Dr., afterwards Sir Charles Nicholson was a friend of all the Macleays. He came to Sydney in 1834, and practised medicine. He was elected Speaker of the Legislative Council on the retirement of Alexander Macleay in 1846. He was also Chancellor of the University of Sydney. One of the extracts given above relates how Dr. Nicholson, as Speaker, sent the skull of the supposed Bunyip to W. S. Macleay. He is also mentioned in Huxley's letter to W. S. Macleay.

A very interesting memento of Dr. Nicholson, included among the memorials, is a letter dated only May 15th [probably 1859, and written in Sydney] to W. S. Macleay, in which he says—"In speaking to you the other day about the Native Bee, I mentioned a conversation I had with a Mr. Lubbock [when Dr. Nicholson was on a visit to England, in the previous year], who read a paper at the British Association on some subject connected with the economy of the Bee, which, I believe, was regarded as one of the most original Essays brought forward. I send you his pamphlet, which pray keep.

"I shall be obliged if you can intimate to me how I could manage to procure specimens illustrative of Mr. Lubbock's favorite study. . . . . If you would also give me any information on the points referred to in the accompanying note, I could send it to him."

The accompanying note by John Lubbock, afterwards Lord Avebury, was written to Sir Charles Nicholson, from London October 12th, 1858. At this time, Lubbock's home was at High Elms, close to Down, where Charles Darwin, whom Lubbock regarded as "his father in science," resided from 1842 onwards. The note is as follows—

"My Dear Sir Charles,

"If I remember right you told me on that pleasant afternoon we spent at Cookridge, that the Wild bee of Australia has a sting without barbs, and that it is being exterminated by the Common Hive Bee.

"Since then, these two facts struck me as being very interesting, and I therefore repeated them to Mr. Darwin, saying, at the same time, that I was not quite certain whether I had understood you correctly.

"Mr. Darwin has asked [me] to write to you, and enquire whether my memory is correct, and if so whether you would kindly allow him to mention the facts, giving you as his authority.

"He would also like to know in what districts especially this destruction of the Australian bee is taking place; and whether it is effected by the Hive bee actually attacking the Australian species, or, as Mr. Darwin presumes to be the case, by the appropriation by the Hive Bee of so much food that too little is left for the Aboriginal species.

"Mr. Darwin would also be very much obliged if you could send him a few specimens of the latter."

"I hope you will excuse the trouble I am giving you, and believe me, dear Sir Charles, Yours very truly, John Lubbock."

W. S. Macleay, doubtless, did his best to answer these questions. He could possibly have answered the first one, and could have supplied specimens of native bees. But the second one was probably unanswerable, for lack of information. Hive bees are said to have been introduced at Sydney, about 1822, and at Bathurst in 1839 and 1842, as mentioned in Henniker Heaton's "Australian Dictionary of Dates" (p. 39). I commend both Lubbock's questions to the notice of Members, as worthy of modern investigation.

Sir Charles Nicholson was a Trustee of the Australian Museum for some years. Both he and W. S. Macleay, together with J. H. Plunkett, as Chairman, were the Commissioners of National Education in Sydney, in 1848. There is, among the relics of W. S. Macleay, his copy of the "Regulations and Directions to be attended to in making application to the Commissioners of National Education, for and towards the building of School Houses or for the support of Schools." These signed by the three Commissioners, as above, were issued, with a preface, dated May 10th, 1848, by the Colonial Secretary, E. Deas Thomson.

Alexander Walter Scott (1800-83), and his accomplished daughters, Harriet (Mrs. Cosby W. Morgan) and Helena (Mrs. Edward Forde), lived for a number of years at Ash Island, Hunter River, but removed to Sydney about 1862. They were the authors of that most meritorious work "Australian Lepidoptera and their Transformations, drawn from the Life by Harriet and Helena Scott, with Descriptions, General and Systematic, by A. W. Scott, M.A., Ash Island, Hunter River, New South Wales," of which Vol. i., comprising Parts i.-iii., was published in London in 1864. Vol. ii., Parts i.-iv., with an amended title, was published in Sydney, in 1890-93, by the Trustees of the Australian Museum, who had purchased the unpublished matter, after the death of Mr. Scott in 1883. The second and last volume was edited and revised by Arthur Sidney Olliff and Helena Forde.

The Scotts were friends and correspondents of W. S. Macleay, and there are several acknowledgments of advice and help, in regard to literature, to him in the first volume. He was greatly interested in their work, not only for its intrinsic merit, but because they were continuing from a more modern standpoint the investigations begun by J. W. Lewin, in his "Lepidopterous Insects of New South Wales" (1805), and also because they were illustrating the life-histories of some of the Lepidoptera described by him, in 1827, from Captain P. P. King's Australian collection.

The only original, unpublished letter written by W. S. Macleay, that I have seen, is one to Miss Scott, dated July 23rd, 1861. For this, I am indebted to the thoughtfulness and kindness of the late Mrs. M. A. J. Shaw, cousin and residuary legatee of the late Mrs. Forde. The purport of this letter, of four closely written pages, is explained by the concluding words, "I have now told you pretty well all I know about *Charagia*."

Up to this time, four species of the genus had been described and re-described by Lewin and various European entomologists, but the synonymy was involved and complicated. Miss Scott had obtained a fifth species, which she thought was new, but had not the necessary literature at hand to enable her to settle the point. She, therefore, appealed to W. S. Macleay for his advice, and the letter is his reply. After explaining the characteristics and synonymy of the four known species, the letter proceeds—"You have got a new and fifth species under the name of *C. Ramsayi* Ramsay Mss.; and my cousin has given me the ♀ of another quite new and sixth species from King George's Sound, under the name of *Charagia scripta*, Macleay Junr. Mss. It has the silver spots like letters, and small instead of being large and round as in *C. Ramsayi*. My cousin will, I am sure, be happy to show you ♂.♀. larva and chrysalis of this K. G. Sound species. He has the larvae now alive in the roots of a Leptospermum."

Mr. Scott afterwards contributed a monograph "On the genus *Charagia* of Walker," at a Meeting of the Entomological Society of New South Wales, held on September 2nd, 1867, in which he described four new species, including *C. Ramsayii* and *C. scripta* [Trans., Vol. ii., p. 25].

The letter continues—"The larvae of all the species of *Charagia*, when they die in the earth, give forth different species of a fungus called *Sphaeria*. At least the *Sphaeria Roberti* [*Robertsii*] of Hooker, a well-known species which proceeds from *C. virescens*, is altogether different from the *Sphaeria Atkinsonae* Macleay Mss. of this Colony. Indeed, I know two species of *Sphaeria* that grow from the *Charagiae* of this Colony, and a Lady-friend of mine, who is a capital botanist, though no entomologist, is now preparing a work on the New Holland species of *Sphaeria*, which she is studying in the country. Dr. Bennett is quite wrong, as I told him, in thinking that it was the *Sphaeria Roberti* [*i.e.*, the New Zealand species] which you found at Ash Island. It must have been some other species, and you had better let me see it."

The belief here expressed that the lignivorous larvae of the species of *Charagia*, which live in the tunnels excavated by them in the stems and branches of Banksia and other shrubs, were victimised by the fungus *Sphaeria* or *Cordyceps*, though generally accepted at that time, was incorrect. Mr. Scott, in 1864, showed that it was the root-feeding caterpillars of species of *Pielus*, etc., which pass some time underground, that serve as the hosts of *Cordyceps*. This was pointed out in the late Mr. A. S. Olliff's paper on "Australian Entomophytes," in the Agricultural Gazette of N.S. Wales for June, 1895. One of the two species from Mount Tomah, in which Miss Atkinson was interested, is therein described as *Cordyceps Selkirki*, sp.n., the other being identified as *C. Gunnii* Berkeley. But the host of the species from Ash Island, described as *C. scottianus*, was shown to be the larva of a Lucanid beetle.

The memorials of W. S. Macleay include fourteen beautiful water-colour drawings—seven of Ash Island spiders, six of Lepidoptera, and one of the Vegetable Caterpillar found by them; and one pen-and-ink sketch of two species of Ticks. The drawings were all done by one or other of the sisters, most of them by Helena. They are nearly all signed, or initialled, and dated, and were done during the period 1852-64. With the exception of two dated Sydney, 1864, the others were done at Ash Island. These were sent from time to time to W. S. Macleay by the Misses Scott. They were carefully treasured, and are as fresh almost as when they were done. The letter quoted above is, unfortunately, the only one that has been preserved.

I had the pleasure of knowing Mrs. Forde during the later years of her life.

She was a very gifted woman, keenly interested in science, and with a memory well stored with recollections of old times. I regret now that I did not ask her to give me some notes of her reminiscences of W. S. Macleay. She told me that, when living at Ash Island, her sister and she used to come to Sydney for periodical holidays; that W. S. Macleay used always to invite them to Elizabeth Bay; and, because they were interested in entomology, that he used to take delight in showing them the most attractive and beautiful specimens in his cabinets.

We have portraits of Mr. Scott, and of Mrs. Forde, but I have not been able to get one of Mrs. Morgan. Mrs. Forde, the last of the family, died on November 24th, 1910, at Parramatta, at the advanced age of nearly fourscore. An obituary notice of her, with references to her sister, will be found in the Society's Proceedings, 1911, p. 9.

Mr. Justice Therry (1800-74), of the Supreme Court of New South Wales (1846-59), author of "Reminiscences of Thirty Years' Residence in New South Wales and Victoria" (1863), thus refers to W. S. Macleay, in his book (p. 35). —On a slope at the eastern [? southern] side of a very snug little bay, with a lawn of English meadow-like verdure in front, stands the mansion of Mr. W. [S.] McLeay—a name known to Europe for the scientific acquirements of its occupant. As a botanist and entomologist, he holds a place in the foremost rank. There, to the friends who visit him he pours forth, with a memory quite astonishing, the stores of a varied and extensive knowledge from his encyclopaedic mind. Those who have the good fortune to know this accomplished scholar, will, like the writer, regard their visits to Elizabeth Bay amongst the most agreeable reminiscences of New South Wales." Some appreciative references to Alexander Macleay are also contained in this book.

Among the memorials of W. S. Macleay there is a pamphlet, inscribed by the author, entitled "Letter to the Right Hon. W. E. Gladstone, M.P.; with the Address to the Jury by His Honor Mr. Justice Therry at the Opening of the First Circuit Court, at Brisbane, Moreton Bay, May 13, 1850; and his Speech at the Dinner given to the Judge and Members of the Circuit, by the Magistracy and Gentry of the District" (8vo, Sydney, 1850).

Dr. John Vaughan Thompson (1779-1847) was appointed Deputy Inspector-General of Hospitals in Sydney on April 1st, 1836. His name appears among those of the gentlemen appointed "A Committee of Superintendence of the Australian Museum and Botanical Garden," on June 14th, 1836, as printed in the Sydney Gazette. Dr. Thompson was a distinguished zoologist. He was an army surgeon, who, when stationed at Cork, in 1830, took to the study of marine Invertebrata by the aid of the microscope. "Thompson made three great discoveries, which seem to have fallen in his way in the most natural and simple manner, but must be regarded really as the outcome of extraordinary genius. He showed that the organisms like *Flustra* are not hydroid Polyps, but of a more complex structure resembling Molluscs, and he gave them the name 'Polyzoa.' He discovered the *Pentacrinus europaeus*, and showed that it was the larval form of the Feather-Star *Antedon* (Comatula). He upset Cuvier's retention of the Cirripedes among Mollusca, and his subsequent treatment of them as an isolated class, by showing that they begin life as free-swimming Crustacea identical with the young forms of other Crustacea." [Ray Lankester, "The History and Scope of Zoology, p. 335, in his volume entitled "The Advancement of Science: Occasional Essays and Addresses," London, 1890].

The results of the three researches mentioned, were published separately by the author, with the title "Zoological Researches and Illustrations; or Natural History of nondescript or imperfectly known Animals, in a series of Memoirs, illustrated by numerous figures." Five Memoirs at least were published at Cork about 1830 or later. The memorials of W. S. Macleay include four of these, the first one bearing the inscription "W. S. McLeay, Esquire, with the Author's Compliments." The others are without covers.

W. S. Macleay appreciatively refers at length to Thompson's observations on Crustaceous animals in the second portion of the "Annulosa of South Africa," "On the Brachyurous Decapod Crustacea," p. 53. In a footnote he says—"The credit of confirming Thompson's observations belongs to my friend Captain Ducane [Du Cane], R.N., who has made at Southampton most interesting observations on the Metamorphosis of *Crustacea*, which I trust he will soon give to the Public" [as he did, in Ann. Mag. Nat. Hist., 1839]. Among the memorials of W. S. Macleay, there is a sketch of two larval shrimps, signed "C.D.C., Southampton, April 30th, 1838," sent to him by his friend.

After Dr. J. V. Thompson came to Sydney in 1836, there is no record of any interest, on his part, in the Port Jackson fauna. He was the author of numerous papers, of which nineteen, not including the "Zoological Researches," are listed in the Royal Society's Catalogue. The last four were apparently written in Sydney, but published in India. Agric. Soc. Journal, Vols. i., ii., iv., 1842-45. These relate to the culture of cotton and sugar-cane. The Journal containing them is not to be found in Sydney libraries.

Dr. Thompson was known to Alexander Macleay as a contributor of papers to, and a Fellow of, the Linnean Society as early as 1808. He was also the donor of seeds of Cotton to A. Macleay in Sydney, as shown in the Seed-book. Though often mentioned in text-books, I have never seen any reference to Dr. Thompson as a distinguished zoologist resident in Sydney, in any Australian publication. He died in Sydney in 1847. The following brief obituary notice appeared in the Sydney Morning Herald on January 26th.—"At his residence, Liverpool Street, Sydney, on Thursday 21st instant, John Vaughan Thompson, Esq., for several years Deputy Inspector General of Hospitals in New South Wales [1836-44], in his 63rd year, after long-continued illness—distinguished for his acquirements in zoology and botany—possessing talents of no common order—and estimable in every relative duty of life—he is deeply lamented by his afflicted family, to whom his loss is irreparable."

Dr. J. F. Watson, in his "History of the Sydney Hospital, 1811-1911" says that Dr. Thompson was an unsuccessful administrator, and that he was superseded in 1844. This need not obscure his fine record of work, as given in the National Dictionary of Biography.

The Rev. Dr. Woolls (1814-1893), referred to as Mr. Woolls in the Rev. R. L. King's letter to W. S. Macleay, in 1859, had not been ordained to Holy Orders at that time. The introduction to W. S. Macleay, suggested by Mr. King, was duly made, and thereafter they frequently corresponded, and Dr. Woolls paid visits. There are several references to W. S. Macleay in Dr. Woolls' two books. One of them records the fact that W. S. Macleay had collected *Dendrobium cucumerinum* near Brownlow Hill, growing on the swamp-oak; and another that he believed that *Corysanthes bicalcarata* had been found near Sydney though Dr. Woolls had not succeeded in finding it. It was also through Dr. Woolls, probably, that Miss Atkinson came to know W. S. Macleay. There are many references to her in Dr. Woolls' two books; as there are also to the Misses Scott, as well as a chapter in one of them on "The Botany of Ash Island."

The writer of the Obituary Notice of Mr. W. S. Macleay, which appeared in the Sydney Morning Herald, probably the Rev. W. B. Clarke, says that he was the life and soul of the Museum. But I have no information about his association with the Australian Museum, which will enable me to add to what is given in Etheridge's article, "The Australian Museum: Fragments of its Early History," namely—"For twenty years or more, that eminent Naturalist, William Sharp Macleay, gave his best energies to the welfare of the Institution. Committeeman from 1841 to 1853. Elective Trustee from 1853 onwards, ill-health compelled him to resign in January 1862. The Board presented him with an address," a copy of which is given [Records of the Australian Museum, Vol. xii., No. 12, p. 394, 1919]. But we have some interesting relics of his connection with the Museum. These include his father's copy of the now rare "Catalogue of the Specimens of Natural History and Miscellaneous Curiosities deposited in the Australian Museum," compiled by the Secretary, George Bennett, F.L.S., and published in 1837. This was apparently an official copy, as it is inscribed, not in his own handwriting, "Alex. McLeay, Esq." It was subsequently corrected, supplemented, and brought up to date, in so far as it relates to mammals and birds, by W. S. Macleay, the alterations and additions being in his handwriting. Charles Coxen, of Yarrundi, donor of many specimens recorded in the Catalogue, was John Gould's brother-in-law. Other relics are three letters about scientific or Museum matters from three successive officers, S. R. Pittard, G. F. Angas, and G. Krefft, the first and last Curators, and the second, Secretary for some time.

Of W. S. Macleay's declining days, Lowe's biographer says—"In 1865 occurred two events which, although hardly unexpected, were in their different ways and degrees a source of sorrow to Robert Lowe. These were the death of his much-valued Australian friend, William Sharpe Macleay, and that of his great political chief, Lord Palmerston. Lowe had kept up an intermittent correspondence with Macleay ever since he left Sydney, but latterly it had become painfully evident to him that the quaint old philosopher of Elizabeth Bay was fast declining. He had, indeed, received warning from others that the death of his old friend was impending" [Vol. ii., p. 236].

W. S. Macleay's last letter to Robert Lowe was dated, Elizabeth Bay, 21 September, 1864. In this, the writer said, concerning himself—"As to my health, it remains *in statu quo;* although I think that I am getting on the whole weaker. At times I am quite prostrated, and at times I am again more lively. I never was what you would call a decided beauty; but if you were to see me now, you would not know the ugly, lanky, thin, scraggy, toothless individual who is now writing to assure you that the immaterial part of him remains still the same, and that it has no friends on earth to which it is more attached than to you and your sensible, kind lady. So I subscribe myself ever, Your most affectionate friend, W. S. Macleay." [Vol. ii., p. 234]

Death ended his sufferings on January 26th, 1865, in his seventy-third year. An obituary notice appeared in the Sydney Morning Herald of 30th January.

The Rev. R. L. King, in his Presidential Address to the Entomological Society of New South Wales, on January 30th. 1865 [Trans. Ent. Soc. N.S. Wales, Vol. i., p. xliii.] quotes extensively from the notice referred to, and also supplements it. He refers to it as "from the pen of an old friend"—probably the Rev. W. B. Clarke, written perhaps, after consultation with William Macleay.

The cenotaph to his memory in St. James' Church, is above that in memory of his sister, Mrs. Harrington; but rather too high for close scrutiny. Below a medallion-portrait, head and shoulders, side-view, is the tersely appropriate inscription:—

GULIELMUS SHARP MACLEAY.
NATURAE INDAGATOR INDEFESSUS
INTERPRESQUE ERUDITUS ACUTISSIMUSQUE.
VIXIT ANNOS LXXII. DECESSIT DIE XXVI.
JAN. A.D. MDCCCLXV.

It is, I think, a reasonable conclusion that the marble portion, with the portrait and inscription, was prepared in England, brought out by George Macleay, and its erection arranged for while he was revisiting Australia between 1869 and 1874. In that case, it is also a reasonable supposition that the inscription was drawn up by Robert Lowe at George Macleay's request.

By several writers, W. S. Macleay, in his later years in Australia, is spoken of as a recluse. An explanation of what this was intended to mean, is not hard to find. He was naturally reserved; and his life in Cuba must have been rather a lonely one, as he could have had but few English friends, who shared his tastes and interests. This would lead to habits of self-dependence, and to his finding recreation and solace in his books, in his scientific work and collecting, and in his garden and culture of orchids. The tropical climate prejudicially affected his health, and seems to have prematurely aged him, as is evident from the remarks of Dr. Stimpson and Dr. Scherzer, quoted above. Long before the onset of diabetes, which caused his last lingering illness, he suffered from gout; and, no doubt, like Adam Sedgwick, the geologist, and other sufferers from this complaint, he found that gout was not conducive to amiability. But his friendship with Lowe, Huxley, and others shows that he was no misanthrope or hermit, when the environment was congenial. There is abundant evidence also that, as some have testified, he was always ready to advise and help those who were genuinely interested in science, and sought his assistance in a proper manner. W. S. Macleay did not marry.

W. S. Macleay's collection, as he brought it to Australia in 1839, comprised the specimens left with him by his father for study; what he may have collected or obtained by exchange or gift in Cuba, or at Philadelphia and the other ports of call on the outward and homeward voyages; and what he may have acquired in England, after his return, by exchange or otherwise; and especially Verreaux's South African collection of insects, which he purchased. Details of what he added to his collection after he came to Australia are not available. Sir William Macleay, in writing to the Chancellor of the University of Sydney in 1874, said that the joint collections of A. and W. S. Macleay amounted to 480 drawers, and his own to 320 drawers. But in addition to the specimens in the cabinets, there were a number of dry specimens on shelves. These are referred to later.

Sir George Macleay, K.C.M.G., F.L.S.

Third son of Alexander Macleay, born in London in 1809, educated at Westminster, resident in Australia for more than thirty years, removed to England in 1859, died at Mentone, June 26th, 1891.

George Macleay came out to Australia with his father, or soon after, but I am not sure which. He and his younger brother James were in charge of their father's property at Brownlow Hill and the farm at Glendarewel attached to it, near Camden, in 1829. The first record of George in print is as the companion of Captain Charles Sturt on his "Expedition down the Morumbidgee and Murray Rivers in 1829-30." The details of this adventurous undertaking were given in an "Official Report to the Colonial Government," which appeared in the Sydney Gazette in May 1830; and more fully in Sturt's Narrative of the Expedition, published in London in 1833, second edition 1834, as the second volume of the work entitled "Two Expeditions into the Interior of Southern Australia, 1828-31." The first volume gives the account of the expedition which resulted in the discovery of the Darling, in 1829.

Sturt, in his Narrative, speaks in the highest terms of Macleay. He mentions "the generous feelings that had prompted McLeay to participate in every danger with me"; and, "it was sufficiently evident to me, that the men were too much exhausted to perform the task that was before them without assistance [on the return-journey against the stream], and that it would be necessary both for McLeay and myself to take our share of labour at the oars. The cheerfulness and satisfaction that my young friend evinced at the opportunity that was thus afforded him of making himself useful, and of relieving those under him from some portion of their toil, at the same time that they increased my sincere esteem for him, were nothing more than what I expected from one who had endeavoured by every means in his power to contribute to the success of that enterprise upon which he had embarked."

Their association during this adventurous excursion was the beginning of a warm and lifelong friendship. Sturt's home for some years was at Bargo Brush, and afterwards at Varroville near Liverpool, so that their neighbourly intercourse continued. From 1839-53 he resided in South Australia, and then returned to England, where he and Macleay renewed their friendship.

Mrs. Napier George Sturt's biography of her father-in-law, "Life of Charles Sturt, sometime Captain 39th Regiment, and Australian Explorer" (London, 1899) gives numerous extracts from Sturt's letters to Macleay. The last of them, dated June 8th, 1869, was a sympathetic reply to one from his friend, announcing the serious illness of his wife, who suffered from bronchitic trouble, and that alarming symptoms had supervened. Sturt died peacefully, while he was alone, eight days later, on June 16th. Mrs. George Macleay died shortly after.

Another early notice of George Macleay and his brother James, is given in a recently published, most interesting book, "Some Early Records of the Macarthurs of Camden. Edited by Sibella Macarthur Onslow" (1914). In a letter dated Camden, December 27th, 1830, written by Mrs. John Macarthur to her eldest son, Edward, then in England, she narrates how two expected visitors, friends of her son, lost their way, were out in the bush all night in pouring rain, and—
"in the morning they made their way to the abode of the young McLeays [Brownlow Hill]—apropos, these young McLeays are very agreeable neighbours of Wil-

liam—they come here frequently—having been well educated and really are well conducted—lively and conversant, with the manners of the times, their society tends to enliven the atmosphere around Camden, where the topics of the day are brought forward in an agreeable manner—from their father's situation as Colonial Secretary and the correspondence with their sisters—they hear early of all English intelligence" (p. 462). Reference is also made to Sturt's expedition, the members of which had returned to Sydney a few months before the letter was written. She also adds that "the younger brother, James, is going an interesting voyage—The *Comet* a King's ship sails from here to Pitcairn Island for the purpose of removing the Islanders to Otaheite—Mr. James McLeay and Capt. Walpole of the 39th go in the *Comet* as a little voyage of curiosity and amusement.

If James went in the "Comet," he returned again to Sydney, because he was still at Brownlow Hill at the time of Mr. Backhouse's visit in 1836, as already mentioned. He did eventually go back to England, entered the Foreign Office, was Secretary and Registrar to the mixed British and Portuguese Commission for the Suppression of the Slave Trade at the Cape of Good Hope (1843-58), and died in London in October, 1892, aged 81 years.

George Macleay was about eleven years older than his cousin William. They were always great friends, and corresponded as long as both were alive and well. They were elected to Parliament in the same year, 1854, George as Member for the Murrumbidgee in the Legislative Council, afterwards the Legislative Assembly, when a Constitution was granted in 1855; and William as the Member for the Lachlan and Lower Darling. After George's removal to England in 1859, William succeeded him as Member for the Murrumbidgee.

The list of gentlemen appointed "A Committee of Superintendence of the Australian Museum and Botanical Garden," dated June 14th, 1836, and published in the Government Gazette, 1836, includes the name of George Macleay. Later on, he became an Elective Trustee. There are a number of references to him, in that capacity, in Etheridge's History. In February, 1859, he resigned, in consequence of his removal to England. "On March 3rd, 1859, a resolution was passed commissioning George Macleay, in conjunction with Professor Owen, to select a suitable person," as Curator, in succession to Mr. Wall, who had retired. This resulted in the appointment of Mr. S. R. Pittard, M.R.C.S., who took up his duties in February, 1860.

George Macleay, being then young, was one of the few Members of the Committee of 1836, who was not a Fellow of the Linnean Society. It is very interesting to note how punctilious Alexander Macleay was in enlisting the co-operation of all the available old "Linneans"—to use an expression once employed by Mr. Bentham—in carrying out scientific enterprises.

He was elected F.L.S. on January 12th, 1860, soon after his return to England; and a Member of the Council on May 24th, 1864. His gift of his father's portrait of Kirby, and his MSS., and correspondence, in 1886; and his bequest of the bust of W. S. Macleay to the Society, have already been mentioned.

George Macleay's permanent home was in the country at Brownlow Hill, near Camden, the latter 40 miles from Sydney, on what was then the Great South Road. He was specially interested in farming and horticulture. Though not a working zoologist, he had a general interest in zoology, which was enlivened and fostered by his father's and brother's influence, the opportunities afforded by a country-life for observing and collecting, and his connection with the Australian Museum as a Trustee from 1836-59. He collected specimens on Sturt's Expedition; he also added to his father's collection, though there is only one quite incidental record of it.

Sturt says in his Narrative of the Expedition—"McLeay, who was always indefatigable in his pursuit after subjects of natural history, shot a cockatoo, a new species, hereabouts" (p. 62). He says also that—"I have already mentioned that shortly after we first entered the Murray, flocks of a new paroquet passed over our heads. . . . . They always kept too high to be fired at, but on our return, hereabouts, we succeeded in killing one. It made a good addition to our scanty stock of subjects of natural history. It is impossible to conceive how few of the feathered tribe frequent these distant and lonely regions. The common white cockatoo is the most numerous, and there are also a few pigeons; but other birds descend only for water, and are soon again upon the wing. Our botanical specimens were as scanty as our zoological, indeed the expedition may, as regards these two particulars, almost be said to have been unproductive" (p. 188).

This report is not surprising. The journey of 1700 miles in a whale-boat was twice as long as was expected, by reason of the failure of the arrangements for the return of the party by sea. There was a shortage of provisions, rowing against the stream was very laborious in the weakened condition of the men, and a crowded boat did not offer satisfactory room for the stowage of specimens.

The only reference to George Macleay's collecting for his father, that I have seen, is to be found in the "Annulosa of South Africa" (p. 75). W. S. Macleay says, of *Arthropterus MacLeaii* Don.—"The only known specimen of this species was purchased by my father at the sale of Mr. Francillon's museum. None of the authors who have written on the species ever saw it, except Donovan, who was its first describer in his work on the "Insects of New Holland." There is another species of *Arthropterus*, which I have seen in the valuable collection of my friend, Mr. John Curtis. . . . . I am ignorant which of these two my brother, Mr. George MacLeay has lately found, or whether his discovery may not prove, on comparison, to be still a third species. But I learn, by a letter from my father, that my brother, 'in one of his late excursions into the interior of New South Wales, discovered several specimens of '*Cerapterus MacLeaii*' in the nests of ants, and, moreover, remarked, that when alive they had the power of exploding, after the manner of Brachini.' "

George Macleay at one time had a station on the Murrumbidgee. He may have collected the specimens mentioned above in visiting this locality. He would have had no trouble in making a good collection in the Camden district. But insect-collecting is not mentioned in Sturt's Narrative.

Sir William Denison and members of his family paid three visits to Brownlow Hill in 1855, 1856, and 1857. I have already referred to one of these.

George Macleay revisited Australia for a time after the death of his brother, W. S. Macleay, but I have not been able to ascertain exactly when. Professor Huxley read a paper "On *Ceratodus forsteri*, with Observations on the Classification of Fishes" at a Meeting of the Zoological Society of London, on January 4th, 1876, in which he said—"Two specimens of *Ceratodus forsteri* have come into my possession within the last two years. The first was kindly placed at my disposal by the Secretary of this Society some time ago; but I was unwilling to dissect it until I had a second. This desideratum was supplied by my friend Sir George MacLeay, who, on a recent visit to Australia, was kind enough to undertake to obtain a *Ceratodus* for me, and fulfilled his promise by sending me a very fine and well-preserved fish, rather larger than the first" [Proc., 1876, p. 24].

W. S. Macleay, who was unmarried, died in January, 1865. George was his residuary legatee, and inherited, among other possessions, the Elizabeth Bay property, the family heirlooms, and his brother's library and papers, but not the Macleay Collections, which passed to William. The object of George's visit to Sydney was to put his Australian affairs in order. Mrs. George Macleay died in 1869. I have in my possession William Macleay's journals for several years, commencing with 1874. George's visit ended before this, as there is no reference to it; but there is a record on July 25th, 1874, that "Brazier finished packing the books to-day, thirteen cases in all. There are still a large number of books remaining on the shelves, but as I have no more cases, I shall not have any more packed at present." The books here referred to were packed for shipment to England to George Macleay, and the others were to follow. These represented the balance of W. S. Macleay's library after the books which George gave to William, had been taken out. An earlier notice is offered by the entry on July 22nd—"Brazier commenced packing up the books I am sending home to George Macleay." And one of July 28th, records, "Brazier has been making lists of the books given me by my cousin George." His visit to Australia, therefore, seems to have been made after 1869 and before 1874.

But in addition to the books, mostly entomological, George gave his cousin the letters, drawings, with the exception of the Stuart collection of drawings sent out from England as a gift in 1887, pamphlets, or memoranda, which I have so frequently spoken of, in the course of my remarks, as the relics or memorials of W. S. Macleay. These were put away in the library, and, after he was rather abruptly and completely prostrated by the onset of his last illness, forgotten by Sir William. Everything in the house at the time of his decease was bequeathed to his widow. When the time came for clearing-up the house, Lady Macleay very kindly handed them over to me, as Sir William's executor and trustee, who was interested in Natural History. This meeting has given me an opportunity that I had been looking for, of exhibiting and recording these interesting relics and memorials of the Macleays, preparatory to handing them over to my successor, as the Society's custodian of them.

The rest of W. S. Macleay's papers, including letters from Lowe, Huxley, and probably many others, as well as any MS. records of work that there may have been, were presumably taken to England by George Macleay.

The concluding portion of Mr. Busk's Obituary Notice of W. S. Macleay is as follows—"After his retirement to Australia, I am not aware that Mr. MacLeay published anything; but he has left, as I am informed, a large collection of MSS. on all subjects of natural history, which, as greatly to the advantage of science, it would be extremely desirable should be carefully examined, and those among them fitted for the purpose, published. There is reason, I believe, to hope that this may be done, and that we may, as in former days, again see the pages of the 'Linnean Transactions' graced by articles bearing the honoured name of William Sharp Macleay."

The Notice was written by Mr. Busk in May 1865, apparently after consultation with George Macleay, who was then a Member of the Council; perhaps also with Professor Huxley, who, as I think, was the author of the notice in the "Reader," from which Mr. Busk quotes. By this time, George Macleay would have received particulars of W. S. Macleay's decease from William Macleay. The information supplied to Mr. Busk by George Macleay would be based mainly on recollections of his intercourse with his brother up to the year 1859, supplemented by anything William Macleay might have communicated by letter. Perhaps Huxley could speak of the work W. S. Macleay was interested in during his visits in 1847-50. Mr. Busk's hope of future results was based on the fact that George Macleay was his brother's heir, and that it was necessary for him to revisit Sydney as soon as possible, to deal with his Australian interests. The delicate health of his wife up to the time of her death in 1869, postponed this visit for about four years.

From what has been said above, it will be seen that the four papers published in England or Calcutta, after W. S. Macleay came to Australia, and the two letters published in Sydney, were overlooked by Mr. Busk. These communications, however, were not entomological. As a matter of fact, the only published records of his own, indicative of his interest in Australian insects after his arrival in Australia, beyond what has been stated above in speaking of his correspondence with the Rev. F. W. Hope, are some observations given by Mr. Hope in a Postscript to his paper, "Observations on the Stenochoridae of New Holland, with Descriptions of new Genera and Species of that Family," read to the Zoological Society on June 23rd, 1840, [Trans. Zool. Soc. Vol. iii., p. 187], but the publication of this was delayed for some time. And some observations on an exhibit, communicated by the Hon. Secretary, on his behalf at a Meeting of the Entomological Society of New South Wales on October 3rd, 1864. Both these records will be considered later, when I come to speak of the history of the latter Society.

In the concluding sentence of his paper on the "Annulosa of South Africa" (1838) W. S. Macleay said of the *Paussidae*—"I hope, however, as I am about to visit Australia, soon to be able to make myself master of the oeconomy of these interesting insects, and also to publish a correct representation of the parts of the mouth."

In his letter "On the Skull now exhibited at the Colonial Museum of Sydney as that of the Bunyip," he said, speaking of the teratological skull of a foal found floating in the Hawkesbury then in his possession—"This skull was prepared by the lamented late Dr. Stewart [Stuart], and he has made drawings and notes of it, which I intend before long to publish, with his other observations on various branches of natural history."

Mr. Hope, in the paper on *Stenochoridae*, just mentioned, says of *Meropachys MacLeaii*, n.sp.,—"This beautifully sericeous insect is named in honour of William Sharpe Macleay, Esq., from whom we may shortly expect some valuable communications relating to the entomology of Australia."

Nevertheless, neither W. S. Macleay's intentions, nor Hope's expectation, came to fruition.

Swainson's classificatory and other aberrations may perhaps have exercised some inhibitory influence on any inclination, W. S. Macleay otherwise may have had, to continue his literary efforts; and to this, the state of his health may also have contributed. But if he did put pen to paper on the subject of Australian insects or Dr. Stuart's notes, and did not subsequently destroy the results, George Macleay, perhaps after consultation with William, became the arbiter of their disposal, and dealt with whatever there may have been, as he thought fit. Mr.

Busk's hope was not realised. The memorials of W. S. Macleay, which George Macleay left with William, comprise nothing at all in the shape of original observations or publishable matter, nor do they include Dr. Stuart's notes.

After his arrival in England, George Macleay purchased a beautiful house and grounds, known as Pendell Court, at Bletchingly, Surrey, which became his home for the rest of his life. An illustrated account of Pendell Court, and of the garden, tropical house, fernery, stoves, orchid-houses, and aquaria, signed F. W. H., appeared in "The Garden," for February 5th, 1881, as one of a series of articles on "Country Seats and Gardens of Great Britain." Mr. Maiden has kindly given me the copy of this article, which is exhibited to-night. This will be added to the other mementos of George Macleay.

Sir George Macleay died, without issue, at Mentone on June 26th, 1891, in his 82nd year, about six months before his cousin William. His first wife died at Pendell Court in 1869. His second wife, a Tasmanian lady, died in England, as recently as 1919.

Mrs. Forde, who was good enough to let me have the portrait of Sir George Macleay, which has been hung in the Society's Hall for some years now, told me that she corresponded with him almost up to the last. And she added, that he was always her good and kind friend.

Before leaving for England in 1859, or while on his visit to Sydney between the years 1870 and 1874, George Macleay disposed of his property at Brownlow Hill to Mr. F. W. Downes, and it has been in possession of the family ever since. Mr. Downes, to whose memory there is a cenotaph in the old Church at Cobbity, died in 1917. By the kind permission of Mrs. Downes—to whom, and to her son, for his kindly guidance, I desire to record our cordial thanks—my friend and fellow-member, Mr. Charles W. Smith, and I were able to visit Brownlow Hill last December. Having a knowledge of Sir William Denison's and James Backhouse's descriptions of George Macleay's old home, and a somewhat faded photograph among the relics of W. S. Macleay, probably taken sixty or seventy years ago, we had no difficulty in realising where we were, or the interest of what we had come to see. Unfortunately it began to rain just as we arrived, which prevented a closer inspection of the interesting plants and trees in the garden. Allowing for the lapse of time, and for the fact that the maintenance of an extensive garden is a much more expensive hobby now than it used to be in the good old days, the old home and the garden have been consistently kept up, and are much as they used to be. The "genteel cottage," as Mr. Backhouse regarded it in 1836, was possibly enlarged about the time of George Macleay's marriage to Miss Barbara Innes in 1842, and may have been added to since. A mute but eloquent historic link with the past is the old sundial in the upper garden, close to the house, probably a gift from some friend. On the four corners of the dial are engraved the words—"George Macleay Esq.—Brownlow Hill—near Camden—New South Wales." In the centre, below the gnomon is the date, "1836." And below this again—"anno coloniae xlviii."

The date recalls the fact, that 1836 was the year in which James Backhouse and his colleagues spent three days at Brownlow Hill, with George and James Macleay, visiting Camden Park twice during their stay. Under date October 21st, Mr. Backhouse records—"I walked into the forest by moonlight, along with George McLeay, to see the Opossums."

(To be concluded, with Illustrations, in the next Part of the Proceedings.)

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Lord, C. E., and Scott, H. H., Hobart.—Two Reprints; "Studies in Tasmanian Mammals, Living and Extinct.' Nos. 1-2 (Papers and Proc. Roy. Soc. Tasmania, 1920).

Mjoberg, Dr. E., Stockholm (donor).—Eleven Reprints of Papers, entitled "Results of Dr. Mjoberg's Swedish Scientific Expeditions to Australia, 1910-13." By various authors. (K. Sv. Vetenskaps Akad., Arkiv for Zoologie, x.-xi.; xii., 15; xiii., 2 & 8; Handlingar, lix., 4; lx., 4 (1916-1920).

Osborn, Professor T. G. B., One Reprint; "Some Observations on the Tuber of *Phylloglossum*." (Ann. Bot., xxxiii., Oct. 1919).

Sloane, T. G. (donor).—"Genera Insectorum." Fascicule 82. Coleoptera-Coleoptera adephaga. By von Dr. Walther Horn (1915).

Smith, Dr. R. Greig, Sydney (donor).—County of Northumberland, Education Committee County Agricultural Experiment Station, Cockle Park Bulletin, Nos. 22-24, 27, 29, 31, 32 (1915-1920).—"Chemical Engineering and Mining Review," x., Nos. 109, (Index to ix.), 111, 115-121 (1917-1918); xi., Nos. 122-132 (1918-1919); xii., Nos. 133-135, 137, 138 (1919-1920).—Dove Marine Laboratory, Cullercoats, Northumberland. Report for year ending June 30th 1919. N.S., No. viii. (1919). —Papers and Proceedings of the Royal Society of Tasmania for the years 1911, 1917, 1919; Annual Report of the Royal Society of Tasmania for the year 1911.

Veitch, R., B.Sc., F.E.S., Fiji.—Agricultural Report No. 4, of the Colonial Sugar Refining Co., Ltd., Fiji ("The Cane Beetle Borer in Fiji"). (Sydney, 1919).

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1913 Fry, Dene B., Northcote Rd., Lindfield [Killed in action, 1917.]
1913 Harrison, Berkeley, Cudgera Park, Burringbar, N.S.W.
1916 Roseby, Miss Mabel, B.A., "Redlands," Military Road, Neutral Bay
1915 Stephens, Harry, B.Sc., Agr., "Erith," City Road, Darlington. [Killed in action, 1917.]
1913 Turnbull, Alex. H., Wellington, N.Z.
1915 Williams, Arthur W., Byron Bay, N.S.W.

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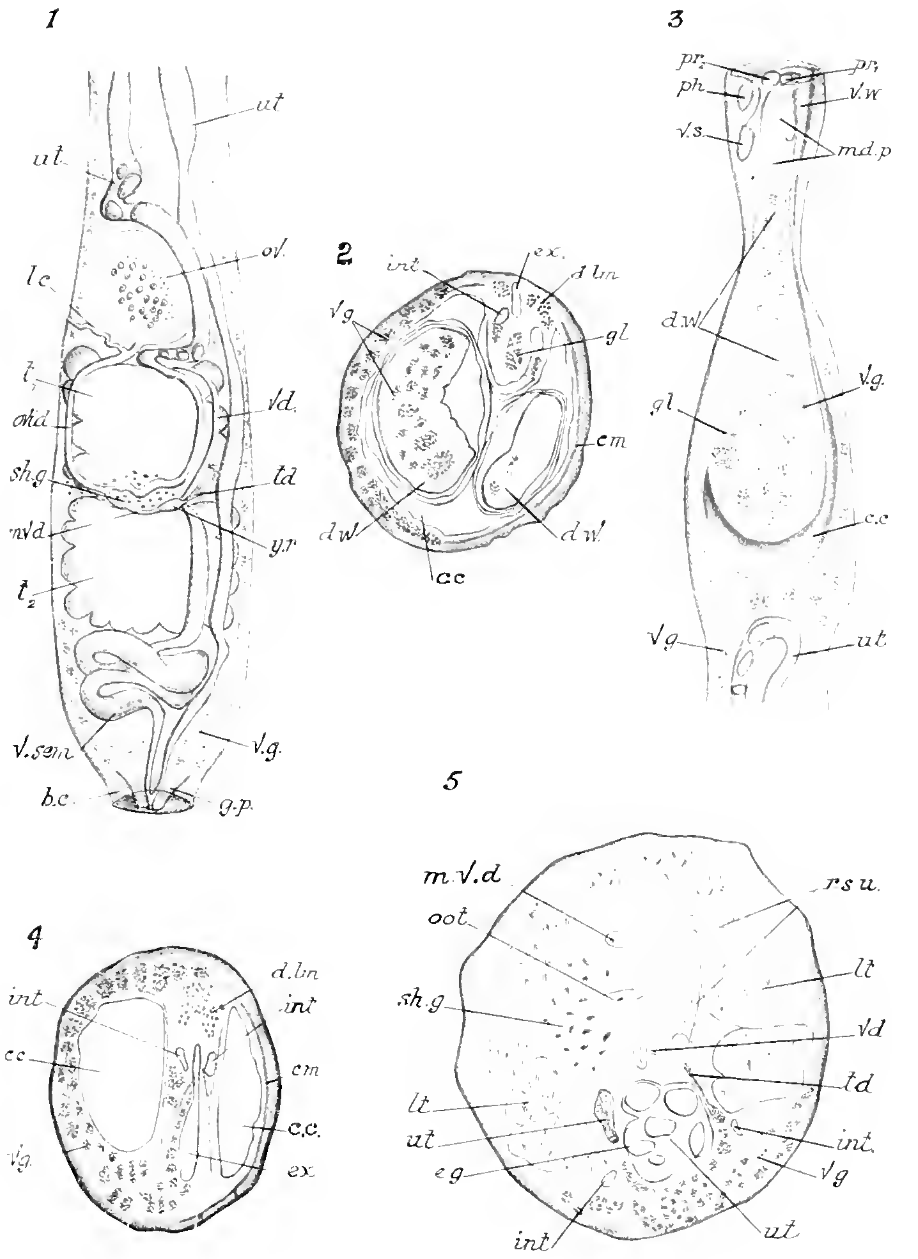
(1920.)

(a) GENERAL INDEX.

(b) BIOLOGICAL INDEX.

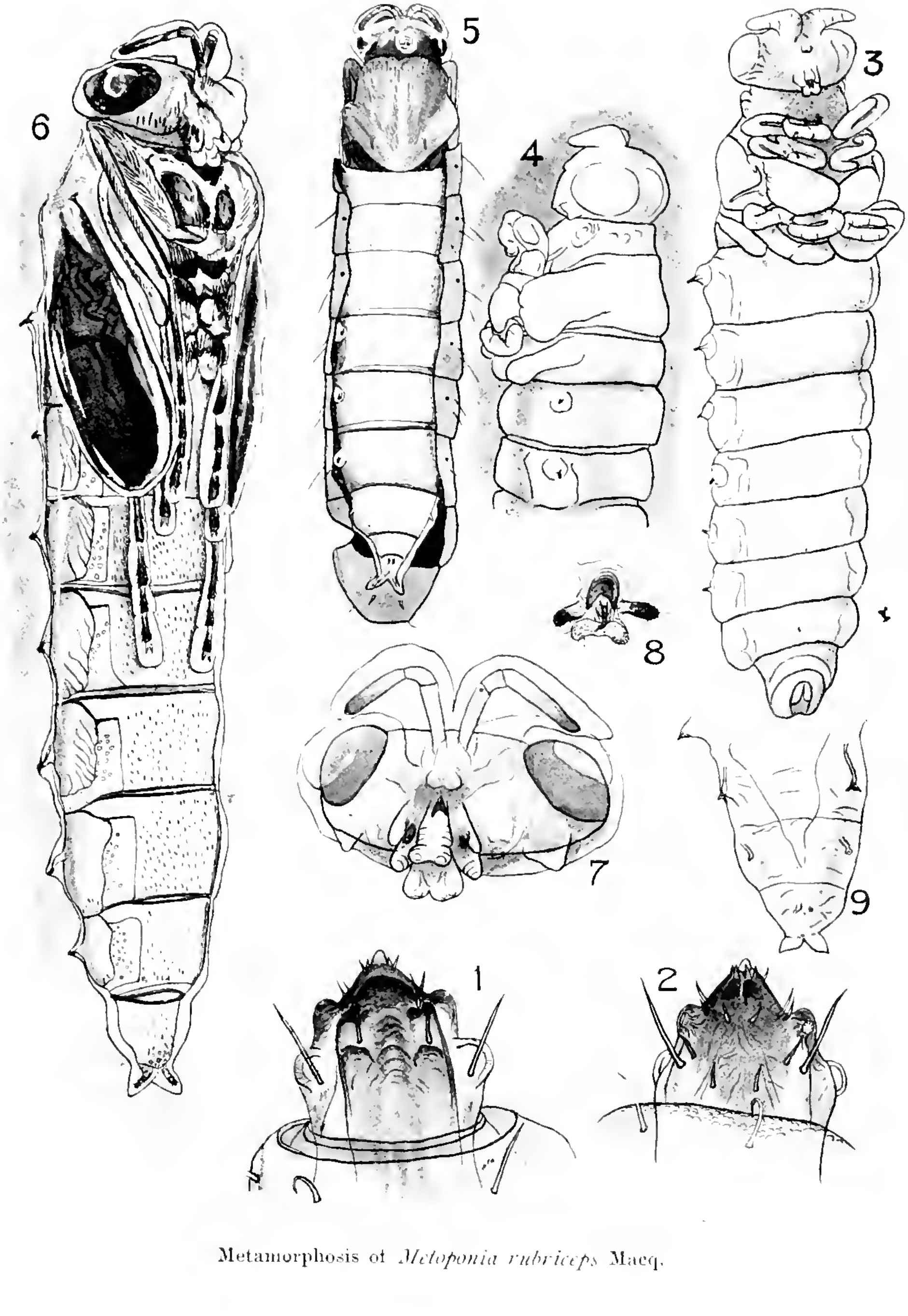
Synonyms are printed in *italics*; new names in SMALL CAPITALS.

(Printed off 1st March, 1921.)

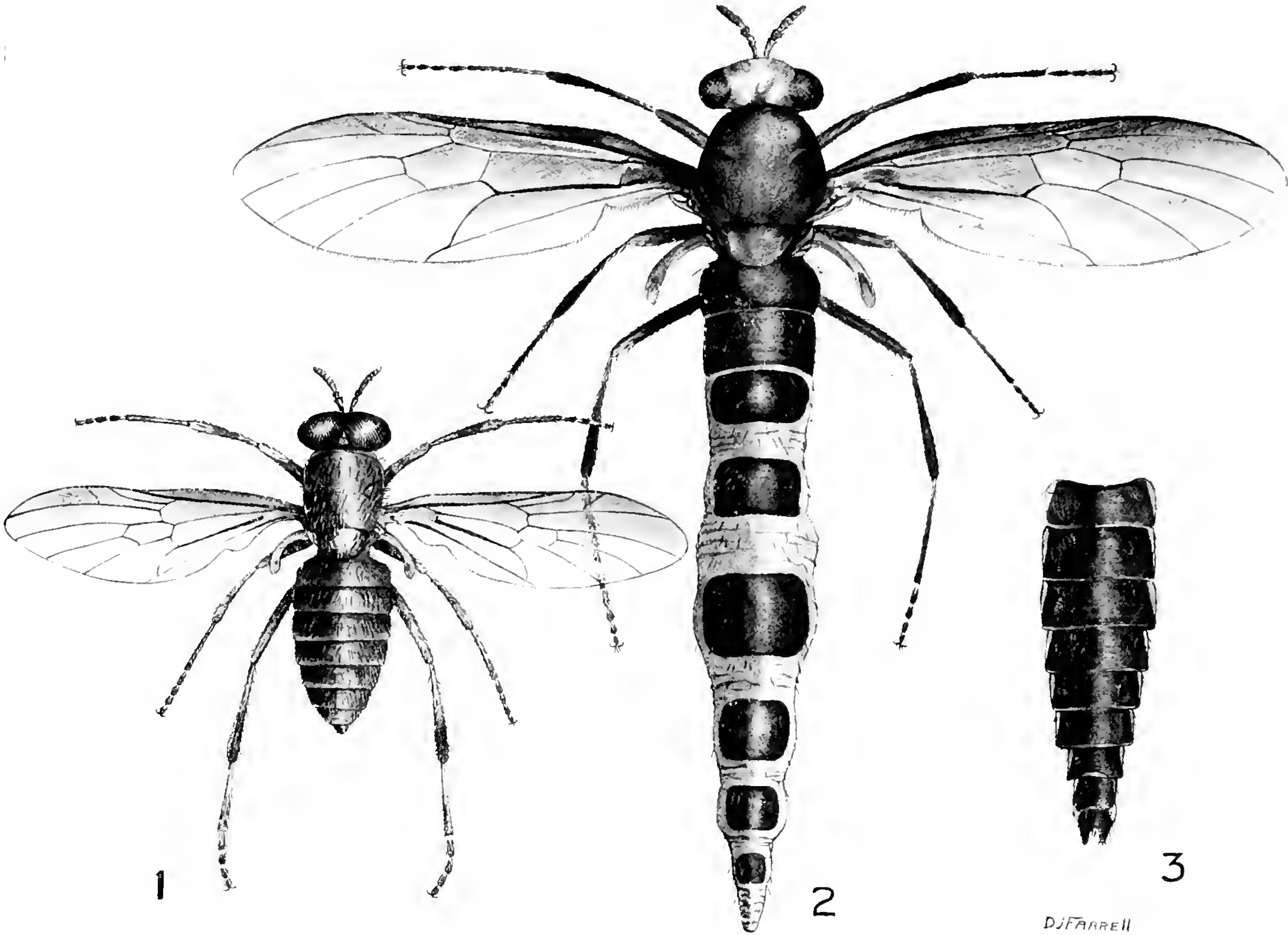


E. E. Chase, del

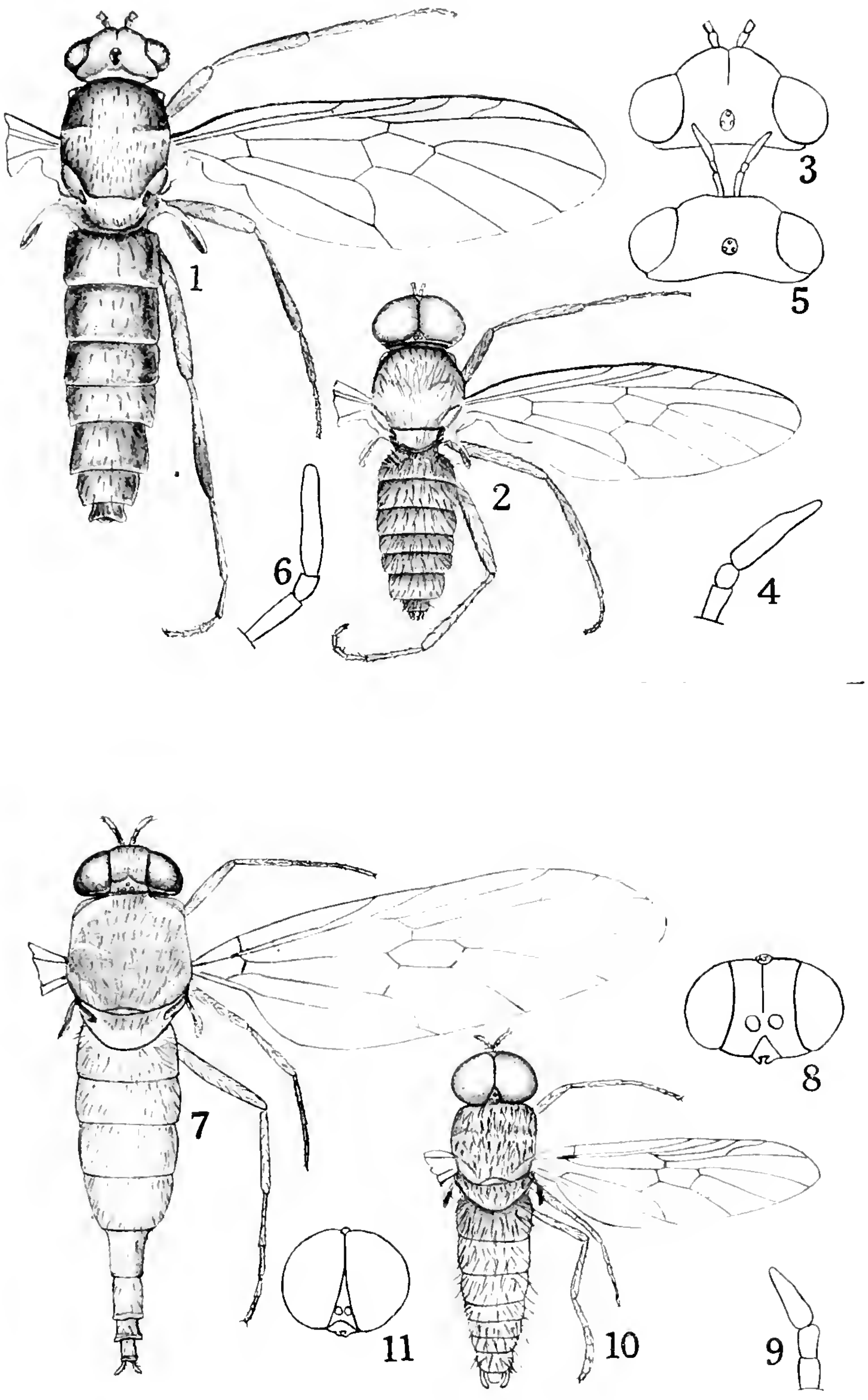
Holostomum repens, n.sp.



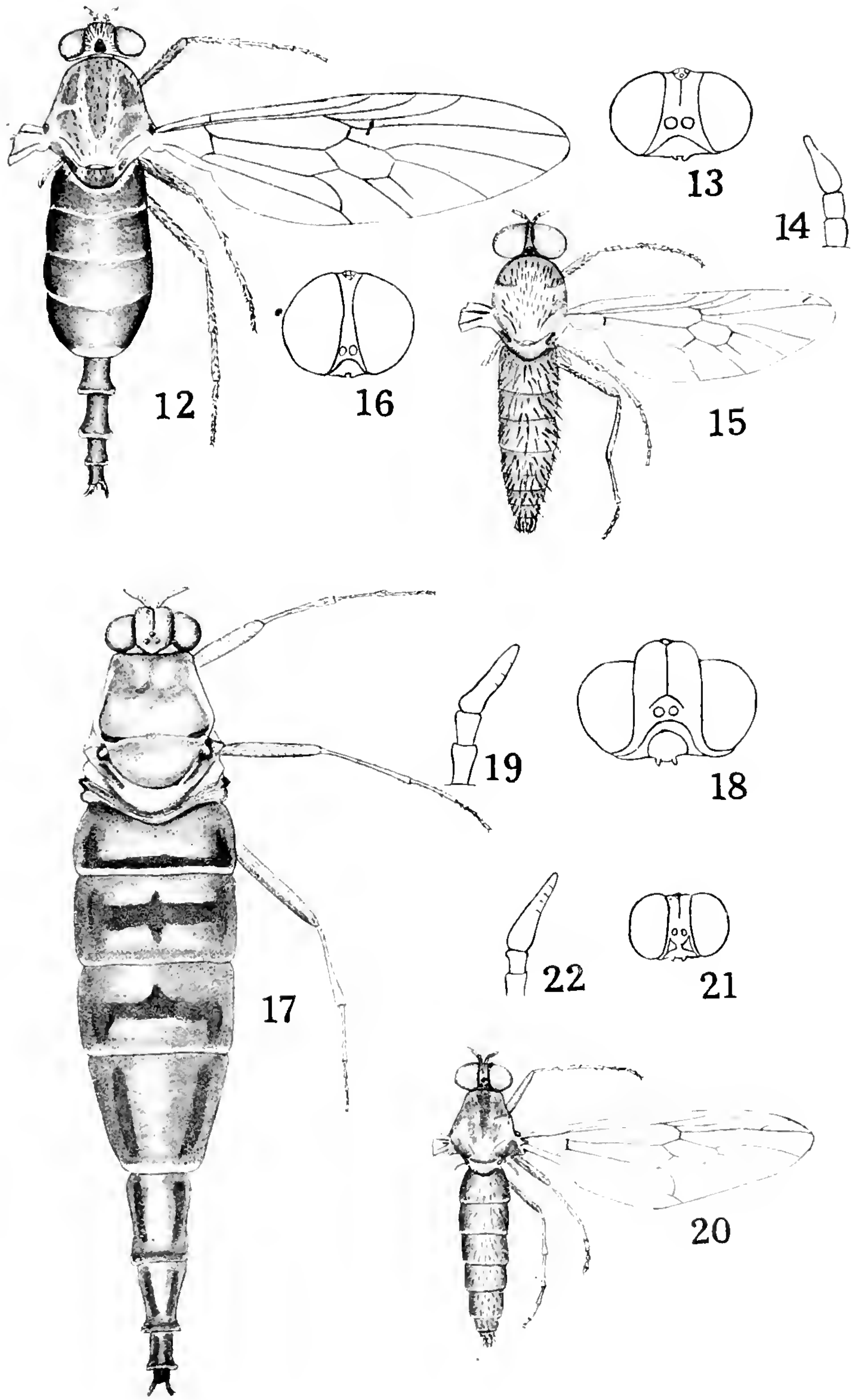
Metamorphosis of *Metoponia rubriceps* Macq.



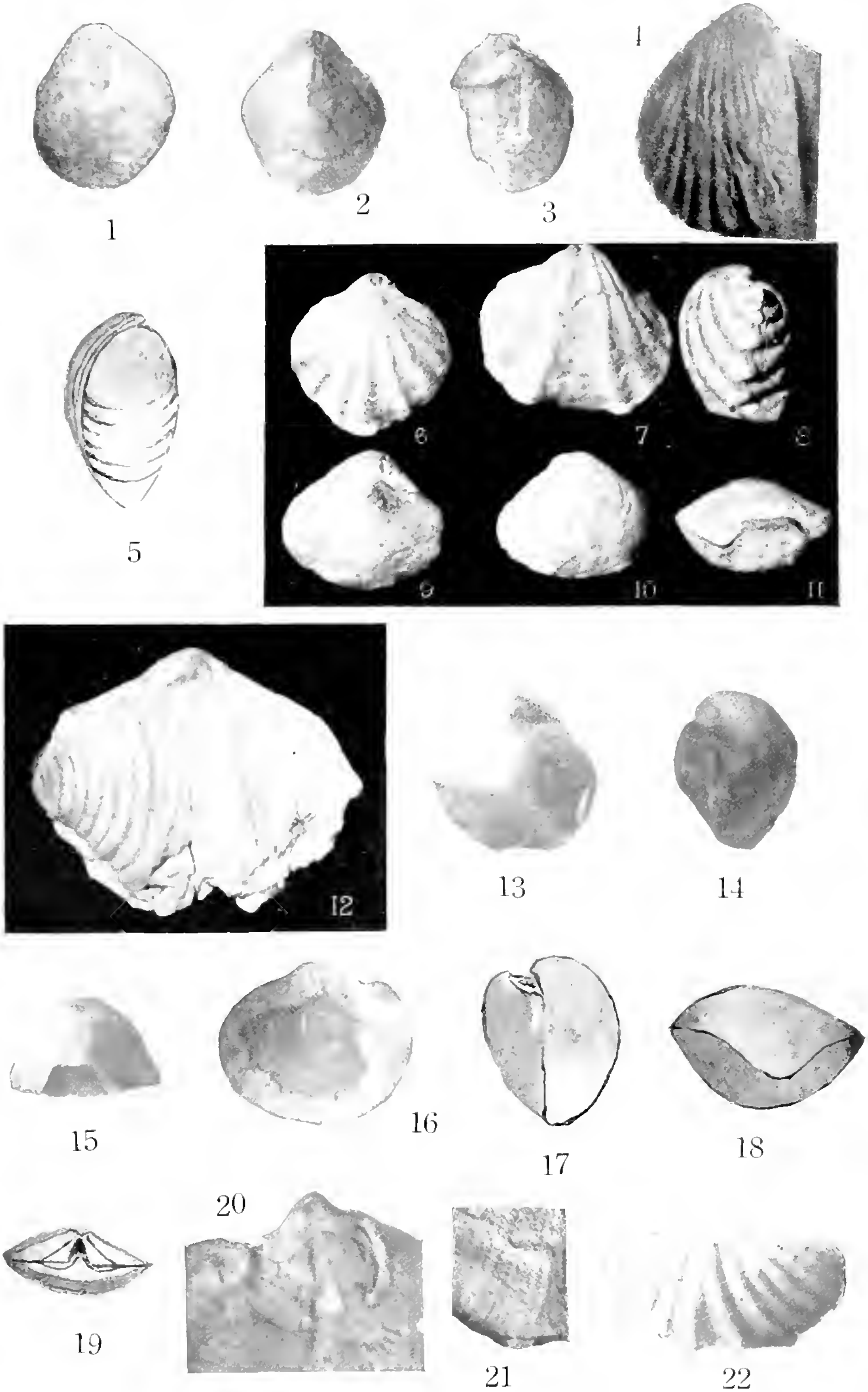
Metoponia rubriceps Macq.



1-4 *Metoponia gemina*, n.sp. 5-6 *M. rubriceps* Macq. 7-11 *Chiromyza prisca* Walker.



12-16 *Chiromyza australis* Macq. 17-22 *Boreoides subulata*, n.sp.



Middle Palaeozoic Brachiopods from New South Wales.

(Issued 25th June, 1920.)

Vol. XLV.
Part I.

No. 177.

THE

PROCEEDINGS

OF THE

LINNEAN SOCIETY

OF

NEW SOUTH WALES

FOR THE YEAR

1920

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[Plates i.-xiii.]

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PROCEEDINGS, 1920, PART 1.

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(Issued 16th August, 1920.)

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Part 2.
No. 178.

THE PROCEEDINGS OF THE LINNEAN SOCIETY OF NEW SOUTH WALES

For the Year
1920

PART II. (pp. 185-317.)
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29*a*. ANDREWS, E. C.—The Geographical Unity of Eastern Australia. Proc. Roy. Soc. N.S.W., xliv., 1910, pp. 420-480.

29*b*. ————Notes on a Model of New England. *Ibid.*, xlvi., 1912, pp. 143-155 (and several other papers by the same author).

EXPLANATION OF PLATES XVII.-XVII*a*.

Plate xvii.—Geological Map of the Currabubula District.
Plate xvii*a*.—Topographical Map of the Currabubula District.

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CORRIGENDUM.

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Page 43, *for* line 18 (fourth from bottom) *read* whether, if one pair of pinnae persists at a certain stage that pair is always the

(*Issued 8th November, 1920.*)

Vol. XLV.
Part 3.

No 179.

THE PROCEEDINGS OF THE LINNEAN SOCIETY OF NEW SOUTH WALES

FOR THE YEAR

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PART III. (*pp.* 317-472.)

CONTAINING PAPERS READ IN

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WITH EIGHT PLATES

[Plates xviii.-xxv.]

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Part 4.

No. 180.

THE

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OF THE

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OF

NEW SOUTH WALES

FOR THE YEAR

1920

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[Plates xxvi.-xxxi.]

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